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Sustainable Development of Aquaculture on the Volta Lake-

A case study of the Asuogyaman District in the Eastern Region of Ghana

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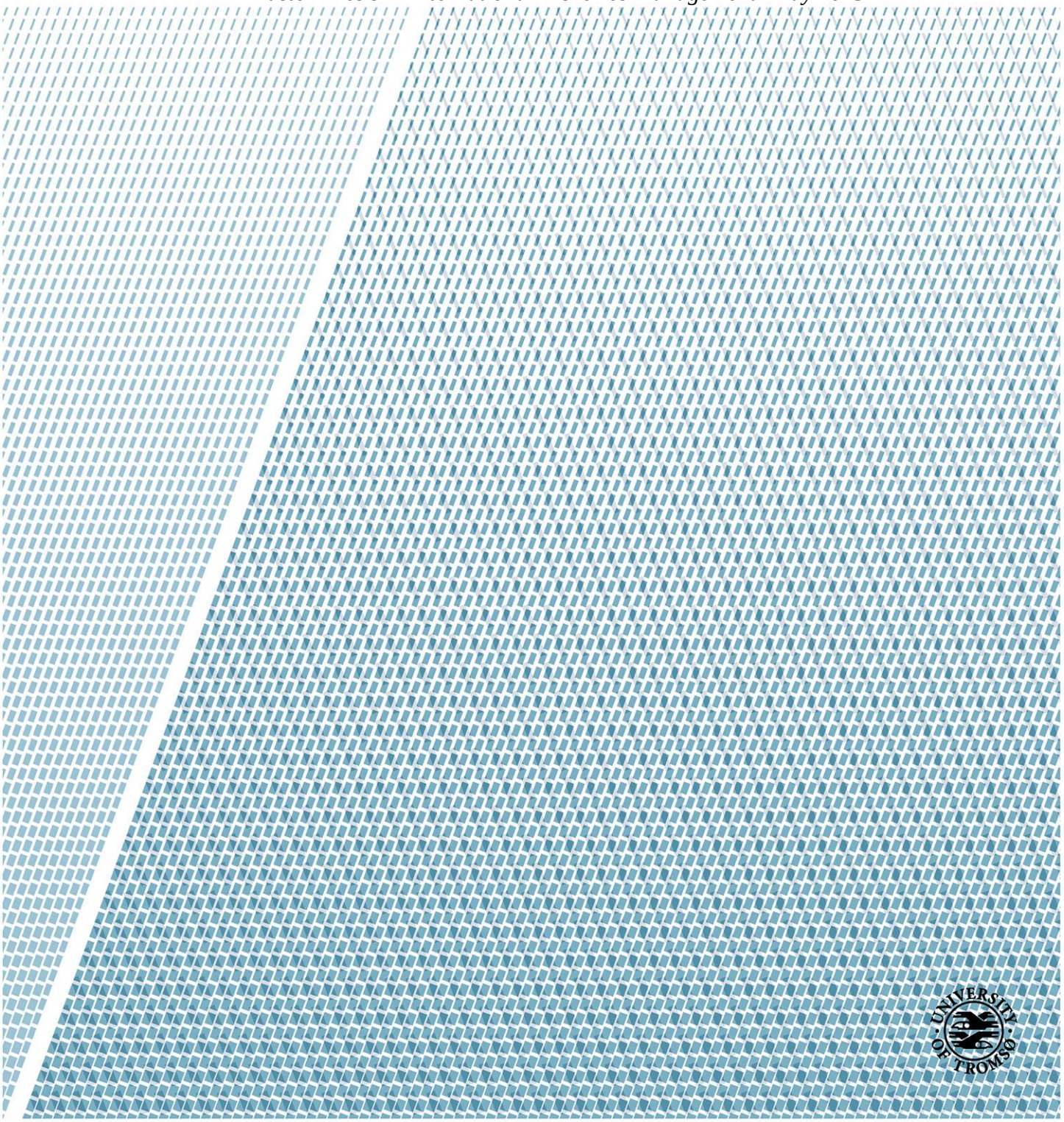

Abstract

Aquaculture in Ghana has been in existence for over 50years. However, it has been less productive despite its high potential for commercial and other scales of production. The Volta Lake presents a huge available resource for the success of cage aquaculture in the country. The cage system of production was introduced in 2001 according to Kasam (2014). This system of aquaculture production even though few numerically happen to be the most efficient production system as compared to the other production systems in the country. It therefore provides the nation with the best option to meet the current demand deficit in fish supply domestically. This reason calls for the need to develop aquaculture on the Volta Lake on a sustainable basis. Data was obtained with the help of a questionnaire based interview from the case study area. This was done in order to know constraints that still plague the development of aquaculture on the Volta Lake. The data collected was analysed with the help of content analysis as described by Liamputtong (2009). Outcome showed that some constraints still existed even though there is a functioning aquaculture strategic framework. The Aquaculture Strategic Framework-Ghana is a set of measures and strategies meant to provide solutions to constraints being experienced by the sector. Results from the field work were compared to the current framework and it was analysed using the SWOT analysis. This was done in order to know to which extent the framework was contributing to the success of aquaculture on the Volta Lake and how it can be improved. It was concluded that in order to transform weaknesses into strengths and avoid threats there is the need for;

1. National policy for aquaculture to be approved in order to enhance the effectiveness of the strategic framework.

2. Inclusion of an implementation plan to the framework during the review process to improve upon the effectiveness of the strategic interventions.

3. National stakeholders to give fisheries and aquaculture priority rather than “politicising” it.

4. Funds to be invested in the sector to support the effectiveness of the framework strategies.

5. To extend aquaculture education to levels lower than the tertiary.

6. A close communication between government institutions and the aquaculture associations.

A SWOT analysis was also used to determine the prospects for the further development of aquaculture on the Volta Lake. It was concluded from the analysis that, there was the need to;

1. Have more fish farmers with aquaculture education and training.

2. Have adequate aquaculture extension officials with access to logistics to operate.

3. Strengthen environmental laws that checks feed administration to fishes, aquaculture activities around the lake and also controlling fish escapes in order to protect the water body and the ecosystem.

4. Monitor the importation of tilapia into the country in order to protect local enterprises.

5. Short term subsidies for input materials and also flexible loans in order to encourage more prospective fish farmers to get into fish farming on the Volta Lake.

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Declaration

I hereby declare that, this thesis is the result of my own original research and that no part of it has been submitted anywhere for else for any purpose. All references have been duly acknowledged and I therefore bear a sole responsibility for any shortcomings.

Derrick Kwame Odei

I hereby certify that this thesis was supervised in accordance with the procedures laid down by UiT the Arctic University of Norway, Faculty of Biosciences, Fisheries and Economics.

Professor Bjørn Hersoug

Supervisor

Table of Contents

List of Figures

List of Tables

Acronyms

AgSSIP- Agricultural Services Sub-Sector Investment Project

CSIR- Centre for Scientific and Industrial Research

EPA- Environmental Protection Agency

FAO- Food and Agriculture Organisation

GAA- Ghana Association of Aquaculture

GAWE- Ghana Association of Women Entrepreneurs

GTZ- Gesellschaft fur Technische Zusammenabeit

KNUST- Kwame Nkrumah University of Science and Technology

MoFA- Ministry of Food and Agriculture

NARP- National Agricultural Research Programme

NGO- Non-Governmental Organisation

SARNISSA- Sustainable Aquaculture Research Network in Sub-Saharan Africa

SME- Small and Medium Enterprises

UCC- University of Cape-Coast

UG- University of Ghana

RW- Rural Wealth

WRC- Water Resource Commission

WRI- Water Research Institute

WTO- World Trade Organisation

UN-United Nations

USAID- United States Agency for International Development

Chapter 1: Introduction

This study will be based on assessing how aquaculture in Ghana can be developed on a sustainable basis. There will be a focus on the case study area; Asuogyaman district located close to the Volta Lake. The aquaculture strategic frame work in Ghana will be assessed on what role it is playing in the sustainable development of aquaculture on the Volta Lake and how it can also be improved. The case study area will provide the basis for assessing the role this strategic framework plays. This can be beneficial in helping the nation meet its local demand for fish products, providing jobs and also being able to provide a potential source of foreign exchange. Information obtained for the study was by; qualitative review of literature, questionnaire based interviews and some quantitative data describing the Ghanaian aquaculture industry.

1.1 Global Impacts of Aquaculture

According to the United Nations (UN) Food and Agriculture Organisation (FAO), aquaculture is the farming of aquatic organisms including molluscs, crustaceans and aquatic plants (FAO 1990). Aquaculture is believed to have started in the fifteenth century in China (Pillay and Kutty 2005). Despite the long existence of aquaculture, its growth has been observed to be very rapid in recent decades compared to capture fisheries and terrestrial farmed meat. There is an estimated over-all growth rate of 11% per year since 1984 compared to 1.4% and 2.8% for capture fisheries and terrestrial farmed meat respectively (FAO 2002; FAO 2003). This growth rate continues to increase. This is supported in a recent publication by FAO (2014) stating that Aquaculture food fish production rose by 5.8% in 2013. Even though the recent growth doesn't seem to be so high as compared to previous years, growth is still evident. This continual increase in production is attributed to; increase in the demand of aquaculture produce, generating profits and income, urgent need for sustainable food supply, increase in scientific, technical and entrepreneurial skills in managing species lifecycles and production environments, and in meeting market and commercial objectives (Barg 1992). This growth may not approach a halt anytime soon due

to these reasons and also due to the fact that the human population keeps increasing and demand for food is still on the rise.

Fish is undoubtedly consumed in almost every part of the world and demand for its consumption is still increasing. According to World Bank (2004), 50% of people in most countries derive their source of protein from fish consumption. Aside from serving as the purpose of consumption, fish may serve as a source of income and livelihood for a large number of people in the world. It is estimated that, 120million people depend on fish for all or part of their incomes (Asmah 2008). All stated above shows how important fisheries are to the socio-economic livelihood of humans.

Aquaculture at the global level has helped to breech the gap in the demand and supply for fish products as a result of the limited increases in capture fisheries (FAO 2003). Currently as obtained from FAO (2014), farmed food fish contributed as much as 42.2% of the total 150 million tonnes produced from capture fisheries (including for non-food uses) and aquaculture in 2013. This is shown in figure 1.1 below;

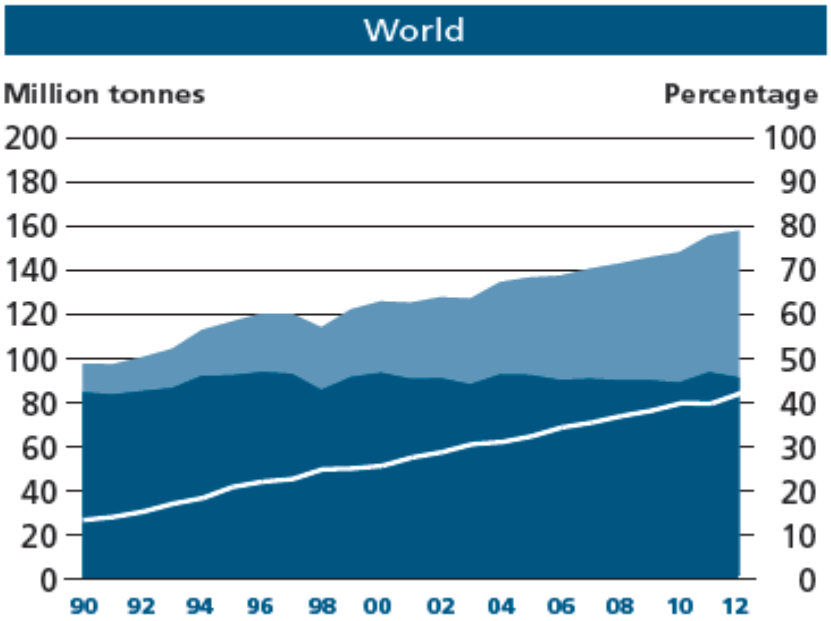

Figure 1.1: A graph showing the world contribution of aquaculture and capture fisheries to total fish production (FAO 2014).

As the human population continues to expand beyond 6 billion, its reliance on farmed food fish production as an important source of protein will also increase (Naylor et al. 2000). This indicates how aquaculture will play an important role in helping to achieve food security globally. Aquaculture also plays an important role in the development of many national economies and a key role in the socio-economic resilience of rural areas, potentially offering valuable and skill-based employment opportunities, and in some cases stabilising the economic base of otherwise fragile communities (Edwards 1999; Haylor and Bland 2001; Muir 1999). This therefore implies the usefulness of aquaculture to the socio-economic development for many developing countries worldwide.

1.2. Impacts of Aquaculture in Ghana

Aquaculture was introduced in Ghana in the early 1950 in the Northern part of Ghana. Currently, it is practiced throughout the whole country but it is more concentrated in the central and southern belt. The main groups of fish species that are farmed in Ghana include; African Catfish (*Clarias gariepinus*) and Nile Tilapia (*Oreochromis niloticus*). 60% of the animal protein intake in Ghana is from fish products (FAO 2006). The average per-capita consumption of fish is thought to be high; at between 20 and 25 kg as the world average consumption is 13 kg (Bank of Ghana 2008). This is seen to be one of the highest fish consumption in sub-Saharan Africa (FAO 2004). This is a clear indication of how important fish consumption is in the life of the average Ghanaian pertaining to food security.

Unfortunately, the fishery sector is not able to meet the consumption demands of fish in the country which was estimated to be around 968,000 metric tons in 2012 according to Modern Ghana (2013)[1]. This has led to the nation spending a lot of money on fish importation. There is an annual fish import of US$ 200 million in Ghana. As a result, the government of Ghana has increasingly been focusing on aquaculture development to compensate the amount spent on importation according to the Ministry of Fisheries in 2005. Source of fish for domestic consumption comes from; marine and inland capture fisheries, aquaculture and imports. There is a current decline in marine capture fisheries, which happens to be the highest source

[1] http://www.modernghana.com/GhanaHome/regions/eastern.asp?menu_id=6&menu_id2=14&sub_menu_id=132&gender= (27.08.2014)

of fish for consumption in the country in terms of tonnage. This decline is observed by viewing the FAO data base which indicates a fall from 490,000 metric tons in 1999 to 330,000 metric tons in 2011. Irrespective of the decline in marine capture fisheries, there has been an overall increase in fish production in the country. According to a database from Ministry of Fisheries and Aquaculture in 2013, fish production increased between 2009 and 2012 from 415,000 metric tonnes to 450,000 metric tonnes respectively. The highest contribution to the overall increase in total fish production is aquaculture. These figures from the Ministry of Fisheries and Aquaculture data base in 2013 attest to the fact that; an increase of approximately 20,000 metric tons originated from aquaculture, 15,000 metric tons from inland fisheries and over 5,000 metric tons from marine fisheries. This has implied that the government needs to go for the option of developing aquaculture in Ghana to meet the increasing demand for fish products due to its rapid increase in production. The government has made important efforts to develop the aquaculture sector in the country. This effort is acknowledged in FAO (2011) that, fish farming has been adopted as an assured way of meeting the deficit in Ghana's fish requirements. This shows an indication of the overall importance of aquaculture in the fishery sector of Ghana. It also provides a strong basis for the need of adopting aquaculture in helping the nation increase production in its fishery in a time where marine capture fishery is increasing at a declining rate. Adopting aquaculture will go a long way in helping the nation meets its demand for fish products and thereby reducing the cost to nation when fish is imported to supplement demand.

Aside from helping to meet demands in fish for consumption, aquaculture serves as a source of employment and livelihood to large numbers of people in the country. According to the WTO (2008) and the National Fisheries Association of Ghana (2004-2005), there are about 1,000 fish farmers in Ghana and over 2,000 fish ponds with a surface area of about 350 hectares. This is just an indication of the direct source of employment aquaculture provides. There is also a source of indirect employment provided through; - processing, distribution and sales of fish from aquaculture. This will go a long way in helping achieve the nation's quest for poverty alleviation if aquaculture in the country is developed and sustained.

Aquaculture may also serve as a potential source of foreign exchange. This can be the case where the nation is able to produce enough for its local demand and also be able to export some to other countries to earn foreign exchange to the state.

1.3 Asuogyaman District

Asuogyaman district is located in the Eastern Region of Ghana. This district was chosen due to its closeness and active involvement in aquaculture on the Volta Lake. In addition, this district was chosen because; according to the Directorate of Fisheries in 2010, cage aquaculture practiced on the Volta Lake is highly concentrated in this district even though it is possible in all other six districts around the Volta Lake. Another reason is also due to the effectiveness of the system of production used in aquaculture in this area compared to the others. The main system of aquaculture production is the cage system. This system provides the best platform for aquaculture in the country to be practiced on a much larger scale. This is because most land-based fish farmers in Ghana practice extensive system (fish pond) where fish are not given high quality feed and as a result the fish production is low (Anane-Taabea 2012). As compared to land based fisheries and others, cage systems of production obviously tend to produce more fishes. This provides the best option for the nation in bridging the gap between the demand for food fish and its availability in the country in the shortest possible time.

1.4 The Concept of Sustainable Development

The term 'Sustainable Development' came into use in policy circles after the publishing of the Brundtland Commission's report on the global environment and development in 1987 (Redclift 2005). This concept points out to the fact that human inhabitants on Earth ought to live responsibly with the notion that some resources are limited and they do not last forever (Pihlstrøm 2010). Sustainable development simply serves the purpose of ensuring that development of resources should be in such a way that it should be able to last as long as possible by protecting the reseource. This can be very useful for the future of a developing country trying to adopt aquaculture.

1.5 Research Questions and Approach

The study was carried out at Asuogyaman district in order to identify limiting factors to the sustainable development of aquaculture on the Volta Lake. These limiting factors will help in assessing the impacts of the current aquaculture policy framework in the country. In order to find out this aim, the following research questions were asked;

1. *To what extent does the aquaculture strategic framework in Ghana help promote sustainable development of aquaculture practiced on the Volta Lake? (based on findings in the Asuogyaman district)*
2. *How can the aquaculture strategic framework in Ghana be improved towards promoting sustainable development of aquaculture on the Volta Lake?*
3. *What are the prospects for further development of aquaculture on the Volta Lake?*

As indicated earlier, in order to answer these research questions, I collected both qualitative and quantitative data. The qualitative and quantitative data obtained were primary, secondary and tertiary based; with the primary data obtained through questionnaire based interviews of fish farm owners while the secondary and tertiary data were obtained through published articles, Fisheries Commission in Ghana and other government websites. The questionnaires were designed based on insights from previous studies on identifying constraints that limits sustainable development of aquaculture on the Volta Lake. The interviews used were both open ended and closed. These were conducted between the periods of June to August 2014. The aim was to interview fish farm owners in the Asuogyaman district on constraints that limit the sustainable development of aquaculture on the Volta Lake.

1.6 Study Format

Chapter 2 of this study will give an in-depth overview of aquaculture in Ghana; production systems, marketing, pricing, organisational and legal framework of aquaculture in the country.

Chapter 3 of this study will give an insight into the case study area; it will also touch on a thorough description of the case study area and why it was chosen. Analysis of the data and

the outcome of the analysed data will also be detailed. This chapter will also give in-depth information on the survey aim and methodology used during field research. The limitations will also be mentioned.

In Chapter 4, a SWOT analysis the Aquaculture Strategic Framework-Ghana will be carried out. The frame work will be assessed on how it is helping to develop aquaculture on the Volta Lake based on the constraints identified in the case study area. Suggestions on how the strategic framework can be improved for sustainable development of aquaculture on the Volta Lake will be made based on the outcome of the analysis.

In chapter 5, a SWOT analysis will be used to identify the prospects that will be required for further development of aquaculture on the Volta Lake.

Chapter 2: The Aquaculture Industry in Ghana

2.1 The Aquaculture Industry in Ghana

As already stated, aquaculture has been in existence in the country since the 1950s. However, there has been a rapid increase in the activity of fish farming in the country in the last decade. This is seen as an opportunity for nation to tap and develop to meet its future fish demand needs among other things that will beneficial to the country and its population.

There are several other farmed fish species in the country but just two are the most dominant in the aquaculture industry. The most dominant of the farmed species are; African Catfish (*Clarian gariepinus*) and Nile Tilapia (*Oreochromis niloticus*). Currently, over 90% of farmed fish in the country is the Nile Tilapia (Kasam 2014).

Figure 2.1: Administrative Map of Ghana showing all 10 regions.

Production in terms of food fish farming is practiced with these main production systems; pond, cage, dugouts (earthen dams) and reservoirs. Out of all these fish farming production systems, the most popular in the country are the pond system and the cage system of production.

The Central belt (Brong Ahafo Region, Eastern Region and Ashanti Region) and the Southern belt (Western Region, Central region, Greater Accra Region and the Volta Region) as seen in figure 2.1 above are dominated by pond and cage system of production.

Out of these two dominant systems of production, it is estimated that over 98% of all the farms in these areas in the southern and central belts are dominated by the pond system of production (Asmah 2008). The pond system of production is far from sophisticated and it is practiced mostly on a small scale. Feed is supplied in a semi-intensive manner and as such requires very little financial resources. The pond culture system of production may exist in different forms with different combinations of fish species with mainly the Nile tilapia. According to Asmah (2008), over 50 percent of these pond fish farms employ a mixed culture involving Nile tilapia with 2 other species; Mud Fish (*Heterobranchus spp.)* and the African Cat fish (*Clarias gariepinus*). About 10 percent of the other fish farms employ the use of Nile Tilapia mixed with Snake Head (*Chana striata*), Heteriotis (*Heteriotis niloticus*) among other species. Others employ only the use of the Nile tilapia or the African Catfish. The most dominant of the farmed fish species in the Ashanti region is the African Cat fish due to the presence of a large market for its consumption.

The cage system of production in the Southern and Central belts in the last decade has become the most dominant production system for tilapia in Ghana in terms of farmed food fish supply. Cage fish farms usually produce tilapia on an intensive basis in terms of supply of feed. (Kasam 2014) claims that, the cage system of production was introduced within the country in 2001.This makes it the last production system to be introduced into the country, it accounts for the least in terms of units of production sites compared to the other production systems. However, it accounts for most productive system in terms of the tonnage of fish harvested. Almost all the cage fish farms are located close to the Volta Lake. The Volta Lake provides readily the best available fresh water medium for the survival of mainly Nile Tilapia. Most cages are made with simple local materials which are submerged in the Volta Lake with growing tilapia secured in them. The majority of the caged fish farms are located in districts close to the Volta Lake in the Eastern Region and the Volta Region as seen on the map in figure 2.1 above.

Fish farming in the northern belts of Ghana (Northern Region, Upper East and Upper West) is quite different from the others in the central and southern belts. Kasam (2014) made mention that, they are mostly found at irrigation sites due to the poor rainfall distribution in this part of the country. A large number of the fish farming practiced in this part of the country is done with dugouts (earthen dams) and the reservoirs. The production is on an extensive basis where little or no feed is supplied.

The dugouts and reservoir system of production as seen in Table 2.1 below is second to the cage system of production in terms tonnage of fish produced. The cage system of production clearly dominates the production as seen in Table 2.1 provided by the Ministry of Fisheries and Aquaculture Development from 2009 to 2012. It is interesting to know however that the cage system of production happens to be the least in terms of units of production sites but it dominates in terms of production. This may be due to its efficiency as compared to the other production systems. It can also be seen that the value of total aquaculture production has almost doubled in these last few years seen in Table 1.1 below. This clearly shows a large potential for the aquaculture industry in the country.

Table 1.1: Production of fish from each production system 2009-2012. (Tons)

Year	Ponds and tanks (metric tons)	Cages (metric tons)	Dugouts, reservoirs and dams (metric tons)	Total production (metric tons)	Value ($)
2009	864	4,912	1,378	7,154	24,605,000
2010	1,093	7,581	1,526	10,200	28,516,000
2011	1,469	16,245	1,378	19,093	50,520,000
2012	1,772	24,249	1,431	27,451	-

Source: Ministry of Fisheries and Aquaculture Development (2013); FAO. (2004–2013). Fishery and aquaculture country profiles: Ghana. In *FAO Fisheries and Aquaculture Department (online)*. Rome: Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/fishery/countrysector/FI-CP_GH/3/en

2.1.1 Limitations

As clearly outlined by Kasam (2014), there may be cases of underestimation, overestimation and a combination of both in the figures obtained by the ministry in the table above. Cases of overestimation were suspected in the cage systems of production. This was because most of the figures were predicted was by looking at the number of cages available and their carrying

capacity instead of the actual fish produced. A case of underestimation was suspected with the pond system of production. Many pond production systems are practiced on a small scale and they are located in very rural areas. As a result of their location a huge number of ponds are not accounted for. The other systems of production may have been underestimated or overestimated in terms of numbers for the same reason as seen on the other production systems or a combination of both.

Regardless of these suspected limitations, the overall impact of aquaculture in the country remains very important with the cage system being in the lead in terms of production potential.

2.2 Marketing of Farmed Fish

Marketing of farmed food fish is usually based on the size of the fish farm. Fish farms in Ghana usually range from; small-scale farms (mostly pond fish farms), Small and Medium Enterprise (SME) cage farms, and few large scale cage farms.

The majority of the small scale fish farms employ the use of the pond system of aquaculture. They have their market target locally based. Products are sold usually fresh and not degutted. Purchasing of farmed fish is usually made at the farm gates. Fishes are purchased by local consumers for their personal consumption. In addition to the purchases made by the local consumers, local fish dealers also make a lot of purchase from these fish farms. They buy the fish, further process it by degutting and sell them at local markets. They also partially store fresh fish by placing ice blocks over the fish in an ice chest in order to keep the fish fresh.

SME cage farms on the other hand like small-scale fish farms sell their products at the fish farm gates. However, their market targets as compared to the small-scale fish farms are quite different. According to Kasam (2014), most of the SME cage farms have their market targets in the three main urban cities; Accra, Tema and Kasoa all located in the Greater Accra Region. The majority of the buyers are located in the urban cities mentioned above. The buyers are also owners of cold stores and sometimes restaurants in the big urban cities. Most of the fish dealers make large purchases from the gates of the SME cage fish farms and transport them to these urban cities to sell them to the customers and also store them in their cold stores for later sale. Fishes purchased are degutted and sold to retailers and consumers who are usually located in the urban cities.

There are very few large-scale fish farms in the country. Currently, there are two main large scale fish farms in Ghana according to Kasam (2014); West African Fish and Tropo Farms. In terms of marketing, the methods employed by these two farms are quite different. West African fish is said to sell fish twice a week at a locally set up market in a town called Asikuma (ibid). Fish dealers and consumers from local and urban areas can make purchases in the local market.

Tropo Farms on the other hand do not have a local market like the West African Fish. Instead, all harvested fish is sent to the three urban cities in the south (Kasam 2014). They are sold fresh on ice, degutted both whole sale and retail on a daily basis (ibid).

Ghana is currently not able to meet its local demand for fish in general, whether farmed or captured. As such, farmed food fish produced locally is consumed locally and the excess demanded is imported. The country is currently yet to export farmed fish.

2.3 Pricing of Farmed Fish

There is no specially set up system for the pricing of fish products in the country. Pricing is usually set by larger farms and also the prices of farmed fish usually depend on the total cost involved in production. Hence, there is a usual trend for pricing of fish in the country usually depending on the system of production. This is shown below;

African Cat fish which is of high demand in the Ashanti Region is priced at approximately (7Ghana Cedi) which is $3.27 per kilogram according to the exchange rates as of 2008 (Asmah 2008). This type of fish is usually produced with the pond system of production. Tilapia produced from the pond system of aquaculture is usually priced at 6 Ghana Cedi per kilogram regardless of the size (ibid). SME caged fish farms usually derive their prices based on those set by the large-scale fish farms.

According to Kasam (2014), commercial or large-scale fish farms grade the fish in terms of size and price their fishes and sell them per kilogram. The prices and grade size per kilogram are as follows; Size 3 = 650g and above, Size 2 = 450g-500g (about two pieces of fish per kilogram), Size 1 = 300g-400g (about three pieces of fish per kilogram), Regular size 250g-300g (about four pieces of fish per kilogram) and the Economy class less that 250g (about five to six pieces if fish per kilogram).

All these sizes stated above have their respective prices. These prices may vary on a yearly basis. For instance in 2012, the price of fish for Size 1 farmed tilapia was 6.5 Ghana Cedi per

kilogram (Asmah 2008). In August 2013 however, the SME cage farm had the price of tilapia as follows; Size 3 = 9 Ghana cedi per kilogram, Size 2 = 8 Ghana cedi per kilogram, Size 1 = 7.4 Ghana Cedi per kilogram, Regular size = 6.5-6.9 Ghana Cedi per kilogram and Economy = 5-5.5 Ghana Cedi per kilogram (Kasam 2014).

2.4 General Inputs for Aquaculture

Inputs for aquaculture are made up of; fingerlings to stock the production system, feed for the fishes and the materials for the production technology especially in the case of the cage fish farms.

Fingerlings are juvenile fishes that grow rapidly. They are usually bought from hatcheries to stock ponds, cages and the other production systems. Fingerlings are fast growing and also experience a great amount of mortality if inadequate care is provided. Like any other aquaculture farm around the world, fingerlings are a very important component of a fish farm. In Ghana for instance, fingerlings bought for production depends on the type of production system and the capital at stake. The small-scale pond fish farms obtain their fingerlings from relatively cheap sources. For instance, fingerlings for production are obtained from other farmers or from the wild. Such fingerlings are usually not of the best quality. This clearly shows why this system of production performs poorly as compared to the others, especially the cage system of production irrespective of their numbers in operation.

Some of SME cage fish farms and most of the large-scale fish farms usually produce their own fingerlings. SME cage fish farms that do not produce their own fingerlings make purchases from recognised private and government hatcheries. According to Kasam (2014), the number of private hatcheries has increased in recent times as a result of the rapid growth in cage fish farms. Cage fish farms depend heavily on hatcheries due to the capital intensive nature of their farms; as such they cannot take the risk of buying fingerlings from other farmers or taking fingerlings from the wild. There has also been an increase in terms of productivity of the government-funded hatcheries as well as in response to increased cage fish farms in the country. In 2005, there was an estimated seven hatcheries in Ghana; made up of three public and four private hatcheries (ibid). Out of these factories, three of them produce only tilapia fingerlings, two of them produce only catfish fingerlings and the other two produce a combination of both species. There was a rapid growth in 2012, this led to a

total of 12 new hatcheries making up a total of 19 hatcheries in Ghana (ibid). This was in response to the increase in caged fish farmers. Hence, there has been an increase in demand for tilapia fingerlings. Out of this number, there were a total of three public hatcheries and 16 private hatcheries. 15 of these hatcheries produce only tilapia fingerlings and the other four produce both catfish and tilapia as at 2012. This is further simplified in Table 2.1.

Table 2.1: Supply of Tilapia and Catfish fingerlings between 2005 and 2012

Year	Public hatcheries	Private hatcheries	Total
2005	261,900	6,583,000	6,844,900
2006	1,420,200	11,024,150	12,444,350
2007	1,927,830	14,556,056	16,483,886
2008	1,266,900	43,733,060	44,999,960
2009	1,361,000	41,301,907	42,662,907
2010	998,000	8,112,500	9,110,500
2011	1,583,000	34,847,390	36,430,390
2012	16,144,030	63,236,239	79,380,269

Source: Abban, E.K., Asmah, R., Awity, L., and Ofori, J.K. (2009). Review on national policies and programmes on aquaculture in Ghana. SARNISSA. Retrieved from www.sarnissa.org; Ministry of Fisheries and Aquaculture Development. (2013). 2012 annual report. Accra, Ghana: Ministry of Fisheries and Aquaculture Development.

It is obvious from the figures above that private hatcheries in Ghana produce more fingerlings as compared to the public hatcheries. This increase in the total production capacity of the hatcheries over the years plays a very vital role in the sustainable development of aquaculture in Ghana.

Another important aquaculture input is the floating feed. It is very vital especially in intensive system of production employed by mostly the cage system of production. Feed takes up the most capital in a cage aquaculture enterprise be it SME or Large-Scale. Floating feed was imported into the country between 2005 and 2012 from Ranaan a feed factory in Israel (Kasam 2014). During this period, access to floating fish feed in the country was greatly limited and not reliable. The cost of imported floating fish feed was far from moderate, making SME and Large-Scale fish farmers suffer. After 2012 however, Ranaan Feed Mill

Industry from Israel set up a factory in Ghana. The set up of this factory provided relieve for the cage fish farms in the country. This was due to the difficulties and the cost experienced by the fish farmers in obtaining floating fish feed. The Ranaan Feed Mill Industry provided floating fish feed at lower prices than for imported feed. The feed factory was set up in a town close to the largest urban city Accra. This was so to make sure the feed factory is not so far away from its market; pond fish farms, SME cage farms and the large-scale farms located in the southern and central belt of the country. Not only does Ranaan produce for Ghana, it also exports some of its feed to Nigeria. Currently, Ranaan's feed factory produces 1,300 metric tons per month for both Ghana and Nigeria (Kasam 2014). It also has the capacity to produce twice the current amount per month. This may be very vital for the potential expansion of aquaculture in the country. In recent times, the price of local floating feed produced by Ranaan has increased since its establishment. The main reasons cited for this refers to the, increase in price of soya bean in the country. Another potential reason is the poor performance of the local currency. Despite the cost, feed is readily available and accessible in most parts of the country due to the opening of several feed depots in several parts of the Southern belt especially in the Eastern and Volta region of the country.

The most sophisticated production system that requires the most effort and funds in construction is the cage system of production as compared to the other systems. The main materials required for cage constructions are; beams, nets, floating rafts, an anchor and wood. Setting up this production technology requires keeping the fish in netted enclosures that are kept open on the surface and floating with the help of rafts attached to beams (Beveridge 1984). This is then secured to the bottom of the water with the help of the anchor and there is also a wooden walkway to make access to the cages for the purpose of feeding and other management purposes (ibid). SME cage farmers are able to get these materials, which are locally manufactured or imported.

2.4 Organisational Setup and Legal Backing

Politics play a vital role in the organisational framework of aquaculture in Ghana. Fisheries and aquaculture used to fall under the umbrella of the Ministry of Food and Agriculture (MoFA) in Ghana until 2005 after a new government was voted to power. It was referred to as the Directorate of Fisheries (DoF), which also used to exist as the Fisheries Department.

The government in power deemed it necessary to set up a separate Ministry of Fishery after 2005. This ministry was in operation until the elections in 2008. After the elections in 2008, there was a change in government and the separate Ministry of Fishery created was fused back into the Ministry of Food and Agriculture. The most recent election, which took place in Ghana, was in 2012, where the current ruling party retained power but a new president was elected. This current government decided to set up a separate Ministry of Fisheries and Aquaculture Development in 2013. This new formation draws attention to the fact that there is the need for aquaculture to be developed. The name of this new ministry indicates the importance of the development of aquaculture in the country.

Working closely with the Ministry of Fishery and Aquaculture Development is the Fisheries Commission of Ghana. The Commission plays a very important role in managing and governing fisheries and aquaculture in Ghana over its years of existence. The Fisheries Commission in Ghana has been in existence for close to two decades. It was set up in 1993 to advice the Ministry of Food and Agriculture or the Ministry of Fisheries and Aquaculture Development pertaining to the sustainable exploitation of fisheries resources in the country (Kasam 2014). The Fisheries Commission of Ghana is an autonomous body even though it is funded by the government. The Fisheries Commission of Ghana has offices in all ten regions in the country and they are responsible to provide free technical advice to all prospective fish farmers and current fish farmers with technical advice through extension services at the district and regional levels in the country. The Fisheries Commission of Ghana is undoubtedly the most important fishery organisation in the country. The commission works together with other important organisations to manage fisheries in Ghana.

The scientific and research aspect is not excluded in the organisational setup of fisheries in the country. The Water Research Institute (WRI) located in Akosombo in the Eastern Region of Ghana is publicly funded for one of the Nation's largest scientific research institution in the Ghana; Council for Scientific and Industrial Research (CSIR). They are responsible for aquaculture research and development on the Volta Lake (Kasam 2014). WRI was set up in Ghana in 1991. Aside for research, they are also responsible for the provision of technical support and also sometimes providing fingerlings for sale to fish farmers. Another activity performed by the WRI according to Kasam (2014) is their genetic improvement program which was done in collaboration with World Fish Centre which has led to development of a much faster growing tilapia strain (grows 30% faster than the indigenous Nile Tilapia) called

the "Akosombo Strain". This has helped in boosting production of tilapia and the overall aim to develop aquaculture in the country.

International organisations also play a very important role in aquaculture in the country. The most notable among them are the Food and Agricultural Organisation (FAO) of the United Nations (UN) and The World Bank. FAO for instance, played a very important role in the drafting of Ghana's Fisheries and Aquaculture policy in 2008, which is yet to be approved. The World Bank through its National Agricultural Research Programme (NARP) and Agricultural Services Sub-Sector Investment Project (AgSSIP) supported aquaculture research and development activities from 1994 to 1998 and from 2000 - 2006/7 (Asmah 2008).

There are also few Non-Governmental Organisations (NGOs), which contribute to aquaculture development. Notable among these are Rural Wealth (RW) and Ghana Association of Women Entrepreneurs (GAWE), which have been known to be engaged with people in aquaculture (Asmah 2008).

In addition to the organisational setup of aquaculture in Ghana, there is also a very important legislative arm. The Environmental Protection Agency (EPA) is responsible for granting licence for operation to operate to prospective fish farmers. License to operate is granted based on an Environmental Impact Assessment required by the fish farmers through the Water Resource Commission (WRC) of Ghana. The WRC is responsible for the management and the use of natural water bodies in the country for any activity.

The main legislative arm for fisheries and aquaculture in the country is the Fisheries Act of 2002. The act works together with the Fisheries regulation of 2010, responsible for fisheries and aquaculture sectors in the country.

Another legislative arm in the country is the EPA Act of 1994. This Act seeks to make sure that the environment is kept safe in the presence of aquaculture activities. Working together with this Act is the Environmental Assessment Regulation of 1999 which makes mention of the fact that both of the main systems of aquaculture in the country (pond and cage) need to undergo Environmental Impact Assessment before certification for operation is awarded (Abban et al 2009). Despite the presence of these organisational and legal frame-works present in the country, one will think it is just normal that there will be a national aquaculture policy that will be guiding the activities of these organisations and institutions. 2008 According to Abban et al. (2009) Ghana has until 2008 not had a complete policy document. However, there is now a complete draft policy document, which is yet to be approved by the

parliament (ibid). In the absence of an aquaculture sectorial policy document, a national aquaculture development framework was launched in 2006 and aquaculture development programmes linked to other national projects have been instituted and used (ibid). This framework is dubbed, 'Aquaculture Strategic Framework- Ghana'.

2.5 Constraints in the Ghanaian Aquaculture Industry

This aquaculture industry however have many constraints associated with it. This may be regarded as the reason why Ghana has not been able to meet its national objectives of fish production. The nation has an overall objective of developing production in aquaculture in order to meet its local demand for fish that will help reduce importation costs incurred by the nation, creating jobs to alleviate poverty and also the potential for obtaining foreign exchange if the nation is able to export products from aquaculture. Even though aquaculture in the country is very capable of meeting these objectives, there are several constraints experienced in the sector limiting its ability to be developed in order increase productivity on a sustainable basis. Previous studies carried out by Hiheglo (2008) and Anane-Tabea (2012) clearly mentions some of these constraints such as, lack of production input factors, cost of production input factors, lack of credit for production, and poorly organised markets among others.

If these constraints are addressed and corrected, aquaculture development in the country will be more capable of being developed on a more sustainable basis to meet the nation's objectives.

Chapter 3: Asuogyaman District and the Field Work

3.1 Case Study Area: Asuogyaman District

This study was carried out in Ghana with a focus on the case study of Asuogyaman District in the Eastern Region of Ghana. The main focus of this study was on aquaculture on the Volta Lake (seen in Figure 2.1 in Chapter 2) where the cage aquaculture system of production dominates. The 8,502 km^2 Lake presents enormous opportunities for aquaculture expansion (ILEC 1999). Aside for expansion, this Lake also presents the opportunity for aquaculture in the country to be practiced on a more commercial basis. According to Modern Ghana, the Eastern Region has an area of 19,323 square kilometres. It occupies 8.1 percent of the total land area of Ghana and it is the sixth largest region of the country. The region has a total of 2,106,696 inhabitants, representing 11.1 per cent of Ghana's population. It is also the third most populous region, after Ashanti and Greater Accra. The region has 17 administrative districts, with Koforidua as the regional capital. There are 26 parliamentary constituencies for the election of the region's representatives to the National Assembly/Parliament. The political administration is decentralized into a system of district assemblies and the Regional Co-ordinating Council. The District Assemblies, in turn, are decentralised into Local/Area Councils and Unit Committees.

Figure 3.1: Map of the Eastern Region of Ghana indicating the location of the Asuogyaman District. (Indicated by the red demarcation).

The Asuogyaman district; seen in Figure 3.1 above forms part of the 17 districts in the Eastern Region. Asuogyaman District happens to be the area of interest for this study. According to the Asuogyaman District Assembly on its official website, Asuogyaman District Assembly forms part of the twenty six (26) Municipalities and Districts in the Eastern Region of Ghana. It covers a total estimated surface area of 1,507 km^2 and constitutes 5.7 percent of the total area of Eastern Region. The Administrative capital of the District is Atimpoku. The District shares boundaries with Lower ManyaKrobo District and Upper ManyaKrobo District to the west, to the east with North Tongu District, to the north with Afram Plains South and to the south with Dangme West District. The district has been divided into two (seen in Figure 3.1 below) by the Volta Lake (the largest man-made lake in the world). According to the district chief executive Mr. Thomas Ampen Nyarko, numerous chains of mountains covered with thick and green vegetation create a serene environment along the banks of the Volta River, and as a result, most of the resort centres are located along the banks of the river. This may serve as a means of tourist attraction for the district.

Due to the presence of the Volta Lake in the region however, fish farming on a commercial basis has been regarded as having a great potential in this district due to the water having conditions suitable for aquaculture production. Members of this district are heavily into agriculture and wild fishing on the Volta Lake. The most notable of the structures in this district due to the presence of the Volta Lake is the fact that it houses the largest hydroelectric dam in the country. This dam provides electricity for the entire country and even neighbouring countries. Aquaculture as stated already is seen to have a large potential in this district due to the presence of the lake and the conditions the lake provides. According to the Directorate of Fisheries (Dof), aquaculture is possible in six other districts around the Volta Lake but the Asuogyaman district seems to dominate. This was the main reason why this district was selected as the area of study for this survey. As such, I believe that the constraints identified in this district will not be so different from issues identified in the other district where cage aquaculture on the Volta Lake is practiced.

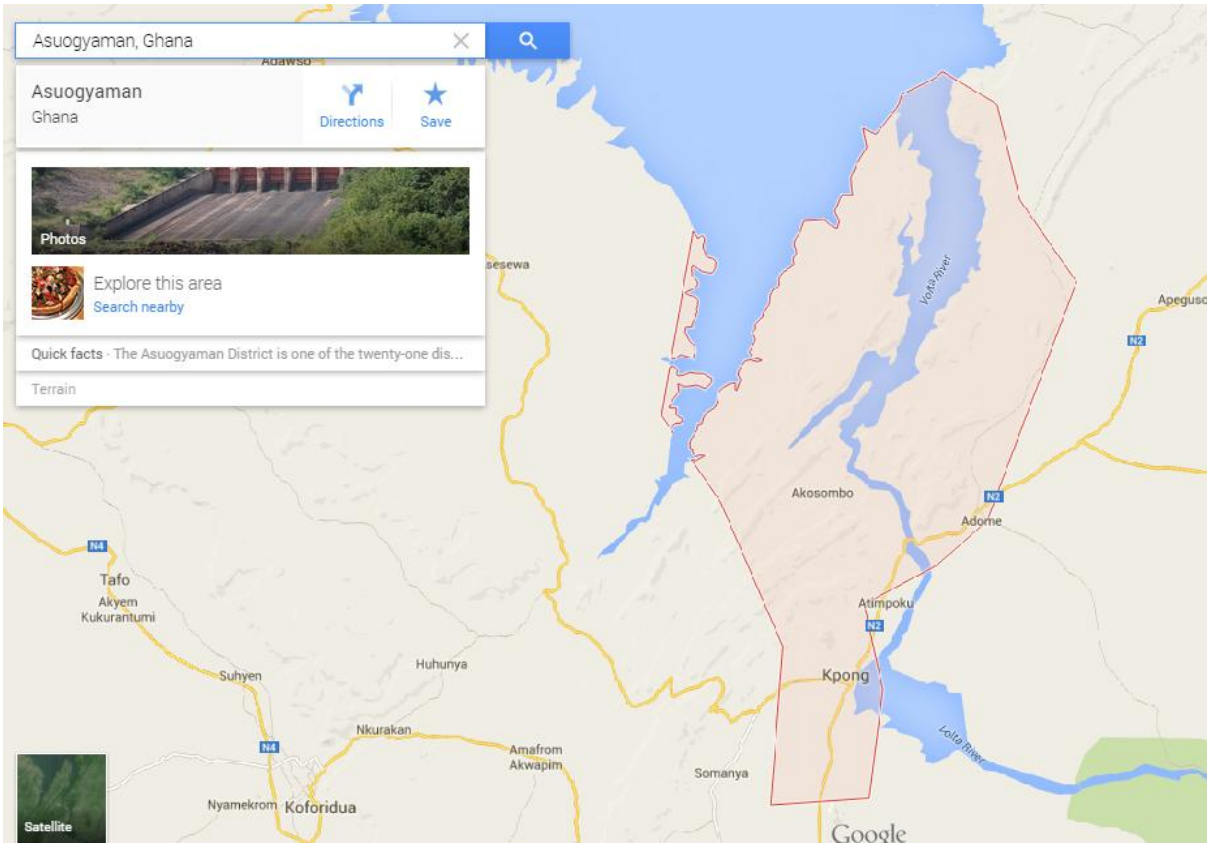

Figure 4.1: Map of the Asuogyaman District (indicated by the red demarcation) showing a clear division of the district into two by the Volta Lake.)

3.2 Sources of Data

There was both a primary and secondary source of data. The primary source came from questionnaire-based interviews carried out during farm visits. The secondary source of data came mainly from the Office of the Inland Fisheries and Aquaculture division of the Fisheries Commission of Ghana located in the district and the head office in the capital, Accra. Access to farmers on their farms would not have been possible without the help of officers from the Fisheries Commission stationed in the Asuogyaman district. I carried out the questionnaire based interviews personally to ensure that I was present to help explain if a farmer had difficulty in understanding some of the questions asked. At the time of the interview, there were about 20 cage fish farms in the district according to information obtained from my personal enquiries from officials from the Fisheries Commission based in the district. My main aim was to talk to as many of the fish farmers as time would allow me. I carried out interviews on farms situated at both sides of the Lake. I was able to talk to 16 fish farmers.

There was an element of "snowball" method of random sampling of respondents whereby the first respondents recommended me to some their friends who are also fish farmers.

3.3 Questionnaire Based Interviews

In this type of survey instrument, I designed a questionnaire whereby all questions asked during the interview followed the list of questions in the questionnaire. Questionnaires were not given out but I filled them in person based on the answers provided by the respondents. The questionnaire-based interview touched on areas that addressed issues of constraints that limited sustainable development of aquaculture on the Volta Lake most of which had been identified by Anane-Tabea (2012) and Hiheglo (2008). The constraints identified in this district will be analysed in order to know to which extent sectorial policies help promote sustainable development of aquaculture on the Volta Lake and also how the sectorial policies can be improved. The questionnaire-based interview was made up of both open-ended and closed questions. Questions asked touched on issues such as; how easy it was to start a fish farm on the Volta Lake, the cost and ease of gaining access to inputs used in running production and starting a fish farm on the Volta Lake, how easy it is to gain access to the production sites, access to extension services, ease of access to markets for the sale of harvested fishes, insurance of farms, and the knowledge of sectorial policies.

Answers to questionnaires in terms of costs constraints were ranked from 1-7; where '1- perfectly unacceptable' to '7- totally acceptable'. Answers to Questions in relation to accessibility constraints to production input capital, materials and equipments, the Lake for fish farming, labour, feed, fingerlings, loans, and extension services from the government were ranked from 1-5. '1- strongly disagree and 5- strongly agree'. In some cases there were polar questions, which had a follow up questions to further elaborate on an answer given.

3.4 Data Analysis

The main method used in the analysis of the data is called the content analysis. It is described in Liamputtong (2009) as the first level of data analysis and the simplest way of analysing a qualitative research as it is in the case of this study. This method of analysis employs

counting and making deductions out of it. Also, *content analysis* according to Bryman (2008: 275) is an analytic approach that attempts to quantify content in terms of predetermined categories in a systematic and replicable manner. The main steps involved in content analysis according to Kellehear (1993a) and Silverman (2001) are:

1. Develop categories before looking for them in the data.

2. Chose the sample to be categorised

3. Systematically record, or count the number of times the categories appear.

In this research however, categories are going to be made based on the constraint identified. From the list of constraints, I categorised them into, access constraints, cost constraints, quality constraints and other constraints. Responses received from each constraint category is counted and recorded as their frequency and their corresponding percentage was also calculated. Looking at the range of rank for the answers produced during the interview, I had to simplify them. For instance, in terms of the cost constraints which usually had their answers ranked between; 1-7 any response from 1-3, being categorized as 'Unacceptable' that of 4 as 'Moderate' and answers in the range of 5-7, being classified as 'Acceptable'. The access constraints had its response ranked from 1-5. All responses from 1-2 are categorized as 'Disagree', 3 is 'Indifferent' and answers that fall within the rank from 4-5 as 'Agree'. Other answers that had 'Yes' or 'No' simply has 'Yes' for 'Agree' and 'No' for 'Disagree' with nothing for 'Indifferent'. Total frequencies from the 16 respondents from the farmers in the district were recorded and corresponding percentages of each of the responses were also calculated using simple statistics. The results from the fieldwork are shown below;

3.4.1 Results

Table 3.1: Access constraints

Constraints	Frequency			Percentage		
Categories	Agree	Indifferent	Disagree	Agree	Indifferent	Disagree
Easy access to Loans	0	3	13	0	18.75	81.25
Easy access to Lake	16	0	0	100	0	0
Easy access to operating licence	2	1	13	12.5	6.25	81.25
Easy access to cage equipments	12	0	4	75	0	25
Easy access to fingerlings	13	0	3	81.25	0	18.75
Easy access to market	16	0	0	100	0	0
Easy access to Extension Services	3	1	12	18.75	6.25	75

Table 4.1: Cost Constraints

Constraints	Frequency			Percentage		
Categories	Acceptable	Moderate	Unacceptable	Acceptable	Moderate	Unacceptable
Equipments	2	6	8	12.5	37.5	50
Fingerlings	5	2	9	31.25	12.5	56.25
Feed	0	0	16	0	0	100
Labour	16	0	0	100	0	0

Table 5.1: Quality Constraints

Constraint	Frequency			Percentage (%)		
Categories	Good	Fair	Poor	Good	Fair	Poor
Fingerlings	10	4	2	62.5	25	12.5
Feed	12	4	0	75	25	0

Table 6.1: Other constraints

Constraints	Frequency			Percentage (%)		
Categories	Agree	Indifferent	Disagree	Agree	Indifferent	Disagree
Knowledge of Framework	4	0	12	25	0	75
Insurance for Farm	0	0	16	0	0	100

3.4.2 Summary of Results

From the results in the tables above made up of access constraints, price constraints, quality constraints and other constraints; it is still obvious that some of these constraints still persist. Looking at the access constraints in Table 3.1 above; 81percent of the respondents disagree that there is an easy access to loans. 19 percent of the total respondents were indifferent about how easy it is to access loans made up the remainder. The reasons they gave were mainly due to the fact that they were not aware of any credit institutions willing to provide loans to prospective fish farmers. Most of the respondents who said they were indifferent felt the loans even when accessible had a large interest on them. Hence, prospective fish farmers have little or no motivation to take loans to start business.

Another access constraint which seemed to still persist looking at Table 3.1 above, is the access to farming operating license. It can be seen that 81percent of the respondents disagree that there is an easy access to the operating licence. The reason cited by the respondents was due to the complicated bureaucracy involved in obtaining the license. Others also made

mention that; even though it is difficult to obtain the license to operate authorities still give them go ahead to operate as long as application to obtain license has been submitted to authorities. This is to make up for the long time it takes for the long time it takes for the actual license to given. The other 13 percent of the respondents think it is easy to obtain the operating licence but they feel the cost of obtaining the operating license.

In terms of access to extension services where by farmers will receive some amount of technical advice from well trained staff from the Fisheries Commission concerning aquaculture practices; 75 percent of the respondents disagree that there is an easy access to extension services. Six percent of the respondents are indifferent based on the fact that, they feel extension services are available but they believe there is fewer trained staff from the fisheries commission to perform this function. The other 19 percent agree that extension services were readily available.

Access constraints which seemed not to be much of a problem amongst the respondent were; easy access to market, easy access to cage fish farm equipment and also easy access to fingerlings.

From the cost constraint in Table 4.1, 88 percent of the total respondents felt the cost of the equipment required for the construction of the caged fish farms ranged from 'Moderate' to 'Unacceptable' with 50 percent saying its unacceptable and 38 percent feel the price is moderate. The remainder made up of 13 percent of the respondents found the cost of these equipments for setting up the production system acceptable.

Looking at the response given on cost of fingerlings in the cost constraint table (Table 4.1) 69 percent of the respondents thought the cost ranged from moderate to unacceptable with 56 percent finding the price unacceptable and 13 percent felt the cost was moderate. The rest of the 31 percent of the respondents found this cost acceptable. The main cost constraint identified in this category was the cost of feed. 100 percent of the respondents felt the cost of feed was unacceptable. Some cited the reason due to the poor performance of the local currency against foreign currency. One constraint that seemed not to be a problem was the cost of labour. 100 percent of the respondent felt the cost of labour was perfectly acceptable.

In Table 5.1 there seemed to be very little wrong with the quality constraints in both the feed and fingerlings for production. The majority of the respondents believe feed and fingerlings for production had their qualities falling between the ranges from fair to good.

Table 6.1 is made up of other constraints. Fish farmers knowing more about the policies that are in place for their business will be beneficial to them to some extent. Knowledge of the

policies in place for the sector will help them to tap into and benefit from the sectorial policies. It was interesting to know that, about 75 percent of the farmers had no idea of the aquaculture sectorial policies in place whiles a minority 25 percent had some knowledge of sectorial policies in place. Insurance which I believe is very important for fish farms in times of natural disasters, fish kills or broken nets were of least importance to fish farmers. 100 percent of the farmers did not agree on having insurance on fish farms. This answer may be explained by the fact that the respondents were operatives and not the actual owners of the farms.

3.4.3 Limitations

The main limitation to the response given from the interviews was a result of the fact that most of the respondents were care takers instead of actual farm owners. The main aim of the study was to interview farm owners on the issues of constraints in setting up and running an aquaculture venture on the Volta Lake. Unfortunately, getting access to the actual farm owners proved to be challenge because they all lived in the bigger cities far from their farms. So I had no other option than just to interview caretakers/operational managers. Caretakers /operational managers might know a lot about constraints but it is very possible that the answers they provide might vary slightly from those of the actual owners.

Chapter 4: SWOT Analysis of the Aquaculture Strategic Framework-Ghana

4.1 Aquaculture Strategic Framework- Ghana

In the absence of an approved national aquaculture policy framework, the Aquaculture Strategic Framework-Ghana has been used in development projects of aquaculture in the country. The strategic framework was launched in August 2006 but its conceptualisation and development started in 2003 (Abban et al. 2009). Normally, a strategic framework for development of this nature would have been derived from an existing national policy (ibid). Instead, this framework is directly linked to developing the aquaculture subsector in the country (ibid). The framework had two main developing partners, FAO and GTZ (Deutsche Gesellschaft fur Technische Zusammenarbeit) a German organisation. FAO played a more technical role in the development of this document whiles GTZ provided the financial support in the publishing of the strategic framework document.

The framework document is to identify major issues of limitations or constraints to the development of aquaculture in Ghana. This implies that constraints or limitations identified should come from all forms of aquaculture activities in the country irrespective of the scale and system of production. Solutions to constraints or limitations identified are provided by the strategic framework. The constraints highlighted by the Aquaculture Strategic Framework-Ghana are listed as; input constraints, institutional issues, educational and training issues (Abban et al. 2009). Solutions to the identified constraints, in other words called the 'strategic interventions' are derived from consultative meetings carried out with stakeholders in the aquaculture sector from all parts of the country (ibid). The outcome of the discussions carried out is called the 'real' strategic framework (ibid). The 'real' strategic framework is the best strategy agreed upon to implement in order to address and solve constraints or limitations identified. If implemented effectively, it could lead to the overall sustainable development of aquaculture in Ghana irrespective of the system of production.

In this study however, a list of the usual constraints identified by Hiheglo (2008) and Anane-Tabea (2012) in previous studies carried out in respect to aquaculture in Ghana was investigated to know which of these constraints still posed to be a limitation to cage aquaculture development on the Volta Lake. Most of these constraints clearly fall under the list of highlighted constraints by the strategic framework. The study area as already stated in

Chapter 3 is the Asuogyaman District located in the Eastern Region of Ghana. The results from the study carried out in the district will be compared to the ones outlined by Aquaculture Strategic Framework-Ghana. This will be done with the help of the SWOT analysis in order to identify to which extent the framework is helping to develop aquaculture on the Volta Lake and also to come up with ideas on how the framework can be improved towards developing aquaculture on the Volta Lake on a sustainable basis.

4.2 SWOT Analysis

SWOT analysis was used to analyse the Aquaculture Strategic Framework-Ghana in relation to findings in the Asuogyaman district in order to determine its role in the sustainable development of aquaculture on the Volta Lake.

SWOT analysis is an acronym which means Strengths, Weakness, Opportunities and Threats. The technique for SWOT is credited to Albert Humphrey, who led a research project in the 1960s and 1970s at Stanford University using data from 500 companies (Arlsan and Er 2007). SWOT analysis is intended to maximise strength and opportunities, minimise external threats, and transform weakness into strength in order to take advantage of the opportunities along with minimizing internal weakness and external threats (Johnson et al. 1989). SWOT is also designed to be used in the preliminary stages of decision making on one hand and also as a precursor to strategic management planning on the other (Arlsan and Er 2007). This fits in the case of this study in terms of being used as a precursor to management planning for Aquaculture Strategic Framework-Ghana. SWOT analysis will help in the strategic management planning of the Aquaculture Strategic Framework-Ghana which will lead to the sustainable development of aquaculture in the Asuogyaman District and other districts involved in cage aquaculture on the Volta Lake as a whole based on findings in the case study area.

Another important use of SWOT analysis is for the study of both internal and external environments in order to obtain a systematic approach for decision making (Arlsan and Er 2007). If used correctly it can provide a good strategy formulation (ibid). This will help in the case of the Aquaculture Strategic Framework-Ghana in order to come up with a good strategy formulation that could lead to the development of aquaculture on the Volta Lake and in Ghana.

In order to achieve the purpose of SWOT analysis, there is the need to identify the role Aquaculture Strategic Framework-Ghana performs pertaining to the issues of constraints in aquaculture on the Volta Lake. These will be grouped into two main factors; internal (strengths and weakness) and external (opportunities and threats) this makes it easy for comparison.

4.2.1 Strengths

Aquaculture Strategic Framework-Ghana has its list of constraints categorised. These constraints according to Abban et al. (2009) are listed as; input constraints, institutional issues, educational and training issues. Strengths of this SWOT analysis are determined by the overall success of the suggested strategic interventions and its impact in helping to solve constraints.

4.2.1 (A) Input Constraints

Looking at the input constraints category in the strategic framework, constraints on fingerlings was addressed. The strategic intervention suggested and their implementations were very beneficial in making sure there is an overall increase in the production quantity and quality of fingerlings in the country. The first intervention strategy suggested by the framework was the need for relevant institutions to compile information on fingerling producers and prospective fish feed producers (Abban et al. 2009). This was done in order to have relevant knowledge on the current state of fingerling production the country. This was also done in order to provide formal and informal training channels from the level of the farmers and that of the researchers in the sector of fish production in the country. The next intervention involved the need for government through agencies like, EPA, WRI, NGOs and the Fisheries Commission to establish guidelines for brood stock management of fish seeds production. This was done in order to strengthen and position prospective producers to ensure economic gains for all. The last strategic intervention employed by the framework also included the need for the private sectors to be encouraged to play a major role in fish seed production by helping in the capacity building of private producers. This was done to help meet the increasing demands for fish seeds in the country.

Impacts of these strategies can be seen from response obtained from the case study area and figures from the ministry. Response from the case study area shows a positive impact from the fingerling production sector. This is shown by a significant 82 percent of the respondents agreeing that there is an easy access to fingerlings for production purposes. The other 18percent of the respondents disagreed with varying reasons. In terms of quality, it can be seen that 87 percent of the respondents agree that the quality of the fingerlings they have easy access to have their quality ranging from fair to good with just 13 percent thinking it is bad. Looking at the private sector fingerling production nationwide from Table 2.1, there has been a total increase in the number of fingerlings for the entire country between the years 2005 and 2009. It can also be seen from Table 2.1 that there has been increase in the total amount of fingerlings produced by private hatcheries. This shows the contribution of private hatcheries to the fingerling production in the country. There is an increase from 6,583,000 fingerlings in 2005 to 63,236,239 fingerlings in 2012 according to the Ministry of Fisheries and Aquaculture Development. There has also been an increase in the total number of private fish hatcheries as well. This may be due to the effectiveness of the strategy put in place from the framework.

Another constraint addressed under the input category was the non-availability of commercial fish feed on the open market. Commercial feed is mainly patronised by the cage fish farm operators which are mostly located on the Volta Lake. Interventions were put in place to address this constraint. From Abban et al. (2009), among the strategies put in place include; stakeholders creating the awareness of the potential of fish feed industry as an industry. This strategy required efforts of the main stakeholders, the Fisheries Commission, fish farmers and NGOs. This effort includes making the fish meal sector investor friendly in order to encourage potential investors or entrepreneurs get into the fish feed industry. This intervention has led to the setting up of the fish feed industry by the Israeli feed industry called ‘Ranaan’ in the country. This setting up of this fish feed industry has resulted in the readily available commercial fish feed on the open market. The issue of unavailable feed on the market as a constraint has been greatly reduced in the country as a result of this industry being set up. Another strategy put in place was for the need for the government to initiate a means to create some incentives for inputs for fish feed producers through tax relief among others (Abban et al. 2009). This strategy is to help make the feed industry more profitable and encourage other fish feed industries to be set up and stay in business. This strategy has been

effective to some extent due to the fact that the fish feed industry set up by Ranaan operates actively and produces enough fish feed for the country and even exports fish feed to Nigeria.
According to Abban et al. (2009), there was the need for public sector institutions with tested fish feed formulations consisting of mainly local agro-industrial by-products to negotiate and establish a working partnership with the fish feed industry is another strategy adopted by the framework. This is to facilitate the availability of environmentally friendly commercial feed on the open market. This also helps to make use of the cheaper and readily available locally produced agro-based raw materials for the fish feed industries. It helps to cut cost incurred by the industry through importation of raw materials leading to profitability. Such is the case for fish feed industries in the country.
The last strategy put in place for feed constraint was an evaluation procedure for feed produced by the industry (Abban et al. 2009). This is to make sure that the feed produced by the industries are of the best quality. The impact of the success of this strategy can be confirmed from the data obtained from the case study area where all respondents thought the feed they obtained had its quality ranging from fair to good. 75 percent of the respondents agreed that the feed they use on their farms were of good quality while the remaining 25 percent thought the quality of the feed was fair. No respondent from the case study area thought the feed they had access to in the country was of bad quality. This clearly shows the effectiveness of the strategy put in place by the framework.

4.2.1 (B) Institutional Issues

Institutions and organisations in the country play a very important role in the development of aquaculture on the Volta Lake. One of constraints identified by the framework in relation to these institutions according to Abban et al. (2009) includes; low recognition of complementary roles of private and public sectors in aquaculture development. This indicated the need for private and public sectors to be included in the process of making the development of aquaculture a reality in the country. The strength identified in the strategic framework put in place to help address this problem was seen whereby the strategy recommended the need for entrepreneurs to be encouraged to provide aquaculture inputs and equipments to start up business where by public sector roles are limited to monitoring and evaluation. As seen in the results obtained from the case study area, most of the inputs required to start up an aquaculture business on the Volta Lake are available. Most of these

inputs are obtained from private companies and industries. These inputs include, equipment needed for cage construction, the fingerlings for stocking and fish feed. Another adopted strategy which seemed effective was the fact that there is a need for the inclusion of private sector (e.g. fish farm associations, farmers, agro-industry and financial institutions) to take up roles in aquaculture development. Members of the private sector institution form part of the stakeholders of aquaculture in the country. As outlined by Abban et al. (2009), strategies suggested by the framework to help solve issues of constraints in the aquaculture sector were identified and brought up as a result of discussions that took place among the relevant stakeholders. This helps to identify actual constraints and help come up with the best strategies to help solve the constraints at hand without bias.

Another institutional issue of constraint identified was the fact that there are weak policies and lack of formal institutional arrangement to support aquaculture development (Abban et al. 2009). The strategy put in place was seen to be beneficial where there was a need to strengthen the capacity of the Ministry of Fisheries and Aquaculture and the Fisheries Commission. This is seen by the fact that, there are offices of the Fisheries Commission in all the ten regions in the country. The presence of the Offices of the Commission in most of the districts and in all the regions in the country strengthens its capacity to reach out to most areas in the country to help address issues experienced by fish farmers and also to provide support in some cases. This is beneficial in the country's quest for the development of aquaculture by being able to have access to all aquaculture activities in all the regions.

Another suggested framework strategy which has been beneficial to the development of aquaculture on the Volta Lake, is with regard to regulations and standards. This strategy calls for the need for regulations and standards in aquaculture operations and products (as codes of practice). This must be disseminated by relevant institutions such as the Fisheries Commission, WRC, EPA, WRI and CSIR among others. This is clearly seen by the procedures prospective fish farmers go through in order to get an operating licence to legitimately operate a fish farm on the Volta Lake. WRC and EPA carry out tests and assessments respectively, before the go-ahead is given by the Fisheries Commission. The role these relevant institutions play helps to ensure the safety status of the environment and secure the quality of the water resource.

All these elements stated above represent the strengths and also the extent to which Aquaculture Strategic Framework-Ghana is helping to promote the sustainable development of aquaculture on the Volta Lake.

4.2.1 (C) Education and Training Constraints

In addressing the constraint of inadequately skilled persons at all levels of aquaculture industry in the country, one of the strategies implemented by the framework was found to be effective to some extent. This strategy outlined the need for fish farmer associations to engage in the training needs and assessment of their members and request responses for them through the public sector (Abban et al. 2009). This success is achieved by a fish farmer association called the Ghana Association of Aquaculture. This association is made up of members from all production levels in this aquaculture industry. The main goals and objectives of Ghana Association of Aquaculture as found in their brochure includes;

1. Facilitate the sharing of experiences; promote awareness of government regulations on aquaculture and good farm management practices.
2. To lobby policy makers to fashion out policies that will facilitate the progress of the industry, avoiding unnecessary cost and delay on applicants in acquiring rights to land and water and the right to undertake aquaculture operations.

These goals and objectives falls within the aim of the implementation of the strategy put in place in helping to solve the constraint at hand. Members of the association may also receive some amount of training through the sharing of experiences from other members of the association. This group also educate members on government regulations and good farm management practices. All these activities performed by the association are clearly in line with the strategy put in place.

Another constraint of importance under this category includes; insufficient education and training facilities directed towards aquaculture at all levels in the country (Abban et al. 2009). The framework came up with some strategies which were successfully implemented. One of the strategic interventions that were successfully implemented includes the need for public sector training institutions to formalise collaborations among themselves to compliment training programs (Abban et al. 2009). Some important aquaculture training programmes exists in the country. An example is USAID aquaculture and fisheries collaborative support

programmes which seeks to address the practicable nature of aquaculture. This support program calls for the need for people to understand aquaculture in such a way so as to gain benefits from aquaculture as a business (Abban et al. 2009). Formalisations of public institution include the acknowledgement of the importance of aquaculture by government institutions and the need for education and training. Measures need to be taken in order to compliment training programs such as that of the USAID Agriculture and Fisheries Collaborative Support. This call for the need for government institutions include aquaculture its academic curricula. This will help promote the training and research activities of aquaculture in the country. Some of these government institutions having aquaculture included in their academic curricula are found on table 7.1 below FAO (2000-2008).

Table 7.1: Public Aquaculture Institutions

Institution	Purpose	Degrees Awarded	Key Personnel	Area of specialisation
Renewable Natural Resources (KNUST)	Training	PhD, Msc, Bsc	PhD(1) Msc(1)	Aquaculture, fish nutrition, itchyology, water resources management, fresh water ecology biodiversity
Department of Fisheries and Oceanography (UG)	Training	MPhil, Bsc	PhD(2) Msc(3)	Freshwater and brackish water aquaculture, fish health.
Department of Fisheries and Aquatic Sciences (UCC)	Training	PhD, MPhil, Bsc	PhD(3) MPhil (1) Bsc	Fisheries, aquaculture, biology and culture shellfish, fisheries biology and conservation of marine mammals.
Kwadaso Agriculture Training	Training	Agricultural Certificate	Bsc (2)	Aquaculture, natural resource development and general agriculture
Ministry of Food and agriculture	Development Agency	-	Msc(8) Bsc(10) Dip(4)	Aquaculture, shrimp and bivalve culture, hatchery management, fish health and extension.
Water Research Institute under (CSIR)	Research	-	PhD (13) Msc (5) Bsc (1)	Aquaculture, genetics, fish breeding, fish biology, fisheries management, biological science and agricultural economics.

4.2.2 Weaknesses of the Aquaculture Strategic Framework-Ghana

Interventions by the strategic framework are regarded as weaknesses if its implementation does not solve particular constraints in the field. It is expected for the purpose of a suggested strategic intervention and its subsequent implementation to help solve a constraint. In order to identify the weaknesses in the strategic framework, it is very important to point out situations where constraints still persist even though suggested strategies by the framework have been put in place to solve them. These identified persistent constraints will be mostly limited to that of cage aquaculture practiced on the Volta Lake.

The most important of all weaknesses of the strategic framework is the absence of an approved and a comprehensive national policy for aquaculture. As already stated, Ghana is yet to have an approved national aquaculture policy framework even though aquaculture has been in existence in the country since the 1950s (Abban et al. 2009). There is now a completed draft of national aquaculture policy document but it is yet to be approved by the parliament (ibid). The absence of an approved national policy for aquaculture has resulted in the nation's quest towards the sustainable development of aquaculture unstructured without a clearly laid out plan. The current strategic framework being used in the absence of an approved national policy document is not structured to follow specific laid down national policies. This has resulted in making the development and expansion of aquaculture in Ghana including that on the Volta Lake in particular. Even though the strategic framework being used may be useful to some extent, the absence of an approved and comprehensive national aquaculture policy framework has made its effectiveness limited in helping to address issues of constraint at hand in the aquaculture sector. Unfortunately, some constraints identified in relation to cage aquaculture in the case study area still remains. Such constraints are also believed to be experienced by cage fish farmers in other districts close to the Volta Lake.

4.2.2 (A) Input Constraints

Availability of most of the inputs was not seen as a constraint based on the findings in the case study area. However, the most obvious of the constraints associated with inputs had to do with the cost involved. These inputs include; fingerlings, feed and equipments required in the construction of a cage fish farm.

Strategies put in place for the constraint of the non-availability of fish feed and fingerlings did not take into consideration strategies to keep its cost at an acceptable level. Fish feed and fingerlings make up a large percentage of the total capital involved in the setting up and running of fish farm. This therefore make these two inputs part of the most important input components in the running of a fish farm. This issue of constraint could have been addressed by the introduction of subsidies among other measures for cage fish farmers. This will help encourage more farmers to get into this business. However, looking at the results of the interviews carried out in the field, a lot of the respondents in the case study area expressed their discontent especially with the cost of fish feed and fingerlings required to operate cage fish farm on the Volta Lake. More than half of the respondents representing (56 percent of the total respondents) felt the cost of fingerlings needed to run a fish farm was unacceptable whiles 12.5 percent of the total respondents were indifferent towards the price. The remainder of the respondents felt the cost of fingerlings was acceptable. This clearly shows that a vast majority of the fish farmers are not content with the cost of fingerlings needed to run their farms. Those that felt the cost involved were acceptable usually produced their own fingerlings or operated government owned farms that receive some form of benefits from government fingerling hatcheries.

Feed which forms as much as 70 percent of the total cost of production had 100 percent of the respondents finding the current costs unacceptable. Feed is the one of the most important input components, which determines the profitability of cage fish farms on the Volta Lake. The amount of capital spent on feed will help to determine the profitability of the fish farm.

Hence, it is necessary for stakeholders to come up with best strategies in order to address the issue of cost constraints regarding feed and fingerlings. This should be included in the strategic framework. This will lead to profitability that will result in the development of aquaculture on the Volta Lake.

The cost of equipments needed to start up a cage fish farm on the Volta Lake also proved to be a constraint based on response from the case study area. Looking at the response obtained from the case study area, about 50 percent of the respondents feel the cost involved is unacceptable whiles the other 50 percent of the respondent felt the cost was moderate (indifferent) or found the cost to be acceptable. This issue of constraint may not seem to be the biggest weakness based on the response received. However, if ignored, it can end up as a major constraint in the sustainable development of aquaculture. This is because in the end,

most of the equipment businesses are privately owned and if investors find it costly, they will not invest. Subsidies may be a short-term solution but they have a tendency to stick.

Another access constraint was access to loans to start up fish farms on the Volta Lake. This constraint was acknowledged by the strategic framework which resulted in strategic interventions being put in place to help solve this constraint. Unfortunately, the constraint still persist based on response obtained from the respondents. 81 percent of the total respondents disagree that, there are available financial support in the form of loans to start up a business. The remainder of the respondents representing 19 percent were indifferent. This constraint will pose to be a major problem in a situation where the responses provided by the respondents are just the same as that of the actual owners. This situation will clearly point out an important weakness that will limit the sustainable development of aquaculture on the Volta Lake. it will therefore be necessary for stakeholders to revise strategies being put in place by the strategic framework to help make loans and other financial incentives readily available for prospective fish farmers on the Volta Lake.

4.2.2 (B) Institutional Issues

The first issue of constraint identified by the strategic framework under this category includes the fact that the roles played by some private and public sectors are not given much recognition in the nation's course for development of aquaculture (Abban et al. 2009). The second constraint identified in relation to institutional issues is that there are weak policies and lack of formal institutional arrangement to support aquaculture development. Strategies used to solve institutional issues of constraints proved to be ineffective to some extent. Ineffective strategies represent the weaknesses involved in a particular strategy suggested to solve a constraint. Also, some ignored strategies, which could have been beneficial in addressing certain constraints, are also regarded as weakness of the strategic framework in this study.

In order to address the first constraint, one of the strategy suggested according to Abban et al. (2009) stated that; "Existing public and private institutions that perform or could perform specific roles in aquaculture development should be identified with their potential to initiate discussions with the public sector".

In most of the cases in the country however, private and public institutions are not identified and do not work closely with the government in order to initiate discussions. Certain issues identified by organisations had to be channelled through the media in order to reach out to the main public institution, the Ministry of Fisheries and Aquaculture Development. For example, there were some cases where prominent existing institutions like GAA had to call on the Ministry of Fisheries and Aquaculture Development on issues of importation of tilapia in the country which is negatively affecting the sales of tilapia producing industries in the country through the media; 'The Fish Site' in December2013 [2]. Had the public institutions been identified, GAA would not have used the media to initiate discussions with the ministry. Instead, the association would have been able to initiate discussions directly with the ministry in order to come up with an amicable solution to this problem.

The solution strategy to this constraint of weak policies and institutional arrangement had certain weaknesses. The strategy is the strengthening of the capacity of the Ministry of Fisheries and Aquaculture Development and also that of the Fisheries Commission for aquaculture policy and regulation development. Strengthening institutions call for the need for adequately staffed Ministry and Fisheries Commission. This is needed in order to effectively educate and train fish farmers on national aquaculture policies and regulation that will lead to development of the sector as a whole. There was some strength to this strategy by the fact that Offices of the Fishery Commission are found in almost all parts of the country. However, these offices are highly understaffed. Results from the fieldwork carried out in the Asuogyaman in relation to access to extension services confirmed this issue. 75 percent of the respondents disagree to the easy access to extension services. This may be due to the fact, that, the commission in the various regions are understaffed and also this may be due to the fact they lack basic logistics like vehicles to get access to the fish farms.

4.2.2 (C) Educational and Training Constraints

The first constraint according to Abban et al. (2009) is insufficient education and training facilities at all levels of aquaculture training. A weakness was identified in one of the

[2] http://www.thefishsite.com/fishnews/22014/ghana-aquaculture-association-decries-importation-of-fish/ (20.08.2014)

strategies suggested by the framework. This strategy pointed out the need for the government to initiate development of basic and comprehensive curricula for aquaculture education and training at all levels in collaboration with appropriate stakeholders (Abban et al. 2009). As it can be seen in Table 7.1 above, aquaculture institutions responsible for training is only limited to tertiary institutions. There is little attention given to basic training for students at senior high school and junior high institutions in a country where few people have access to tertiary education.

The second constraint according Abban et al. (2009) is inadequately skilled persons at all levels. The framework suggested the need for government in collaboration with certificate and diploma awarding institutions to set up special practical programmes to produce urgently needed extension agents. The strategy suggested did not seem to be successful looking at the response received from the case study area. From the Asuogyaman district where cage aquaculture dominates, 75 percent of the total respondents disagree that there is easy access to extension services. This clearly indicates the ineffectiveness of the strategy suggested to help address the constraint.

4.2.3 Opportunities

There are several opportunities that can make the Aquaculture Strategic Framework-Ghana more effective in the near future. It will help address most of the weaknesses that limits the effectiveness of the framework. These opportunities will allow for the improvement of the framework in order to make it more effective in its role towards promoting the sustainable development of aquaculture in Ghana

The first opportunity that needs be capitalized upon to improve the strategic framework for sustainable development of aquaculture is the fact that government has recognised the need for aquaculture to be developed. This is seen by the name of the Ministry of Fishery and Aquaculture Development formed in 2013. The name of the ministry indicates the need for aquaculture in the country to be developed. The setting up of this ministry will provide the best opportunity to influence the drafted national aquaculture policy document to be approved by parliament. This would not have been the case if the fishery and aquaculture sector is placed under the umbrella of MoFA. The approval of the national policy document will help

provide a strong foundation for the strategic framework in place to be improved through review. Review will be geared towards the need for improvement and development of aquaculture in the country in such a manner that it will be in line with the set national objectives.

In the course of reviewing the Aquaculture Strategic Framework-Ghana, there is an opportunity for the framework to be improved by addition of an implementation plan. Reviewing or improving the strategic framework by addition of an implementation plan after the approval of the draft will not just put the strategic interventions in line with the approved set national aquaculture policies. Instead, it will help to make the strategic framework more effective. As it can be seen from the weaknesses above, the major source of weaknesses for the framework is that it clearly lacks an implementation plan. This weakness is also supported by Abban et al. (2009) which makes mention of the fact that major improvement that could be have been added to the strategic framework was an implementation plan. The approval of the national aquaculture policy and subsequent review by the addition of an implementation plan will be very beneficial to the development of aquaculture in Ghana as a whole. The implementation plan will help make the strategies provided by the framework in solving a particular constraint more effective through clearly laid out plans which will lead to development of aquaculture on the Volta Lake and in Ghana as a whole.

Cage aquaculture on the Volta Lake is the production systems in Ghana, which has the best commercial potential. Attention should therefore be given to this system in order to improve upon its potential to become a commercial business. The current framework is not specific in addressing constraints of aquaculture productions from different production systems. Instead, the strategic framework generalises all constraints irrespective of the production system. Strategies suggested by the framework are also directed at collectively solving these generalised constraints identified. This has lead to its inability to address certain constraints which are specific to a particular system of production, especially cage aquaculture on the Volta Lake. It will be more beneficial to make strategic interventions that will be specific to a production system.

4.2.4 Threats

Threats to the success of the Aquaculture Strategic Framework-Ghana lies in the political will of a ruling government to recognise the importance or the potential impact of aquaculture on the national economy. Governments that give priority to fisheries put it under a separate ministerial body, whiles other governments that do not give much priority to fisheries usually put it under MoFA. Currently, the strategic framework for aquaculture is used directly for aquaculture development projects (Abban et al 2009). The effectiveness of a strategic framework of this nature would have been greater if it was derived from set and approved national policy for aquaculture.

Unfortunately, there is yet to be an approved national policy document for aquaculture in the country even though there is an existing draft policy. The continual change of government after elections poses a threat for the drafted policy to be approved by the government. When there is a ruling government with a less priority to fisheries, fisheries and the production sector placed under MoFA. Issues from the larger agricultural sector overshadows that of fisheries and aquaculture production sector. As a result, the fisheries and aquaculture sector receives less attention, hence slowing the push for the drafted policy to be approved by parliament.

For instance, the current ruling government has a separate ministry for fisheries and aquaculture it has also acknowledged the need for aquaculture to be developed. This is a ruling government that has fisheries and aquaculture development as a priority. Such a government also creates the best opportunity to push for the approval of the drafted national policy by the parliament. The main threat will be posed during the next election. A new government if elected might decide to maintain the current system in place or decide to put the new ministry back under MoFA. This will lead to less attention given to the fisheries and aquaculture production sector and hence negatively affect the push for the drafted national policy to be approved by the parliament. If this is the case, the Aquaculture Strategic Framework-Ghana remains unapproved which will limit its legitimacy and effectiveness.

4.2.5 Conclusion and Discussion

Analysing the SWOT factors helped to identify roles the framework plays in the sustainable development of aquaculture on the Volta Lake and in Ghana as a whole. It also outlines limitations to its role for aquaculture development. Some opportunities that allows for the framework to be improved was also mentioned in the SWOT analysis. Possible threats to the improvement and effectiveness of the framework were also mentioned in the analysis.

Strengths of the framework showed positive impacts the framework has towards addressing constraints experienced by aquaculture on the Volta Lake with reference to the case study area. It will be very important to build upon these strengths provided by the framework in order to maximise the benefits it provides in the course of sustainable development of aquaculture on the Volta Lake and in Ghana.

The absence of an approved national aquaculture policy framework for aquaculture may be a limiting factor to the effectiveness of the framework. But the effectiveness of the strategic intervention put in place plays a very important role in the effectiveness of a framework. The inclusion of an implementation plan will be very beneficial to help improve the effectiveness of strategic interventions to some extent. Issues of funds to help in implementation should also not be overlooked.

Weaknesses identified from the strategies to solve constraints in the Aquaculture Strategic Framework-Ghana documents are detrimental towards the sustainable development of aquaculture on the Volta Lake. Even though the framework identified most of the constraints to the development of aquaculture in the country, the strategic solutions provided to address constraints was not effective to some extent. Under the input category of constraints, the most notable issues were; cost of the input factors and the access to loans to start business, the best solution to these constraints is the introduction of subsidies and also making flexible loans available for prospective fish farmers on the Volta Lake. This calls for the need of funds to be invested in the aquaculture sector. This is I believe the country should be able to do due to some funds received by the nation to support the aquaculture sector. According the Ministry

of Finance[3], the World Bank Board of Executives approved an investment cost of USD$53.8 million for Ghana to boost the fishery and aquaculture sector on July 14, 2011. Out of this amount, USD$8 million was allocated to aquaculture. Among the intended use of the funds were:

1. Catalyze aquaculture development for medium and large-scale enterprises.

2. Provide support for small-scale aquaculture development.

Short-term subsidies will be very beneficial in helping to encourage more prospective fish farmers into business. This is because, there is a potential of many fish farmers who are encouraged into the production sector to stay after certain subsidies have been removed. In order to also help support the small scale fish farmers, there is the need to help provide funds for prospective fish farmers in the form of flexible loans. This way the interest on the loans will not discourage farmers to apply for in order to start business. The amount allocated to aquaculture, even though not enough can be used to some extent to encourage other private investors to get into this business.

There was no close relation between prominent stakeholder organisations and the government institutions after strategic framework interventions were derived through consultative meetings. Including stakeholders in the process of coming up with strategic solutions should not be the end point. There is a need for a medium of communication to be created in order ensure direct and close interaction between the ministries and important stakeholder associations. In this way issues that come up in the sector can be readily discussed in order to come up with an amicable solution in the shortest possible time.

Another institutional issue leading to few farmers getting access to extensions personnel is as a result of lack of logistics like vehicles, and fuel for vehicles among others. This calls for more funds to be invested. It will be very beneficial for the nation to invest in the aquaculture sector since it provides the best option for the nation to increase production in its fishery production sector after the main contributor; capture fisheries is now declining. This will help provide officials with the right logistics in order to regularly visit farms and provide them with extension services.

[3] http://www.mofep.gov.gh/?q=press-release/030811 (28.04.2015)

Weaknesses to solve educational and training constraints were mainly seen by the fact that, aquaculture is only taught at the tertiary level. Since very few Ghanaians are able to afford education at the tertiary level, many people do not get the chance to be trained and educated in the discipline of aquaculture. As a result, there are very few adequately trained personnel to either manage fish farms or provide extension services to fish farmers. There is therefore the need for aquaculture to be introduced into the educational curricula below the tertiary level. This will help provide basic in aquaculture knowledge to many of the educated youths in the country.

In dealing with the threats, it is important for national stakeholders to acknowledge the fact that fisheries and aquaculture serves as a means of livelihood to millions of Ghanaians. The Fisheries Commission may exist as an autonomous body, but it requires government backing in order to function effectively. This backing will be beneficial in the push for the drafted framework to be approved by the parliament especially. In view of this, it is time the national stakeholders recognise the importance of fisheries and aquaculture in the lives of Ghanaians and to Ghana's economy. For this reason, this sector of production should be given the priority it deserves in order to facilitate its development rather than "politicising" this production sector.

Chapter 5: Prospects for Further Development of Aquaculture on the Volta Lake using SWOT analysis

Development of aquaculture on the Volta Lake has a lot of potential. There are also other factors that limit or can limit this potential. Using the SWOT analysis will help to identify probable strengths, weaknesses, opportunities and threats in this production sector. This will help lead to a better conclusion on the prospects for the development this production sector. Aquaculture on the Volta Lake is relatively new in the country but its contribution to the production of aquaculture cannot be over looked.

5.1 Strengths

The system of aquaculture being practiced on the Volta Lake is water based. This system is relatively new in the country as compared to the other systems which are usually land based. There are several factors that have been attributed to the success of aquaculture being practiced on this lake. Some of these will be discussed in this subsection representing the strengths that facilitates its development.

According to Beveridge (2004), there are three main categories needed for the success of cage aquaculture. First of which includes the physico-chemical conditions (temperature, salinity, oxygen, currents, pollution, algal bloom, exchange and many others). These are natural conditions which cannot be controlled. These natural conditions help determine whether a particular cultured specie will thrive or not in a certain environment. The second category includes factors that are needed in order to place the cage system successfully. Conditions for this category are mostly made up of natural conditions which include the weather conditions, shelter, and depth of the lake. The third category to consider in setting up a cage fish farm includes establishment and profitability of a cage fish farm. Conditions required to achieve this condition are not natural. This implies that these conditions can be managed in order to facilitate the development of cage aquaculture on the Volta Lake. Some of these conditions include; legal aspects, access, land based facilities, security, economics and social considerations. If managed well, it will lead to easy establishment of cage fish farms on the Volta Lake which will also be profitable. Out of all the categories listed above,

the most important of them in respect to strengths for the success of cage aquaculture fall under categories which have natural conditions as determinants to facilitate the success of aquaculture on the Volta Lake. These categories fall under the first and the second categories mentioned above.

The first condition (physico-chemical) helps to determine whether the quality of water found in the Volta Lake will be suitable for the success of aquaculture or not. A study was carried out by Karikari et al. (2013) in order to determine the physico-chemical conditions of the Volta Lake. Out of the components of the physico-chemical conditions; temperature, dissolved oxygen and acidity will be discussed in this section due to its importance for fish survival. In general, the water quality of the Volta Lake was found to be very suitable for fish farming looking at the results from the physico-chemical study carried out by Karikari et al. (2013) shown in figure 5.1 below where the lake is divided into segments indicating sampling sites for assessment. The study carried out by Karikari et al (2013) covered areas where active cage fish farms are currently being practiced on the Volta Lake. This makes results from the study important for future aquaculture farms on the Volta Lake.

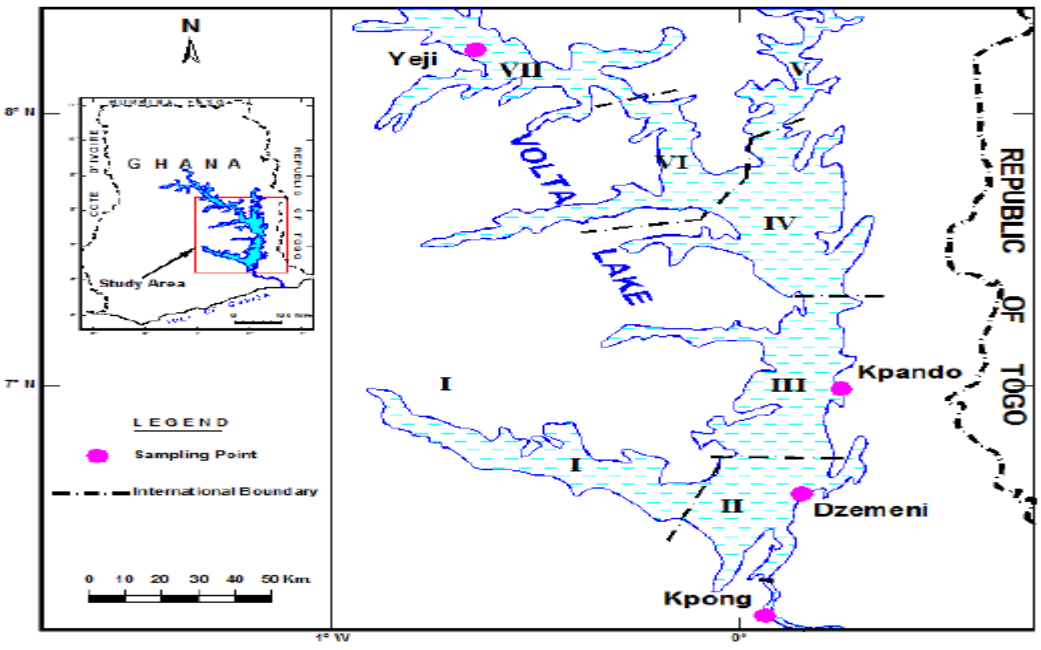

Figure 5.1: Map of the study area showing the sampling sites and Volta Lake segmentation: I= Afram arm, II= Lower main body, III= Middle main body, IV= Upper main body, V= Oti river arm, VI= Lower Volta riverine body, VII= Middle Volta riverine body, VIII= Upper Volta riverine body (Karikari et al. 2013).

From the study carried out above, temperature of the lake was known to show narrow variation from the surface down to eight meters depth. The surface mean temperature recorded for Kpong was found to be 28.5^{o}C and 27.9^{o}C at a distance of 100m-500m offshore (Karikari et al. 2013). At Yeji, the mean surface temperature recorded was 20.7^{o}C for both sampling sites (ibid). These temperatures recorded on the Volta Lake did not show significant variations from the optimum temperature required for the growth of tilapia. This implies that, temperatures in the Lake are very suitable for tilapia culture

In terms of acidity (PH), the surface mean for the Volta Lake according to the study carried out varied between 6.8 to 7.5 from Kpong to Yeji as seen in fig 5.1 at a distance of 500m offshore (Karkari et al. 2013). The PH range recorded on the Lake above falls within the suitable range for culture tilapia (Salam 2000).

Dissolved oxygen from the assessment carried from the sampling points on the lake by Karikari et al. (2013) showed a mean average that varied between 7.3mg/L and 8.1mg/L. Dissolved oxygen levels from the study carried out is clearly above 5mg/L which is considered to be the minimum for the proper growth and development of fish (Alabaster and Lloyd 1982). It is one of the limiting environmental factors affecting fish feeding, growth and metabolism (El-Sayed 2006).

All these conditions stated above show the physico-chemical conditions of water in the Volta Lake. This goes ahead to validate the reason that cultured tilapia will thrive successfully in this Lake.

The second natural condition to be considered has a focus on issues that influence the placement of the cage. It basically refers to site selection for caged aquaculture. Research into this condition was carried out by Xia et al. (2014). This study used Geographical Information Systems based spatial models to optimize cages location that have been developed for three different sizes of cages: small cages (5*5*4m), medium cages (15*15*5m) and large cages (30*30*6m) respectively (ibid). The spatial models were developed based on consideration of bathymetry, hydrography, access and market and water quality sub-models (ibid). The results from the study carried out by Xia et al. (2014) indicated that there are numerous suitable areas for all the three cage sizes indicated above. From the results of that study, out of the Volta Lake which has an area of 8500 km^2; 249 km^2 was highly suitable for small cage fish farming, 993 km^2 was suitable for medium cage fish farming and 790 km^2 was suitable for

large-scale fish farming. The research carried out shows that large portions of the Volta Lake provided varying conditions for fish farming depending on the scale of production. These areas are yet to be fully exploited. It goes ahead to show strong favourable conditions for the success of aquaculture irrespective of the size of the fish farm to be established.

5.2 Weaknesses

In the presence of an enabling environment for the success of aquaculture on the Volta Lake as in indicated in the strengths above, the caged system of production which is usually employed for fish farming purposes on the Volta Lake still experiences some weaknesses. These weaknesses are the cause of its limited development on the Volta Lake. Some of these will be mentioned in this section. Most of the weaknesses experienced in the development of aquaculture on the Volta Lake are found under the third condition as stated by Beveridge (2004). This category has concerns with cage aquaculture establishment and profitability.

In terms of establishment, many factors negatively affect the development of aquaculture on the Volta Lake. Such factors include, lack of formal or informally trained personnel to man these cages found on the Volta Lake. Most of the respondents who man these cages interviewed in the case study area had little or no formal education on how to manage and run fish farms even though most of them have been in this sector of production for long periods of time. The aim of USAID program in Ghana is educate fish farmers of the fact that aquaculture is very technical and there is the need for them to understand the practicable nature of it in order for gain economical benefits from it as a business (Abban et al. 2009). Even though most of these fish farmers have considerable amount of knowledge based on their past experiences, most of them still lack formal education. Formal and informal education will help them to understand aquaculture in the right manner in order to benefit from it as a business.

In addition to inadequately trained personnel managing most of the fish farms, there are also limited access to personnel in the fisheries Commission offices located in all the areas where aquaculture on the Volta Lake are actively practiced. It is the role of these extension officials to educate fish farm workers on new national and international policies and practices that help to develop aquaculture on the Volta Lake on a sustainable basis. However, from the

interviews carried out in the case study area where aquaculture on the Volta Lake dominates, it was found out that most of the fish farms hardly get extension farm visits from the officials of the Fishery Commission. This can be seen the results of the study carried where 75 percent of the respondents disagreed to the easy access to extension services. As a result, most of the fish farmers are not aware of national policies and the best aquaculture practices that may help in the progress of their businesses.

Another issue that limits the establishment of cage fish farms on the Volta Lake is the lack of avenues to provide loans or credit to prospective fish farmers. Like any other business, capital plays a very important role in its establishment and running. Since the nation has a plan to develop aquaculture on the Volta Lake, it should also provide avenues for loans and credits to be accessed by the fish farms. This issue is debatable due to the limitation of the study carried out where respondents were mostly care takers and not actual farm owners. Most of this respondents disagreed to the ease of access to loans to start a fish farm business on the Volta Lake. The most credible response to this issue will be from actual farm owners. Regardless of this limitation, this issue cannot be overlooked since it plays a very important role in the establishment of fish farms on the Volta Lake. Lack of access to loans and credit to start fish farms slows down the whole concept of the sustainable development of aquaculture on the Volta Lake.

Under the issue of profitability, the main source of weakness was seen with the input cost of production. The main running cost of production of a fish farm is the cost of fish feed the cost of fingerlings and cost of fish farm equipment. The most important of these three inputs is the fish feed which is believed to form over 50 percent of the total cost of production looking at the results from the case study area. High cost of feed affect the overall profitability of the business. There is therefore the need for the cost of fish feed to be kept at acceptable price in order to make the business profitable. In the case of aquaculture in the case study area, it was found to be otherwise. 100 percent of the respondent did not find the cost of fish feed which forms the bulk of total production cost acceptable. This means that the cost involved in acquiring feed to run the fish farm was considered too high.

This same reason goes for cost of fingerlings and equipment required to start and run a fish farm on the Volta Lake. This discourages prospective cage fish farmers from getting involved in this business which in turn slows down the overall development of aquaculture.

5.3 Opportunities

There are many opportunities present that need to be tapped in order to achieve success of developing aquaculture on the Volta Lake. Some of these will be discussed below.

Countries located south of Sahara have abundant water resources. These water resources are yet to be fully tapped for aquaculture purposes in order to increase production in this sector significantly (Machena and Moehl 2001). Ghana which is located in sub Saharan Africa is blessed to have the largest man-made lake in the world. Aquaculture activities are currently taking place on this lake; the most dominant of these is cage farming of tilapia. However, the Volta Lake as a water resource is yet to be fully tapped in terms of aquaculture activities. As a result, many experiments have been carried out to determine how suitable the Volta Lake is for the fish farming. Most recent research carried out by Xian et al. (2014) showed that aquaculture fish farms of different scales; small, medium and large are very suitable to be established on the Lake. The physico-chemical conditions from the research carried out Karikari et al. (2013) proved to be very favourable for the survival of Tilapia which is mainly cultured on Lake using cages. These reasons provides diverse opportunities (small sized farms, medium sized farms and large scale farms) for prospective cage fish farmers to get involved in fish farming on the Volta Lake irrespective of their economic capabilities.

Aquaculture in Ghana since its inception has been predominantly land-based. These include, pond systems of production and reservoir systems, among others. However, the land-based system of production has had very little impact of total aquaculture production in the country. Available data to support this statement suggests that output from land based aquaculture in 2006 was estimated to be less than one percent to total fish produced for human consumption (Abban et al. 2006). This situation changed significantly looking at the figures from 2009 to 2012 provided by Ministry of Fisheries and Aquaculture Development (2013) in Table 2.1. This is due to the contribution of cage aquaculture to total fish production. The nation has an objective to improve food security. Further steps to achieve 20 percent of fish produced locally for human consumption (similar to that of the global mean) is what the government seeks to achieve (Abban et al. 2006). Cage aquaculture on the Volta Lake provides the best opportunity to achieve this due to its effectiveness in terms of production quantity as compared to other land-based system.

The nature of consumption and local demand for fish in the country provides ready market for farms that are involved in fish farming on the Volta Lake. The current demand for fish products in the country is yet to be met. The United Nation Food and Agricultural Organisation estimated that the total annual supply of fish for direct human consumption in Ghana including imports stood at 600,000 metric tons. Domestic fish supply in the country however has a decreasing trend. According to a data base from FAO [4], the total fish produced in the country fell from 490,000 metric tons in 1999 to just over 330,000 metric tons in 2011. This clearly shows that there is a supply deficit. This implies that there is an opportunity for expansion of aquaculture on the Volta Lake due to the readily available domestic demand for fish products. There is also a potential export market for the fish products from the Volta Lake. The nature of consumption of fish products in the country shows importance of fish in the diet of an average Ghanaian. As already stated, an estimated 60 percent of the main source of protein in the average Ghanaians diet is from fish according to FAO (2006). The average per capita fish consumption is also seen to be one of the highest in sub Saharan Africa at 27.1kg in 2009. The inability of the nation's fish production sector presents a threat to the nation's quest for food security. The opportunity to meet the supply deficit in domestic fish production is the cage system aquaculture practiced on the Volta Lake.

Development of aquaculture on the Volta Lake will help create more employment opportunities for Ghanaians. A large number of Ghanaians depend on fishery as a source of employment and livelihood. According to Global Food Alliance[5], it is estimated that 1.5-2 millions Ghanaians depend on fisheries for employment for their livelihoods. In view of this, developing aquaculture on the Volta Lake will help create more room for a lot of people to gain employment. This will help in poverty alleviation and development of the country as a whole. Looking at the production statistics in the country, there is no doubt that aquaculture plays a very important role in total fish production. Looking at the systems of production in the country, it is also important to note the important contribution of cage aquaculture which is mainly practiced on the Volta Lake to the total aquaculture production in the country. According to Global Food Alliance[5], a 2004 report by the African Development Bank lists Ghana as one of ten African countries where fisheries "appear to be a significant motor for

[4] http://www.fao.org/figis/servlet/SQServlet?ds=Capture&k1=COUNTRY&k1v=1&k1s=81&outtype=html (30.09. 2013)
[5] http://www.globalfishalliance.org/pdfs/03_Ghana_G-FISH_Food_Security_8-05-09.pdf (23.09.2014)

growth". The report also suggests Ghana forms part of three countries where the main poverty alleviation plan adequately covers the important role of fisheries in national development and poverty alleviation (ibid). For this reason, the development of aquaculture on the Volta Lake will help provide a good opportunity for the nation to reach its overall objective for poverty alleviation and national development.

5.4 Threats

Some threats have been identified that may hinder the further development of aquaculture being practiced on the Volta Lake. Some of the main threats to the further development of aquaculture on the Volta Lake will be discussed in this section.

Fish kills on the Volta Lake has become a matter of concern to fish farmers on this Lake. Several human activities and production activities on and along the Volta Lake is the major cause of this issue. This is seriously affecting the viability of business of aquaculture being practiced on the Volta Lake. an incident cited by an online media website Spy Ghana[6], reported that: In one particular incident, fish farmers on the Volta Lake lost tilapia that was valued at over 632,000 Ghana Cedis, which is approximately about USD 165,000. The report on the incident suggested that, the fish kill was caused by the presence on certain chemicals in the Volta Lake coupled with the sudden change in the temperature of the Lake (ibid). A report from the Ghana Standards Authority according to Spy Ghana[6], on the same incident revealed loads of agrochemicals (Synthetic Pyrethroids- Fenvalerate), organophosphates (Chlorpyriphos) and the presence of volatile poisons in both water (Volta Lake) and meat (flesh) respectively (ibid). All these chemicals get into the Lake as a result of agricultural activities that are carried close to the Volta Lake.

Aside from the chemical run-offs from agricultural activities that causes the pollution of the Volta Lake, the feeding activities of the cage system of production is also know to pollute the lake some extent. Pelleted fish feed is mainly used by all the cage fish farms located on the Volta Lake. The feed s usually dumped into the water bodies where the cages are located in order for the fishes to feed. In most of the cases on the Volta Lake, very little measure is taken to monitor the feed being deposited for fish consumption. As such, a lot of the feed is

[6] http://www.spyghana.com/volta-lake-for-tilapia-culture-under-threat/(13.02.2015)

not consumed by the fishes. When all of the pelleted feed is not eaten, it sinks to the bottom of the cage, and the accumulation of this high protein will lead to ammonia build-up (Rao et al. 2012). High build-up of ammonia in the Lake results in a situation called ammonia toxicity which can be very detrimental to the health of cultured fish. The end result is an elevation in body ammonia levels in fishes, leading to convulsions and death (Rendal and Tsui 2002).

Another threat to the sustainable development of aquaculture in the Ghana is the excessive importation of fish into the country. The nation is currently not able to meet the current domestic demand for fish in the country which as a result led to the importation of fish to supplement local production in order to meet the domestic demand for fish in the country. However, there have been cases of excessive importation of fish into the country which is affecting the sales of locally produced Tilapia. In view of this, several outcries from local fish farmers have been made in order to address this situation. An example of such an outcry was made by the Ghana Aquaculture Association (GAA) to the Ministry of Fisheries and Aquaculture development in article on an online media website called The Fish Site in December 2013.

Fish escapes from caged fish farms may pose a threat to the ecosystem in the Volta Lake. Many cage fish farms on the Volta Lake stand at a very high risk of fish escaping. Issues fish escapes come as a result of nets of cages being damaged. This may occur in many water based cage fish farms around the world. Cage fish farming on the Volta Lake is no different from this situation experienced by the cage fish farms around the world. In Ghana, the species of tilapia used is specially created to optimize growth by private hatcheries; therefore this species is a mix of several different types of tilapia (Appleyard and Mather 2002). A typical example is the ‘Akosombo’ strain of tilapia. If this genetically modified tilapia escapes from a farm, then there would be a good chance it would out-compete the species native to the habitat, which would disrupt the food web and organism interactions (Rao et al 2012).

5.5 Conclusion

The SWOT factors helped to address certain issues that need to be analysed when taking into consideration the further development of aquaculture on the Volta Lake. Certain categories showed conditions that need to be met in order to ensure the success of aquaculture on the Volta Lake helped in this analysis according to Beveridge (2004). Out of all the categories, the two natural conditions required for the success of aquaculture on the Volta Lake proved to be very favourable for cage aquaculture development on the Volta Lake. Research also showed that the Lake is capable of supporting the three variable production scales of cage aquaculture namely; small scale, medium scale and large scale. This shows that, Ghana has a very suitable environment for fish farming of variable scales which need to be utilised efficiently to maximise production.

Issues that limit the sustainable development of aquaculture on the Volta Lake has more to do with the category that addresses the establishment and the profitability of the operation. Only few cage fish farmers have received formal education on aquaculture. There are also inadequate personnel and lack of logistics at the offices of the Fishery Commission to help provide extension services to fish farmers. Without formal education on aquaculture and inadequate help from personnel from the Fisheries Commission through extension services, many fish farmers do not get the chance to understand the technical and practical nature of fish farming as a business. Hence, it is therefore a need for the government to help fund the addition of more personnel and also provide logistics in order for them to help fish farmers with the required technical advice in order to improve production.

The cost of input materials keeps increasing. This makes the total cost of production high which will lead to low profits. This deters prospective fish farmers from getting into business. As already stated in Chapter 4, there is the need for the government to introduce short term subsidies which has a potential of sticking in the future.

There are several opportunities that call for the need for aquaculture to be developed on the Volta Lake. Several threats are present that limits opportunities for cage aquaculture to be developed. Therefore, threats have to be minimised in order to fully take advantage of the

opportunities presented for the Volta Lake to be used for aquaculture. These threats are detrimental to the conditions that make the lake viable for Tilapia culture. There are laws and environmental impact assessments that are responsible to control these threats to help protect the water body but it is obvious that enforcement of these laws is not effective to some extent. The threat of fish escaping through the nets of the cages should also be taken into consideration in order to protect the ecosystem. There is a need for regulations for the control of escaped fishes by the use of a control mechanism like an escape recapture plan for cage fish nets. This will help protect the ecosystem in the Volta Lake.

Importation of fishes at lower costs has a negative impact on the sales of fish farms in the country. This is seen where by these imported fishes come from developed aquaculture nations at prices that locally producing tilapia enterprises cannot compete with. If importations of this nature are not controlled and they become excessive, profitability of the tilapia industry is affected. The locally produced fish from the Volta Lake will not be able to benefit from the huge market demand for fish products in the country. The government may stand at a dilemma. This is by looking at the situation in the perspective of both the fish farmers and the consumers. From the perspective of the consumers, it is good for fish to be available to them as cheap as possible which is beneficial for the purpose of food security. Looking at the point of view of the fish farmers, they also require protection during this period until production is up and running.

Chapter 6: Conclusion

The study was aimed towards the sustainable development of aquaculture on the Volta Lake in Ghana based on the case study area; Asuogyaman District in the Easter Region of Ghana. The district dominates in terms of cage aquaculture being practiced on the Volta Lake. This implies that, information obtained from this district will be beneficial to other districts close to the Volta Lake practicing cage system of aquaculture.

In answering the first research question which aimed to identify to which extent the Aquaculture Strategic Framework-Ghana is helping promote aquaculture on the Volta Lake. The purpose of the Aquaculture Strategic Framework-Ghana is to identify constraints and provide solutions to constraints. Identifying to which extent the framework was contributing to aquaculture development on the Volta Lake was done with the help of a SWOT analysis. This was by comparing the constraints identified and addressed in the framework to the constraints identified from the case study area. The strengths of the analysis showed to which extent the framework was helping to solve constraints in the case study area. In this situation, the strategies suggested to solve a constraint seemed to be effective. This needs to be built upon in order to maximise the benefits the framework provides.

The second research question sought to find out how the framework can be improved to help promote aquaculture on the Volta Lake. This question called for the need to find the weaknesses and threats faced by the framework. These were identified with the help of the SWOT analysis. There was the need to transform weaknesses into strengths and also provide solutions to threats in order to take advantage of the opportunities for the framework to be improved. All these were identified with the help of a SWOT analysis and solutions were suggested. Some of which includes the need for;

1. National policy for aquaculture to be approved in order to enhance the effectiveness of the strategic framework.

2. Inclusion of an implementation plan during the review process to improve upon the effectiveness of the strategic intervention.

3. National stakeholders to give aquaculture much priority rather than “politicising” it.

4. Funds to be invested in the sector to support the effectiveness of the framework strategies through the provision of subsidies for production inputs, logistics to Fisheries Commission officials and flexible loans to prospective fish farmers.

5. To extend aquaculture education to levels lower than the tertiary to allow for more youths to be educated.

6. A close communication between government institutions and the aquaculture associations.

The third research question sought to identify the prospects for further development of aquaculture on the Volta Lake. This was identified with the help of a SWOT analysis. It was concluded from the analysis that, out the three categories required for the development of cage aquaculture, which is mainly practiced on the Volta Lake as stated by Beveridge (2004), two of which were favourable. The two categories were;

1. Conducive physico-chemical conditions of the lake. This implies that the Lake has physical and chemical properties that favour the culture of tilapia.

2. The Lake possessed the right properties for the placement of variable scales of cage production; small, medium and large.

The SWOT analysis also helped to identify the weaknesses and threats that affect the development of aquaculture on the Volta Lake. The weaknesses mainly fell under the category of establishment and profitability as identified by Beveridge (2004). In order to promote development of aquaculture on the Volta Lake, there is the need to transform identified weaknesses into strengths and address threats faced by the industry in order to take advantage of opportunities. A suggested solution for weaknesses includes the need for;

1. Have more fish farmers with aquaculture education and training.

2. Have adequate aquaculture extension officials with access to logistics to operate.

3. Strengthen environmental laws that check feed administration to fishes, aquaculture activities around the lake and also controlling fish escapes in order to protect the water body and the ecosystem.

4. Monitor the importation of tilapia into the country in order to protect local enterprises.

5. Short term subsidies for input materials in order to encourage more prospective fish farmers to set up production enterprises.

To sum up, the major limitation to the study was due to the fact that majority of the respondents were farm care takers. The initial aim of the study was to interview farm owners to in order to obtain their views on constraints experienced in cage fish farm operation on the Volta Lake. Unfortunately, most of the farm owners lived in different places in bigger cities several kilometres away from their fish farms. This made it difficult to gain access to them for interview. Also due to time and mobility constraints, I could not visit and interview actual farm owners living in the big cities. For this reason, it was easier for me to interview care takers since they lived close to the fish farms and also since they have a fair idea on how cage farms are operated on the Volta Lake.

However, there is a possibility of varying views from the actual fish farm owners and care takers on the issues of constraints experienced by farm operations. Views from farm owners in respect to constraints will be more valid as compared to care takers. This is due to the reason that they are the main financial driving force for the initiation, operation and establishment of cage fish farms. Hence, it would have been prudent to have interviewed them instead.

In view of this, for future studies of this nature, time and effort should be put in place in order to gain access to actual farm owners for interviews concerning constraints experienced in this production sector. This will lead to a much clearer image of the constraints experienced in operating cage fish farms on the Volta Lake. This will also help policy makers to come up with the best strategic solutions to address these constraints.

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Appendix

Sustainable Development of Aquaculture on the Volta Lake

July 2014.

Questionnaire

Assessing the Economic Viability and Sustainability of Aquaculture on the Volta Lake; A Case Study of the Asuogyaman District in the Eastern Region of Ghana.

Thank you for agreeing to take this survey. The survey is being done by the Faculty of Fisheries, Biology and Economics; University of Tromso. The purpose of the survey is to collect information and opinion from fish farm managers who are involved in aquaculture on the Volta Lake in the Asuogyaman District in the Eastern Region of Ghana.

All of the answers you provide in this survey will be kept confidential. No identifying information will be provided to the University of Tromso. The survey data will be reported in a summary fashion only and will not identify any individual person.

This survey will take about 20 minutes to complete.

There is an easy access to bank loans to start business.

- Strongly disagree
- Disagree
- Either agree or disagree
- Agree
- Strongly agree

There is a flexible nature of loan repayment.

- Strongly disagree
- Disagree
- Either agree or disagree
- Agree
- Strongly agree

Is it difficult to gain access to fish farm operation licence from the authorities?

- Yes
- No

If yes,
why?.....
.....
.....
.....

Are there conflicts in gaining access to the water resource?

- Yes
- No

If Yes, why?
.....
.....
.....
.....

Equipments needed to start fish farming on the Volta Lake are accessible on the market.

- Strongly disagree
- Disagree
- Either agree or disagree
- Agree
- Strongly agree

Are the prices of equipments needed for production on the market acceptable?

- Totally unacceptable
- Unacceptable
- Slightly unacceptable
- Neutral
- Slightly acceptable
- Acceptable
- Perfectly Acceptable

Fingerlings for production are readily available.

- Strongly disagree
- Disagree
- Either agree or disagree
- Agree
- Strongly agree

Are the prices of fingerlings acceptable?

- Totally unacceptable
- Unacceptable
- Slightly unacceptable
- Neutral
- Slightly acceptable
- Acceptable
- Perfectly Acceptable

Of what quality are the Fingerlings?

- Poor
- Fair
- Good
- Very good
- Excellent

The feed for production is readily available.

- Strongly disagree
- Disagree
- Either agree or disagree
- Agree
- Strongly agree

What is the quality of the fish feed?

- Poor
- Fair
- Good
- Very good
- Excellent

Is the cost of feed acceptable?

- Totally unacceptable
- Unacceptable
- Slightly unacceptable
- Neutral
- Slightly acceptable
- Acceptable
- Perfectly Acceptable

The prices of products on the market meet the right standards as compared to prices in other countries.

- Strongly disagree
- Disagree
- Either agree or disagree
- Agree
- Strongly agree

Is the cost of labour acceptable?

- Totally unacceptable
- Unacceptable
- Slightly unacceptable
- Neutral
- Slightly acceptable
- Acceptable
- Perfectly Acceptable

Is there an easy access to the market and other value chain of production?

- Yes
- No

If not, why?

.....
.....
.....
.....

There is an easy access to extension services and information.

- Strongly disagree
- Disagree
- Either agree or disagree
- Agree
- Strongly agree

Are you aware of Aquaculture Strategic Framework-Ghana?

- Yes
- No

We appreciate your response. We are seeking to understand the how economically viable and sustainable aquaculture is on the Volta Lake. Thank you for your time.