UNIVERSITY OF TROMSØ UIT

NORWEGIAN COLLEGE OF FISHERIES SCIENCE

The Role of the Market in the Development of Aquaculture in Ghana

Edmond Hamenoo

Master's Degree Thesis in International Fisheries Management
(30 credits)

May 2011

Abstract

Aquaculture in Ghana has over the years been little productive despite earlier claims about the high potential of the country. These claims are supported by an abundance of latent natural resources that can support large scale commercial production and the existence of a strong traditional market for fish products. A survey of consumer behavior in the local market for tilapia and fish in general was conducted in Ghana. The data were subjected to tabulation and multivariate analysis to assess the availability of market for tilapia and the determinants of its demand among different income earners. Local production according to the survey is not able to satisfy the market. Whereas low income earners and large families are avid fish consumers, it is mostly the relatively small group of high income earners that can afford tilapia at current retail prices. The performance of Ghana was measured in terms of the relative competitiveness of the value chain of tilapia in China, Egypt and the Philippines, as well as with prices on the global market. All the three countries profiled had a cost advantage and this was a result of wide differences in the cost of some factors of production or their relative scarcity in Ghana. The cost of importing fish feed, high interest rate on credit and poor production technology were some of the bottlenecks that greatly reflected on first sale prices. While a kilogram of fish feed for instance cost US$ 0.3 in Egypt and US$ 0.53 in China, the average price in Ghana is US$ 1.96. The export price of frozen tilapia fillet from China is about US$ 1 while the retail price of frozen whole tilapia in Ghana is about US$ 6.5. Tilapia from any of the countries surveyed would be more competitive to that of Ghana not only in the global market but also on the Ghanaian local market given the current price differences.

Acknowledgement

To God be glory for His sustenance and strength throughout my studies. I am grateful to my wife and lovely daughter Ena, for their unfailing love and support. I am thankful to my supervisors Torbjørn Trondsen and Jorge Santos for their time, encouragement and direction towards the success of this study. To you Mr. Noble Gati, I say, you are indeed a friend among friends. God be gracious unto you for every support you gave me and my family during my time of study in Norway. Jimmy and George, thanks for being available when I needed a brotherly hand. I am also grateful to my Dad who started it all and my Mum for her daily prayers for the success of my family in all we do. God bless you.

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ACRONYMS

ACP-EC	African, Caribbean and Pacific agreement with European Commission
AMS	Agricultural Marketing Service
Avail	Availability
BFAR	Bureau of Fisheries and Aquatic Resources
CA	Correspondence Analysis
CANOCO	Canonical Community Ordination
CCA	Canonical Correspondence Analysis
CMC	Cocoa Marketing Company
DCA	Detrended Correspondence Analysis
EAGA	Egyptian Agribusiness Association
EU	European Union
Expwk	Expenditure on fish per week
FAO	Food and Agriculture Organization
Famsize	Family size
FishCons	Fish consumption per week
GAFRD	General Authority for Fisheries Resources Development
GDP	Gross Domestic Product
GET EXCEL	Genetically Enhanced Tilapia with ‘Excellent’ strain
GIFT	Genetic Improvement of Farmed Tilapia
GIS	Geographic Information System
GNI	Gross National Income
GST	Genomar Supreme Tilapia
GTZ	German Agency for Technical Cooperation
HACCP	Hazard Analysis and Critical Control Points
Highinc	High income earners
IOC	International Olympic Committee
ITC	International Trade Center
Lowinc	Low income earners
Midinc	Middle income earners

MOFEP	Ministry of Finance and Economic Planning
MSSP	Multi-Sector Support Program
n. d.	No date
NOK	Norwegian Kroner
NPA	National Petroleum Authority
NSEC	Norwegian Seafood Export Council
PCA	Principal Component Analysis
PMMC	Precious Mineral Marketing Company
RDA	Redundancy Analysis
SWOT	Strength, Weaknesses, Opportunities and Threats
TilCons	Tilapia consumption per week
UN	United Nations
USA	United States of America
USDA	United States Department for Agriculture
VASEP	Vietnam Association of Seafood Exporters and Producers
WTO	World Trade Organization

1.0 Chapter One

1.1 INTRODUCTION

1.2 Global Trend

The contribution of aquaculture to global fisheries has increased sharply especially in the last decade. Aquaculture production by weight has increased from about 3.6% in 1970 to 36% of world production in 2006 (FAO, 2009). On the average, aquaculture with an annual growth rate of 7.2% has outpaced the world population growth rate (Subasinghe, 2005). In 2006, total world production of food fish products was about 110 million tonnes out of which aquaculture supplied 47% (FAO, 2009).

1.3 Aquaculture in Ghana

Ghana; a West African country, has a coastline of about 550 km with a continental shelf area of 24,000 km^2 (Ashitey and Flake, 2009). The whole country is traversed by numerous rivers and lakes with over 50 lagoons of different sizes which were seen as huge natural potentials for aquaculture development in Ghana (Prein et al, 1996).

Fig. 1: Map of Ghana showing the rivers and lakes

Source: Jorgen Henriksen, 2009

Fisheries contributed 3.9% to the Gross Domestic Product (GDP) in 2006 (Budget Statement, 2008). According to the Bank of Ghana Report on the Fishery Sub Sector for 2008, there has been a steady decline in fish production from 6% of GDP in 1993 to 3.9% in 2006 (Bank of Ghana, 2008). Ghana, which was a fishing country 'of regional importance' (Mills et al 2008), is currently a net importer of fish and fish products (Ashitey and Flake, 2009).

1.4 Problem Statement

Earlier research revealed the production potential of large scale aquaculture in Ghana (Prein et.al., 1996). Despite all her rich natural and physical resources, the growth rate of aquaculture in Ghana has been very slow over the years. This study therefore seeks to understand the reasons for the slow growth rate. With wild capture on the decline from 459,000 metric tones (mt) in 2000 to 357,000 mt in 2008 (Ashitey and Flake, 2008), "aquaculture is assigned the significant role in meeting the shortfall" (Prein et. al., 1996 pg 4).

Some studies already done on fish farming in Ghana include; Kapetsky et. al., (1991), FAO (1991a), FAO (1991a), Prein et. al., (1996),Uzokwe (2000), Hiheglo (2008), Asmah (2008), Henriksen (2009) and Ofori et al., (2009), Bank of Ghana (2008) and Ashitey and Flake (2009). As relevant as all these studies are in contributing to knowledge in fish farming in Ghana, none positioned the production process in Ghana within the context of competition from other producing countries neither was there an analysis of the local market relative to the international market for tilapia. The justification for this work is to have an overview of practices that achieved results in world tilapia production and marketing relative to what is done in Ghana. How does tilapia production cost in Ghana competitively relate with those in other countries and how is the market currently influencing what is being produced? These are two important knowledge gaps this research seeks to fill for improving the background for promoting aquaculture development in Ghana.

1.5 Aim

The aim of this paper is to understand the reasons that account for low rate of aquaculture production in Ghana compared with other countries in order to facilitate an increase in tilapia production.

1.6 Objective

The main objective of this research is to examine if local and international markets are determining factors in the production of tilapia in Ghana. The cost of production of other countries relative to Ghana will also be examined.

1.7 Research questions

1. Is there a competitive market for tilapia in Ghana?
2. What are the main bottlenecks to growth in the value chain of tilapia in Ghana?
3. How does the global tilapia market influence Ghana's competitive position for tilapia production?

1.8 Organization of Study

The study is organized in six chapters. Chapter two discusses the theoretical background of the study. Chapter three presents profiles of three tilapia producing countries to help identify the trade opportunities and threats for Ghana's tilapia industry. The methodology and data analysis of a field survey is discussed in chapter four. Chapter five will present the result of a survey of fish consumption patterns and bottlenecks in the tilapia value chain from the perspective of consumers, retailers and farmers. The final chapter discussed the results and findings and end with suggestions and conclusion.

2.0 Chapter Two

2.1 Markets and value chains

This chapter presents a theoretical discussion of the main concepts used in this work. A series of research works and experiences from some countries that tend to support the claim that the growth of aquaculture and other agricultural products is a function of the market (Ades and Glaeser, 1999) are reviewed. In addition, the concepts of value chain and supply chain, as well as the methods here introduced to evaluate them, including SWOT analysis are introduced.

2.1.1 Appraisal of value chains

A value Chain consist of series of activities by which a product or service is created and delivered to the end user (Kaplinsky and Morris, 2000). The structure of a value chain is made of design, production, marketing and consumption (Kaplinsky and Morris, 2000). The value chain of a firm according to Porter (1980) is a part of a much larger system known as the value system (NetMBA, 2010). Every firm within the value system thus has its own value chain. There are linkages within the firm's value chain and between chains in the value system (NetMBA, 2010). Aquaculture production can be considered as a value system with fish production and marketing as firms within the system with their own value chains. The value chain is important to the firm because its level of profit or market share depends on how effectively these functions are performed (NetMBA, 2010). How competitive a value chain becomes or remains is a result of its ability to 'create a cost advantage by reducing the cost of individual value chain activities' and 'focusing on those activities with core competencies and capabilities in order to perform better than do [other] competitors' (NetMBA, 2010). A failure at one stage of the chain will eventually affect the cost outcome of the product. And since the price consumers pay reflects the cost of production, firms that produce at relatively lower cost remain competitive. The basis of this work is to examine the importance of the market in the value chain of aquaculture production in Ghana.

2.1.2 Markets and aquaculture development

Traditionally, a market is a place where transactions involving the exchange of goods and services take place (Quagrainie and Engle, 2006). The concept of a market however has a broader scope. According to Quagrainie and Engle (2006), a market involves the whole relationship between demand and supply. The market thus represents what consumers want and can pay for (demand) and what producers are willing to supply at different prices (Quagrainie and Engle, 2006). In a free market economy, it is the market that decides how much of a good is produced by "finding the price at which quantity demanded equals quantity supplied" (Begg et al., 2000). Price which is indicative of the scarcity of a product on the market shows the level of consumers' need for that commodity (Quagrainie and Engle, 2006) and is a signal to producers as to how much to produce (Asche et al., 2008). In a free market economy, price is determined by the interaction between demand and supply, *ceteris paribus* (Whelan and Msefer, 1996). Anytime supply is greater than quantity demanded, the surplus created all things being equal will cause price to fall (Mankiw and Taylor, 2011). And when demand is greater than quantity supplied, there is excess demand (shortage) which all things being equal will push up the price (Mankiw and Taylor, 2011). An increase in market demand increases the value and the potential profit in the value chain. This attracts new entrants thus leading a growth in the value chain. Apart from price, the level of income of consumers determines how much of a commodity they will buy. The effect of income change on the quantity that consumers are willing to buy of a product depends on the type of good (Mankiw, 2011). Where there is a positive relationship between income and the quantity bought, the good is referred to as a normal good. A case in which an increase in income leads to a reduction in the quantity of a good a consumer wants to purchase will mean the consumer considers the good to be inferior (Mankiw, 2011). There is an inverse relation between income level and quantity demanded of an inferior commodity (Mankiw, 2011).

Every commercial producer requires a market for his goods; locally, internationally or both. A local market in the context of this work will be referred to as the processes of demand and supply within the boundaries of Ghana while international market which will

be used synonymously with international trade involves the exchange of goods and services across the boundaries of Ghana (Begg et al., 2000). Apart from the existence of a market (demand), the following conditions among others as stated by Cateora (1987, pg 46) must be present for international trade to be initiated and sustained.

- Tariffs must not exist or must not exceed the difference in costs after transportation and profit are considered.
- No governmental or financial restrictions inhibit the products and trading of those products.

International trade will be considered in the light of two advantages it has with respect to production of goods and services. Firstly, specialization which is a result of the theory of comparative advantage leads to an increase in the quantity and quality of goods and services produced (Anderson, 2008). Secondly, producers benefit from economies of scale as they engage in international trade (Anderson, 2008) which may lead to further increase in production.

Performance (profit, market shares etc.) is dependent on a firm or value chain's position and market power in its transactions for scarce raw materials and the processing of those raw materials into finished products for target consumers. Strength, Weaknesses, Opportunities and Threats (SWOT) analysis is a tool used by value chains to do an initial assessment of their performance and their ability to expand and compete with other value chains (Swinton, 2005). Strengths are generated from controlling internal resources or structures important in maintaining a strong market position that a firm will want to maintain and if possible improve upon (Swinton, 2005). They are advantages a value chain considers it has over other competitors (IOC, n. d.). These may include capital, cheap labour and access to an advanced technology. Weaknesses are lack of internal resources that do not allow a value chain achieve its full potential (Swinton, 2005). They are obstacle and bottlenecks that hinder the growth of a firm and makes it less competitive. Examples include relatively high interest rate on loans, poor infrastructure and inaccessibility to some factors of production. Opportunities are external factors that a value chain can take advantage of either currently or in the future (USDA, 2008). Finally threats are external factors which may sometimes be unforeseen circumstances that

adversely affect the growth and competitiveness of a value chain (USDA, 2008). Examples include unstable inflation and currency exchange rates, the discovery of a natural resource like oil and its associated problems like 'Dutch disease' and many more. They are factors that retard the growth of the value chain.

Bottlenecks to growth are considered as hindrances to optimal transactions throughout the entire value chain. They are factors that limit output (Schmenner, 1984). Bottlenecks especially those between different value chains in the same value system may require government intervention or regulations to solve them.

2.1.3 The Role of the Government

Government interventions in ensuring optimal transaction within and between value chains through the removal of bottlenecks may be in the form of infrastructural development and regulations may take the form of tariffs and levies. An instance is the regulation by the Norwegian government to institute a value tax of 3% on salmon exports that will be used to market the product in generic markets (Bjørndal et al, 2008). The importance of markets in the promotion of aquaculture growth has driven governments of various producer countries and private agencies to invest in advertising and locating buyers for their products. The Norwegian Seafood Export Council (NSEC) which is a government agency for instance spent 235 million Norwegian Kroner (NOK) in marketing atlantic salmon between 1997 and 1999. This was expected to increase to 290 million NOK in 2001 (Bjørndal et al., 2002).

The success of Vietnam as a major aquaculture producing and exporting country was a result of a strategy well planned and executed by both the government and the private sector (ITC, 2009). According to Cuyvers and Binh (2008), there was a shift from a production oriented approach to a market oriented approach in 2003. Unlike the production oriented marketing in capture fisheries, aquaculture production according to Pillay and Kutty (2005), should be market oriented. There is therefore the need for clear policy directions by the government towards the achievement of set targets.

Vietnam signed a bilateral trade agreement with the USA in 2000 (Cuyvers and Binh, 2008) and joined the World Trade Organization (WTO) in 2007 (ITC, 2009). These agreements laid very solid foundations for an increase in production and exports. Aquaculture production increased from 59,000 mt in 1976 to 1,150,100 mt in 2004 (Nguyen and Minh, 2005). Pangasius (*Pangasius hypophthalmus),* which, for example, was exported to only 17 countries before 2000 was by 2006 being exported to over 60 countries (Cuyvers and Binh, 2008). The ability to discover and penetrate new foreign and domestic markets was enhanced by the formation of the Vietnam Association of Seafood Exporters and Producers (VASEP) in 1998 (Cuyvers and Binh, 2008). VASEP is a non-governmental organization made up of farmers, exporters and companies of the sea food sector (VASEP, 2011). They provide training and market information to farmers as well access to farm inputs while exploring new and existing markets for their products (VASEP, 2011). Apart from the availability of farm inputs such as feed and fingerlings at a low cost, the main driver of the aquaculture industry in Vietnam has been access to international markets (Cuyvers and Binh, 2008).

Changes in markets have had "a profound impact on both the demand for products from aquaculture and the production sector itself" (Josupeit et al., 2000). Governments and producer associations in countries such as Jamaica, China, Thailand and Chile have therefore been very active in creating markets for aquaculture products both locally and internationally (Hishamunda and Ridler, 2002). The United States government through the Agricultural Marketing Service (AMS) creates growth opportunities for aquaculture producers by assisting in the development of markets (Olin et al., 2000). They also buy meat products off the market 'in order to stabilize market conditions' for the sake of promoting aquaculture growth (Olin et al., 2000).

In summary, competitions among value chains or between value systems are influenced by cost advantages in the markets in which they operate. Though the market is not an isolated growth catalyst, it is an important link in the value chain of aquaculture that has a direct impact on production. How much is produced is dependent on the effectiveness of

the market both local and international. The next chapter will discuss relative cost advantages different value chains have in tilapia production.

3.0 Chapter Three

3.1 Country Profiles

This chapter presents the profiles of three tilapia producing countries and that of Ghana. "Given that producers' ability to compete is a function of differences in production and transport costs" (Norman-Lopez and Bjorndal 2009), there was the need to investigate the value chains of some selected countries that are already major competitors on the international market in tilapia vis-à-vis that of Ghana. The focus is on the main components of the cost of production and how the various countries have managed to keep it low thus a lower price and an attractive local and international market for their tilapia. The strengths and weaknesses in the various value chains are discussed.

3.1.1 China

Tilapia is among the top of cultured fresh water fish species in China (Qiuming and Yi, 2004). From 18,100 mt in 1984 (Qiuming and Yi, 2004), China produced 1,150, 000 mt of tilapia in 2009 (Josupeit, 2010). China is the main supplier of tilapia to the US market with over 70% of the total market share (Josupeit, 2010). Russia, the EU region and some Asian countries are the other major importers of Chinese tilapia (Josupeit, 2010). About 50% of total tilapia produced in China is consumed domestically (Fitzsimmons, 2009). The success of China as the world's major producer of tilapia is among other things due to the ability of the Chinese farmer to produce at a low cost. The reasons for the low cost; at least at the onset of the growth in Tilapia aquaculture according to literature (Appendix 5), was due to the following factors:

Firstly, the juvenile are fed on algae bloom which is created by fertilizing nursery ponds with chicken or duck manure (Fitzsimmons, 2011)[1]. Secondly, fingerlings were produced by state hatcheries and distributed to farmers. Thirdly, there were government sponsored research programs that helped in the introduction of Genetically Improved Farmed Tilapia (GIFT) (Qiuming and Yi, 2004). Another incentive was that fuel, feed ingredients, electricity and health care were also subsidized for farmers. Finally there

[1,] Email correspondence with Kevin Fitzsimmons (March, 2011) – can be found in appendix 5

was a government backed marketing association that was able to create a ready market for produce[2]. To avert the problem of high interest rates and the challenges in getting credit from the banks, small scale farmers arrange a scheme Qiuming and Yi (2004) referred to as 'company + base farm + farmers'. In this model, companies provide the farmers with farm inputs and technical assistance and in turn buy the grown tilapia. There are at least 20 tilapia processing factories owned by investors and certified by the EU, USA and authenticated by Hazard Analysis and Critical Control Points (HACCP) that are able to turn out over 200,000mt a day (Qiuming and Yi, 2004). Apart from the above stated strengths of the value chain of tilapia production in China, the quantity and quality of tilapia seeds (Qiuming and Yi, 2004) and rising cost of production (Einhorm, 2010) are some bottlenecks in tilapia production in China.

3.1.2 Egypt

Egypt is the second largest tilapia producing country after China with a total harvest of 390,280 mt in 2009 (FAO, 2010) up from 27,854 mt in 1996 (Nassr-Alla, 2008). A number of factors account for this steady growth, some of which are the following.

Growing seasons are preceded with the application of chicken manure to the ponds to 'improve natural productivity' (El-Gayar, 2003). This develops algae that the juveniles feed on. Secondly, apart from tilapia seed from state owned hatcheries and natural resources, the General Authority for Fisheries Resources Development (GAFRD) has issued licenses to private hatcheries (Nassr-Alla, 2008). Thirdly, both public and private organizations such as GAFRD, Multi-Sector Support Program (MSSP) and the Egyptian Agribusiness Association (EAGA) are into the technical and management training of farmers (Nassr-Alla, 2008). Also, more than 16 fish feed manufacturing companies and over 300 hatcheries have been established in the last 10 years (FAO, 2010). Fourthly, farmers are financed by wholesalers who receive the produce at an agreed price (FAO, 2010). Finally, the Ministry of Agriculture is supporting fish production in tanks in the desert from which a production of 1030 mt was reported (FAO, 2010). The main bottleneck of tilapia farming in Egypt is the competition for land use with respect to tourism.

[2] Email correspondence with Kevin Fitzsimmons (March, 2011) – can be found in appendix 5

3.1.3 The Philippines

According to the Bureau of Fisheries and Aquatic Resources (BFAR) (2008), tilapia is the second most cultured fish in the Philippines.

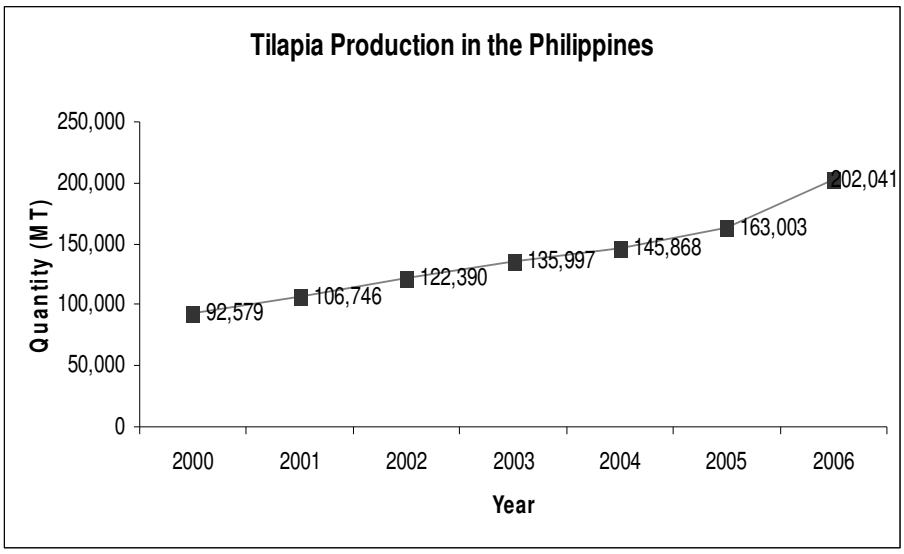

Fig. 2: Tilapia production in the Philippines from 2000 to 2006
Source: BFAR, 2008

Tilapia production has grown steadily over the years from 16,591 in 1981 (Guerrero, 1994) to 202,041 in 2006 (BFAR, 2008), as shown in the Figure 2. This increase was among other things attributed to improved quality of seeds such as GIFT, Genomar Supreme Tilapia (GST) GET EXCEL (which claims to result in 38% faster growth than natural seed) and others (Toledo *et al.,* 2008). This is because the first attempts to implement commercial Tilapia aquaculture in the East were based on narrow genetic varieties of fish. Additional genetic diversity for artificial selection programs had to be brought in later from Africa where Tilapia species originate. Based on a Master Plan for the Tilapia Industry, there is a public/private sector partnership especially in the development and distribution of improved tilapia strains (Toledo *et al*., 2008). Over 1 billion tilapia seeds are supplied annually out of which about 90% is produced by the private sector (Toledo *et al.,* 2008). Due to the need for collaterals for credit from formal

sources, most farmers finance their operations through informal credit schemes. The financier-caretaker or the trader-operator arrangements are made in which profits are shared between the two parties or the produce is exclusively sold to the trader in the case of the later arrangement (Bestari and Morales, n. d.). Another strength of the Philippines' value chain is a strong local market. Tilapia consumption has exceeded that of milk fish which was traditionally more popular, thus creating the need to expand tilapia production (Toledo et al., 2008). The main challenge of tilapia farming in the Philippines is getting modern technologies of farming to the rural farmers (Toledo et al., 2008). The Philippines is currently among the top 5 producers of tilapia in the world (Fitzsimmons, 2010).

3.1.4 Ghana

Fish farming started in Ghana in the 1950s (Quagrainie et al 2009). The stages of aquaculture development in Ghana can be divided into three. The pre-1980s when most of the ponds were constructed by the government for training and demonstration and for research (Quagrainie et al 2009). The second phase was in the 1980s which saw a widespread response to the government's initiative towards self sustainability in fisheries (Prein et al 1996). Many ponds were constructed by both individuals and communities. Much of the effort in the first and second phases yielded very little and created disillusion among those who ventured into it (Prein et al 1996). The most recent phase began about a decade ago (Quagrainie et al 2009). This is characterized by a gradual shift from subsistence to commercial farming and from the pond system to the cage system which contributes over 80% of total aquaculture production in Ghana (Ashitey and Flake, 2009). Much of the fish on the local market are thus from cages and not ponds. Since 2000, the general annual growth rate of fish farms is about 16% (Asmah, 2008). This is evident in the numerous farms both small and large along the lower section of the Volta Lake but not in the quantity of fish produced annually. Certain factors have kept the cost of production of the Ghanaian farmer at a level where his produce is affordable to only a section of the market. Three of these factors are fish feed, cost of lending and price of fuel.

It is estimated that feed constitutes between 50% and 70% of the total cost of producing tilapia (Partos, 2010) The gradual shift from pond system to the cage system in Ghana requires the use of floating fish feed. With a feed conversion rate between 1.4 and 2.5 (Ofori et al., 2009) the national feed requirement is estimated as not less than 15,000 mt per year (Ashitey and Flake 2009).There is however no feed mill in Ghana at present (Ashitey and Flake 2009). All the feed needed are thus imported from countries like Israel, Denmark, China, Vietnam, France, the Netherlands and Brazil. There are varieties of feed types with different protein levels on the local market (Table 1). The average price of a kilogram of feed in Ghana as at January 2011 was about $1.96. Not only is the price high but also unstable as a result of the instability in the currency exchange.

Table 1: Retail price of imported tilapia feed on the Ghanaian market as at January 2011

Feed Type	Country of Origin	Price (GH¢)	No. of kg	Price per kg (GH¢) [US$][3]	Protein %
Coppens	Nertherlands	48	20	2.4[1.54]	42
Raanan	Isreal	37	20	1.9[1.22]	35
Nicoluzzi	Brazil	45	25	1.8[1.15]	40
China Tilapia Feed	China	40	25	1.6[1.03]	30
Biomar	France	35	15	2.3[1.47]	40
Biomar	France	45	20	2.3[1.47]	40
Zeigler	USA	43	20	2.2[1.41]	40
Inter-aqua	Vietnam	40	25	1.6[1.03]	30
Pira	Brazil	42	25	1.7[1.09]	36

Source: Personal survey

Access to credit is a major problem facing all kinds of businesses in Ghana (Yeboah, 2011). Apart from the high lending rate which ranges between 25% and 30% (Yeboah, 2011), it is extremely difficult for farmers to access loans because of demand for collateral securities from banks.

[3] http://www.oanda.com/currency/converter/(28.01.2011)

Since the deregulation of the petroleum sector in Ghana, subsidies on fuel have been removed (GTZ, 2009). Ex-refinery prices are now calculated based on the world market prices. Thus any fluctuation in the world market price, directly affects the retail price on the local market. The current retail price of a liter of diesel which fish farmers use is GH¢ 1.53 (US$ 1.03) (NPA, Ghana 2011).

3.2 Country Comparison and World Market Prices of Tilapia

Table 2. A comparison of price/rates of cost items in four tilapia producing countries

Items/Countries	China	The Philippines	Egypt	Ghana
Price of feed per kg	0.53	0.95	0.3	1.96
Price of Diesel/Litre	1.04	0.7	0.32	1.03
Lending Rate	6.06	6.89	12.33	25+
Price of Tilapia	0.9	1.85	0.51	6.5

Prices are stated in US $ and lending rates in percentage per annum

The price of feed per kilogram in Ghana is about twice that in the Philippines and about four times that of China (Table 2). It should be noted here that all the countries have many feed manufacturing mills except Ghana that currently imports all floating feed for its cage cultured operations. The price of Diesel in China is the highest but only 1 US Cent above the price in Ghana. The lending rate in Ghana which is between 25% and 30% is more than twice the rate in Egypt and more than four times that of China and the Philippines. The price per kilogram of whole tilapia is highest in Ghana at about US$6.5 and lowest in Egypt at US$0.51.

The price of tilapia is determined by the form of the product; whole, live, fresh fillet or frozen fillet (Fig. 3). Prices from the world market show fresh fillets as the most expensive form of tilapia. The price trend of fresh fillets shows a price range of between $5 and $6 per kilogram. This is followed by the live fish and frozen fillet. Whole tilapia is the cheapest with an average price of $1.2 per kilogram.

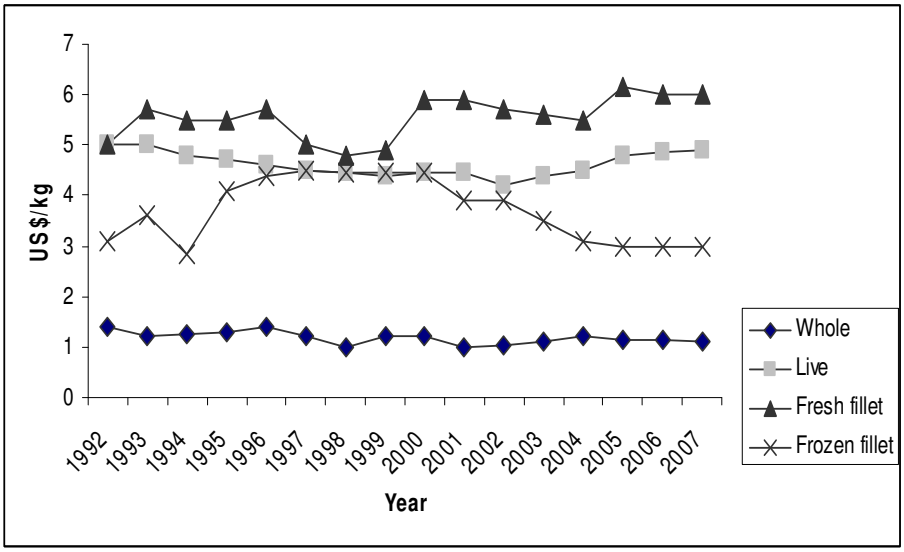

Fig. 3: World market prices of tilapia

Source: Fitzsimmons (2008)

The price of whole tilapia looked the most stable over the years; not fluctuating as steeply as that of the fresh and frozen fillets. There are currently no tilapia fillets on the Ghanaian market from the survey done. The fish is sold either live whole, frozen whole, smoked whole or dried salted whole. Given the trend of whole tilapia prices over the period (Fig. 3), Ghana's local market price is about thrice the price on the international market.

Statistics from both country and global tilapia production show that price falls over time as production increases (Figures 4 and 5). This may be due to two reasons. With improvement in technology and the benefit of economies of scale, the cost of production reduces and this translates into lower prices (Asche et al., 2008). Secondly, as more is supplied, the only way to attract consumers and remain competitive is to reduce price (Begg et al, 2000).

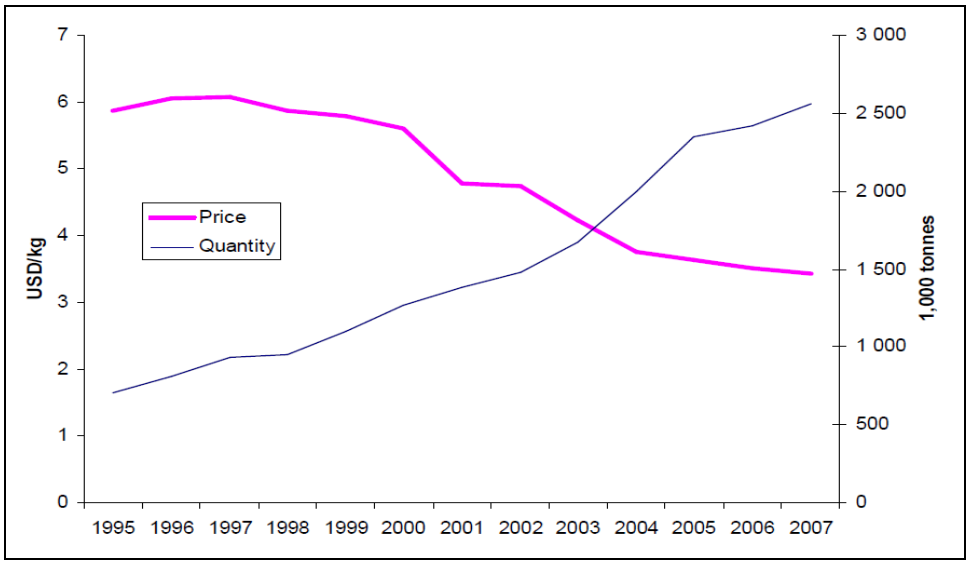

Fig. 4: Global tilapia production and USA import price for frozen fillets

Source: Asche et al, 2008

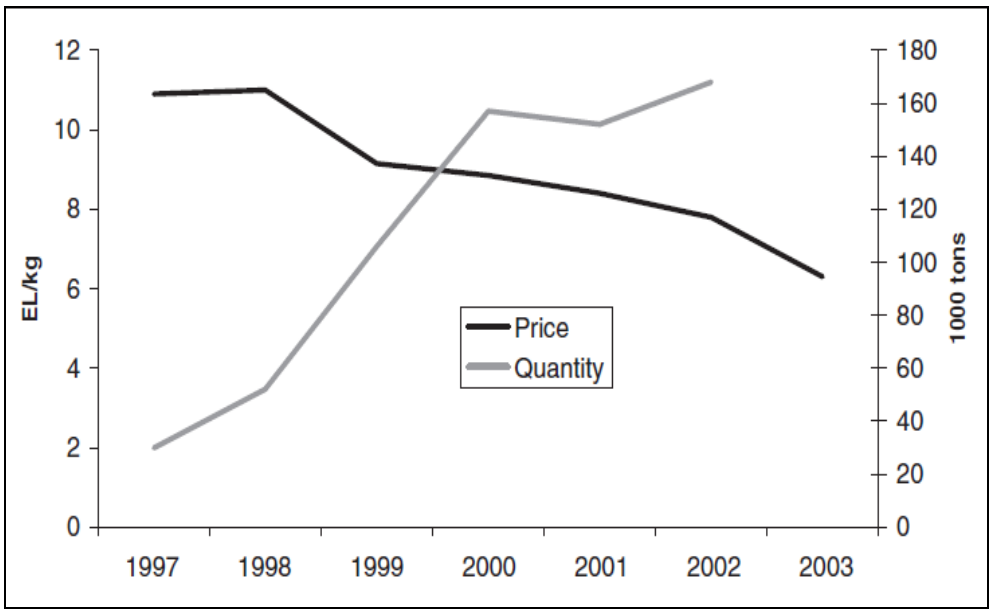

Fig. 5: Egyptian production of tilapia and wholesale price

Source: Asche et al, 2008

In conclusion, the performance of Ghana was measured in terms of the relative competitiveness of the value chain of tilapia in China, Egypt and the Philippines, as well as with prices on the global market. All the three countries profiled had a cost advantage

over Ghana and this was a result of wide differences in the cost of some factors of production and in some cases their relative scarcity. The cost of importing fish feed, high interest rate on credit and poor production technology were some of the bottlenecks that led to high cost of production which greatly reflected on first sale prices. While a kilogram of fish feed for instance cost US$ 0.3 in Egypt and US$ 0.53 in China, the average price in Ghana is US$ 1.96. The export price of frozen tilapia fillet from China is about US$ 1 while the retail price of frozen whole tilapia in Ghana is about US$ 6.5. Tilapia from any of the countries surveyed would be more competitive to that of Ghana not only in the global market but also on the Ghanaian local market given the current price differences.

4.0 Chapter Four

4.1 Methodology in Field Investigation

As part of this research, a field investigation was conducted among tilapia farmers, wholesaler/retailers and consumers in Ghana. This chapter presents a methodology of how data was collected and the tools used in analyzing the data.

4.1.1 Sources and Tools of Data Collection

This research adopted a mixed method approach. The study is aimed at finding out whether or not the market is a factor in the development of aquaculture in Ghana. To help achieve this, primary and secondary data was collected. Primary data was collected through the use of interviews and questionnaires from the main stakeholders in the supply chain; farmers, wholesalers/ retailers and from the demand side; consumers. In all, 44 consumers, 31 wholesalers and retailers and 14 farmers were sampled. The secondary data was collected from the Fisheries Commission of Ghana and the Bank of Ghana and consist of interviews and documentary reviews. To get an overview of important statistical factors by comparing development in different countries, data and information on the profiles of China, Egypt and the Philippines were collected from reviewing of reports and research works found in journals and on the internet. Where there was the need for further clarification on some information or data, email correspondence or telephone interviews were conducted with the various authors.

4.1.2 Sampling Methods

Convenience sampling was used in selecting the location for the research. Though there are numerous farms in different parts of the country, the choice of the area was done first to facilitate easy communication to avoid the use of interpreters. Secondly, I had a target of getting information from both cage farmers and pond farmers, so I had to select an area where the two are not geographically too far from each other. Based on these criteria the Volta and Eastern Regions were chosen. Most of the cage system is practiced along the Volta Lake which passes through these two regions. Convenience sampling is a non-probability sampling method where unit selection is based on accessibility or convenience (StatPac, 2011). Its advantage is that it is direct, easy and a relatively less

expensive method (Trochim, 2006). The disadvantage however is the difficulty in extrapolating the result as a true representation of the whole population (National Audit Service, 2000).

I used the snowball sampling in selecting the farms to work in. I had to be introduced to a farmer by a friend who in turn directed me to some of his colleague farmers. Snowball sampling is another non-probability method that depends on referrals (StatPac, 2011). I could not get any information from farms that had only caretakers without permission from the managers/owners who were most of the time resident in the capital city. An initial person who meets the criteria is identified and that person in turn recommends others. Just as the convenient sampling, it is easy to use but at the cost of introducing some level of bias (StatPac, 2011). Retailers and wholesalers were sampled in three cities based on their willingness to answer the questions; Accra, Tema and Ho, so also were the consumers.

4.2 Data Analysis

Data analysis was done using tables and graphs in Excel and Multivariate statistical tool for Canonical Community Ordination (CANOCO). Multivariate techniques were utilized because the description of individual consumer, or groups of consumers, is typically multi-dimensional. A consumer is more appropriately described by a number of interacting variables accounting for his/her status, preferences and actions, rather than by one variable at the time. Redundancy Analysis (RDA) which is one of the ordinations of CANOCO (Leps and Smilauer, 1999) was used to analyze demand determinants of tilapia and reasons for fish preferences. CANOCO is a tool for constrained and unconstrained ordination in ecological applications but have also been used in public health, geology and market research. Morales et al. (2001) for example used CANOCO in analyzing the primary economic sector of Mexico. In multivariate ordination, the species and the environmental variables are arranged in a plane and interpreted by x-y axes. CANOCO uses species data to mean response variables and environmental variables to mean predictors (Ter Braak and Šmilauer, 2002). The response variable is explained by

the ordination axes and the predictor variable is used to define the ordination axes (Ter Braak and Šmilauer, 2002).

The response variables in this work are made of the number of days respondents consume tilapia in a week, expenditure on fish per week and fish consumption days per week. The environmental variables are determinants of demand for tilapia, determinants of demand for fish and income levels. Respondents were divided into three income groups. Not able to access any national standard criteria in Ghana, the classification was done according the World Bank criteria for countries. According to the World Bank grouping, high income earners are those with an annual Gross National Income (GNI) per person of US$11,906 (GH¢18,019) while the middle income are those within the range of US$11,455 (GH¢17,337) and US$936 (GH¢1,416). Low income earners are those with a GNI of less than US$935 (GH¢1, 4159) (WWF Living Planet Report, 2010). The average incomes of different professions in Ghana were considered in the classification. A teacher for example was classified as middle income earner and the manager of a road construction company was placed in the high income category. From the survey, high income earners constituted 23% of the total sample, middle income earners, 41% and low income earners were about 36%. The currency conversion was done using the international conversion site; OANDA.com with rates as of 11.04.2011.

There are four main ordination techniques based on whether weighted averaging or linear methods are used and if or not the ordination is constrained or unconstrained (Leps and Smilauer, 1999). These are Principal Component Analysis (PCA) and Redundancy Analysis (RDA) which are both linear methods. The rest are Correspondence Analysis (CA) and Canonical Correspondence Analysis (CCA) (Leps and Smilauer, 1999). A Detrended Correspondence Analysis (DCA) was initially performed to check the statistical length of gradient which was less than 4. According to Ter Braak and Šmilauer, (2002) if the gradient is less than 4 standard deviations, the data shows a linear response. The linear methods of PCA/RDA were thus selected. A test of relative significance of the explanatory variables and the effects of the explanatory variables on other variables was performed using the Monte Carlo test. The results and also that of an initial PCA biplot

was created to show how samples relate to the species variables could be found in the appendix. A SWOT table on the bottlenecks in the tilapia supply chain in Ghana is constructed based on the results of the analysis and other secondary sources at the discussion stage of the work.

Based on the principle of validity, discussion of findings and any conclusion that will be reached in this work will be based only on the primary data and the secondary data collected. Any other information used will be appropriately referenced.

5.0 Chapter Five

5.1 Survey Results

This chapter presents the results of a survey conducted among tilapia farmers, wholesalers/retailers and consumers in Ghana. The results are analyzed under two headings. These are bottlenecks to growth in the value chain of tilapia and the demand for tilapia. The chapter ends with a presentation of a multivariate analysis on consumer behavior with respect to tilapia and fish consumption in general.

5.2 Bottlenecks to growth in the Value Chain for Tilapia

The perceptions retailers and farmers have on the bottlenecks in the tilapia supply chain is presented in Figures 6 and 7. About 60% of the concerns of farmers were about tilapia feed and the cost of loans. There is currently no fish feed manufacturer in Ghana. The only feed mill produces sub standard quality and this is rarely patronized by farmers (Ashitey and Flake 2009). Even that mill was recently shut down due to 'technical reasons'. Farmers must therefore import all the feed they need, the price of which changes with the currency exchange rate.

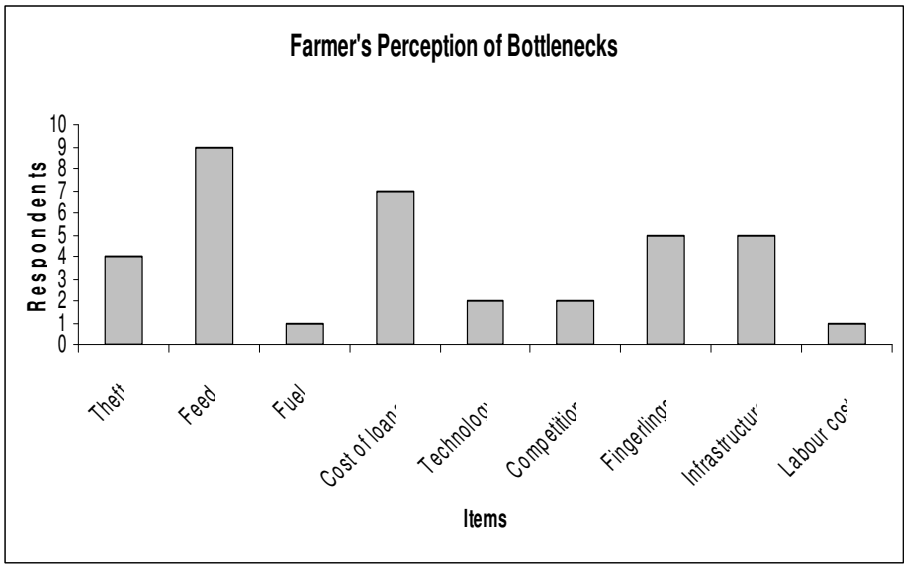

Fig. 6: Bottlenecks to growth as stated by tilapia farmers

Some other factors stated are poor quality fingerlings, theft and poor infrastructure. Some of these farmers had to construct their own feeder roads to their farms from the nearest

town or villages. This was because access roads were either too bad or non-existent. This is not only a challenge for farmers in transporting fingerlings to their farms but also for retailers in moving their products to the market.

The retailers on their part mentioned lack of credit and the cost of fish (the price at which they buy it from farmers and wholesalers) as the two most hindering factors. The farm gate price of tilapia currently ranges between GH¢4.5 (US$ 2.9) and GH¢5 (US$ 3.3). Other factors include the cost of transportation, lack of storage facilities, frequent power cuts and competition from imported fish.

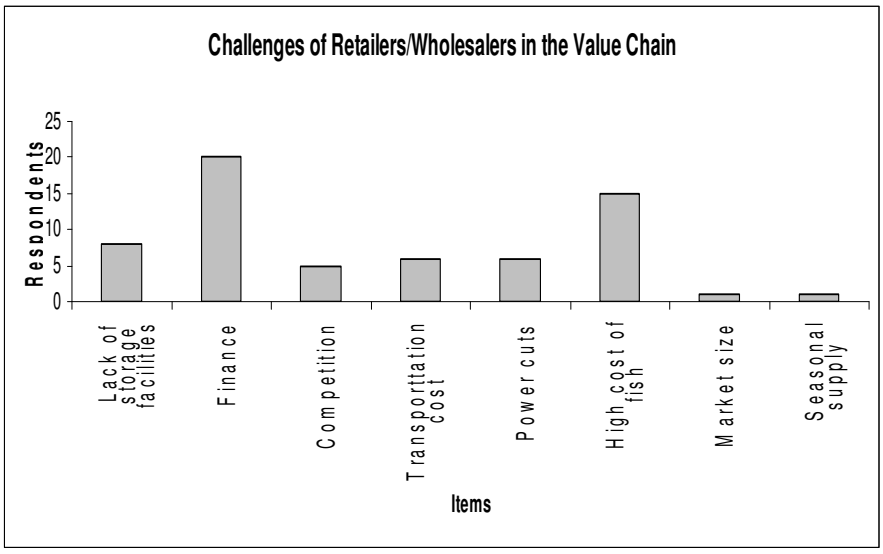

Fig. 7: Bottlenecks to growth by wholesalers/retailers in the tilapia value chain

A direct question on the availability of market for tilapia was posed and 84% of the retailers registered a yes while 16% said no. And as to whether there is always enough supply to meet demand, 64% responded no and 36% said yes.

5.3 Demand for Fish

Retailers and wholesalers interviewed in the survey claimed that salmon and tuna (*Scombridae*) were the most common fish species sold by retailers and wholesalers (Figure 8). Other species include Sea breams (*Sparidae*), Mackerel (*Carangidae*), shrimp

(*Penaeidae*), sardinellas (*Clupeidae*), and catfish (*Ariidae*). Visibly missing from the list of fish most sold by retailers and wholesalers in Ghana is tilapia (*Oreochromis niloticus*).

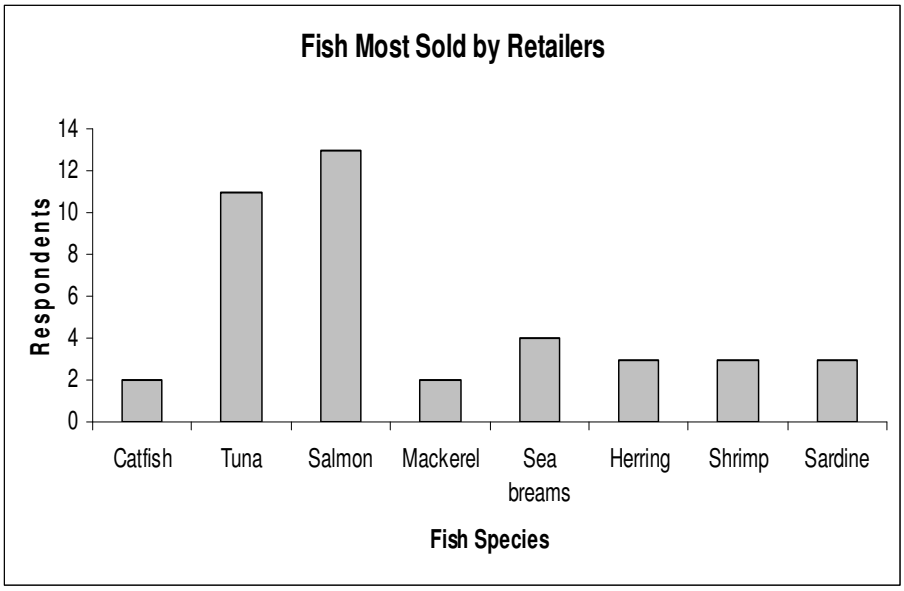

Fig. 8: Retailers/Wholesalers response on fish commonly sold

Though the retailers and wholesalers sold some tilapia, most claimed the quantity sold compared with the other fish species was very small. About 52% of consumers surveyed did however express preference for tilapia relative to most of the other species they currently buy from the market all things being equal (Figure 9).

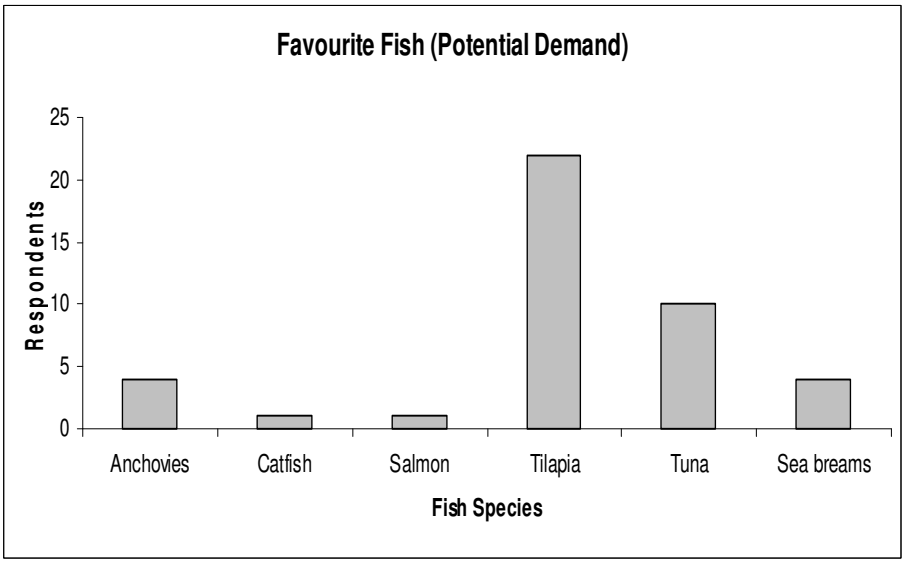

Fig. 9: Fish species on the market consumers will prefer to buy according to consumers

Thus given that they have purchasing power, the majority of consumers will buy tilapia. This was followed by tuna, sea breams, anchovies, salmon and catfish. The majority of the respondents who preferred tilapia will have it because of its taste and in the fresh or frozen form.

About 70% of the consumers interviewed complained of the high price of tilapia (Fig.10). This is against the background that the current retail price of a kilogram of tilapia ranges between GH¢ 8 ($5.2) and GH¢10 ($6.5) depending on the size of the fish and the geographical location of the shop or market. The price of salmon ranges between GH¢ 2.5 (US$1.7) and GH¢ 4 (US$2.7) and sea breams are between GH¢ 4 (US$2.7) and GH¢ 8 (US$5.47). Most of the respondents believed that salmon, which is imported, is patronized because of its relatively low price compared to other species like sea bream and tilapia. Other concerns raised were the non-availability of mostly fresh and frozen tilapia when they need it, the size and the unhygienic conditions to which retailers especially expose the fish.

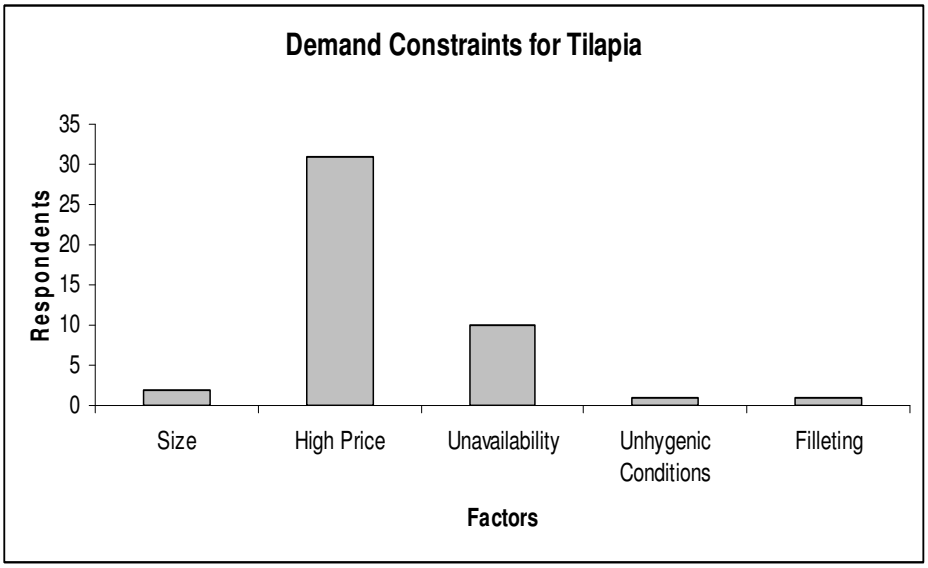

Fig. 10: Factors that constrain demand for tilapia according to consumers

The concern of the consumers was supported by the perception of most of the retailers and wholesalers (Fig. 11) who claim that consumers are guided in their choice of fish by three main factors. These include price, taste and availability of which price is the main determinant.

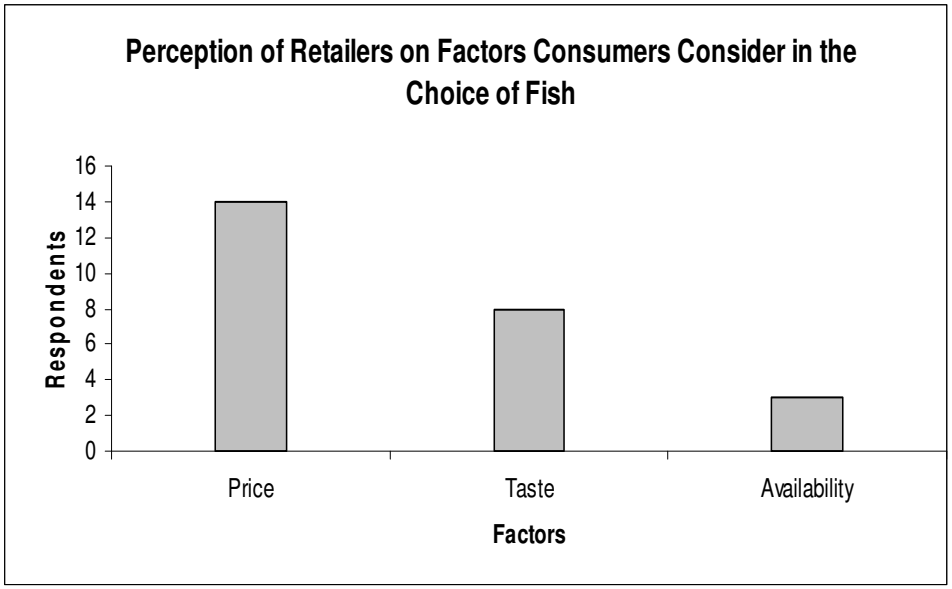

Fig. 11: Perceptions of retailers/wholesalers as to factors considered by consumers in the choice of fish

5.4 Consumer Behaviour

Two sets of multivariate data were explored to describe consumers and their preferences. The first set was explored in the first RDA analysis to understand which consumers prefer fish, and how often, particularly tilapia. The second analysis was to infer which characteristics of the product most influenced the choices of the different consumers.

The first RDA plot of response and predictor variables explained 100% variation in response-predictor data, with the first axis accounting for a greater percentage of 99.9 (Appendix 3). Overall the predictor variables describing the consumers explained 19.5% of the variance in their preferences. Tilapia consumption per week (TilCons) and Expenditure on fish per week (Expwk) were associated with the first axis while fish consumption per week (FishCons) was associated with the second axis. Price, which was

at the origin of graph, seems to be a major determining factor for all income levels in the demand for tilapia. High expenditure on fish per week is influenced mainly by High income earners and large family sizes. High income earners (Highinc) consume tilapia though they are generally not high fish consumers. They spend more on fish than low income earners (Lowinc), even though low income earners consume fish more regularly than they do. This high expenditure on fish by High income earners can be explained by the high price of tilapia which they patronize more. Low income earners consume fish more regularly but their total expenditure on fish is moderate basically because they buy cheaper priced fish.

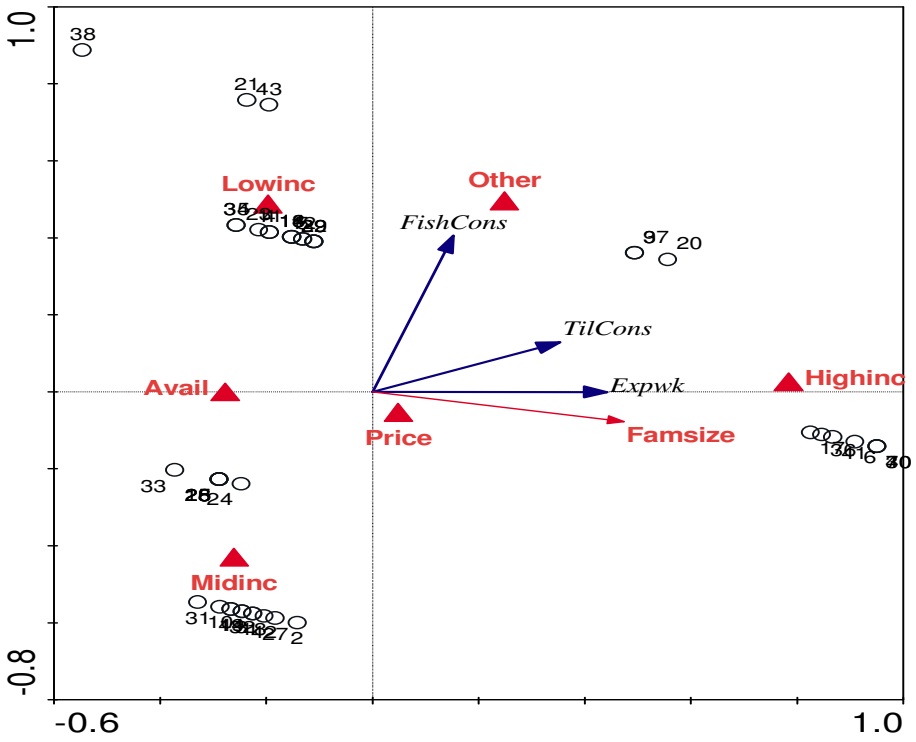

Fig. 12: A triplot of Redundancy Analysis of Response data, Predictor variables and Samples. Response: FishCons (Fish consumption), Tilcons (Tilapia consumption) and Expwk (Expenditure on fish per week). Predictor: Highinc (High income earners), Midinc (Middle income earners), Lowinc (Low income earners), Price, Avail (Availability), Other (Size, hygene) and Famsize (Family size).

The Middle income earners (Midinc) are not regular fish consumers neither are they regular consumers of tilapia. This may be explained by the price of tilapia which is relatively too high for them and secondly because of a shift in consumption pattern as a result of a shift from lower income level to their current status. They may thus go in for meat which is relatively more expensive than the fish they earlier consumed but not tilapia which is higher than the price of meat. Factors such as unhygienic conditions, size of fish and taste classified as other, were not important determinants in the purchase of tilapia in this group.

The results from the second RDA (Fig. 13) were similar in terms of variations explained in the data; as the first axis explained 99.8% of variation in response-predictor data (Appendix 4).

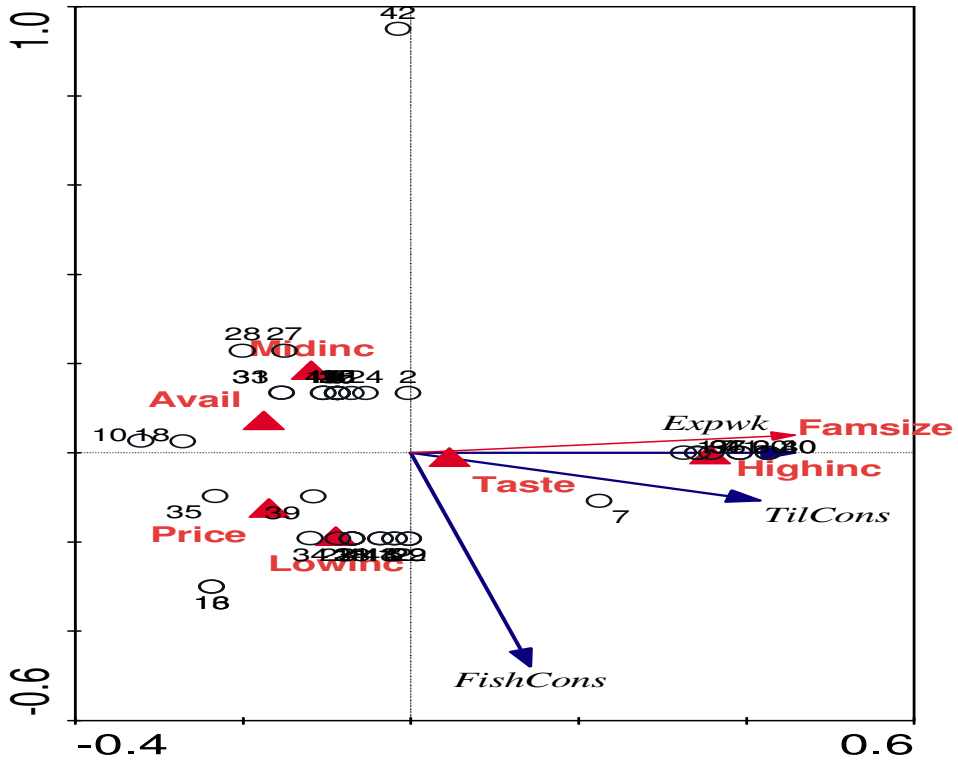

Fig. 13: A triplot of Redundancy Analysis of Response data, Predictor variables and Samples. Response: FishCons (Fish consumption), Tilcons (Tilapia consumption) and Expwk (Expenditure on fish per week). Predictors: Highinc (High income earners),

Midinc (Middle income earners), Lowinc (Low income earners), Price, Taste, Avail (Availability), and Famsize (Family size)

Overall the predictor variables describing the consumers explained 20.9% of the variance in their preferences. The triplot in Figure 13 shows that in choosing the type of fish to consume, taste is the major determinant for all income levels, especially the High income earners. Low income earners are however more sensitive to price in their choice of fish than all the other levels. As seen in the first triplot (Figure 12), expenditure on fish is determined by family size and High income level. It is again clear from this diagram that High income earners consume tilapia but are generally not fish consumers. Though availability was mentioned, it is not a major determinant in the choice of the type of fish to buy.

The results from the survey which will be discussed in the next chapter, suggest the presence of a local market for tilapia. The local tilapia market share based on the total number of respondent was about than 23%. The findings also revealed some bottlenecks in the value chain. They include cost of feeding, interest rate on loans, poor production technology and theft.

6.0 Chapter Six

6.1 Discussion, Conclusion and Recommendations

The purpose of this study was to investigate the role of the market in aquaculture development in Ghana. Based on the theory that production is influenced largely by the market (Begg et al., 2000), there was thus the need to establish whether or not there was a local market for tilapia in Ghana and the possibility of accessing the global market. To have an overview of how competitive tilapia from Ghana is the value chain of three countries were reviewed. The chapter begins with discussion and recommendations ends with a conclusion on the whole work.

6.2 Market for tilapia in Ghana

Despite the quantity of fish imported, results from the research showed there is still market for domestically farmed fish which in Ghana consist basically of tilapia. Results from both retailers and consumers indicate that there is not enough tilapia to satisfy the market which is directly a result of low production. The current market for tilapia is patronized only largely by high income earners. The present observations (Fig. 12 and 13) indicate that consumer expenditure on fish consumption is strongly controlled by family size and high income. High income earners were however not regular fish consumers. It may therefore be understood as though they do not consume fish regularly, they buy relatively expensive fish, thus putting their expenditure on fish way above low income earners who the results show as regular fish consumers. Taste was the major determinant in the choice of fish for all income levels, even though low income earners were very sensitive to price. The result (Fig. 13) indicates that middle income earners cannot be seen as strong fish consumers. This may be an indication of a recent movement in income level (low to middle) thus shifting their taste for fish to for example meat. Migration from one income level to the other may change the types of good consumed and the quantity (Mankiw, 2011). The effect of income change on the quantity that consumers are willing to buy of a product as earlier stated, depends on the type of good (Mankiw, 2011). This may be the case of middle income earners in Ghana. If fish is considered inferior to say meat, most of them will switch from buying fish to buying meat.

The present results indicate that both middle income earners and low income earners in Ghana especially in the cities consume little or no tilapia. This as shown in the plot is a result of the relatively high price. Tilapia price on the local market is out of reach of the average Ghanaian with a minimum daily income of GH¢ 3.11 (US$ 2.13) (MOFEP, 2011).

The very high price may be among other things a result of a shortfall in supply given the level of demand. As indicated in chapter two of this work, when demand is greater than quantity supplied, price will increase all things being equal (Begg et al., 2000). In this particular case there is excess demand over supply and thus a relatively high price. There is no indication that farmers are regulating supply in order to keep prices high. Price according to Quagrainie and Engle (2006) indicates the scarcity and thus the cost of the factors of production. The general understanding is that less of tilapia is currently being produced at a high cost. From the survey, high income earners constituted 23% of the total sample, middle income earners, 41% and low income earners were about 36%. By implication, farmed tilapia is patronized by less than 23% of the 60% population that depend on fish for protein. Depending on the elasticity of demand for tilapia which can be researched, it may or may not favor producers reducing price in order to have a larger market share. A reduction in price all things being equal has two effects on the consumption of a product. The first is an increase in the quantity of the commodity purchased by the old consumers. The second is an increase in demand due to consumption from new consumers who hitherto could not afford the product (Mankiw and Taylor, 2011). As indicated in the general consumption of fish, result (Fig. 13) show that middle income earners are not particularly tilapia consumers and this may be due to the high price. Thus as they consider other fish types as inferior, tilapia may be too expensive for them given that a kilogram of tilapia is more expensive than a kilogram of most meat types on the market. The market price of a kilogram of beef for instance from personal survey ranges between GH¢ 3.5 (US$ 2.3) and GH¢ 5.5 (US$ 3.6) while that of fresh or frozen tilapia is between GH¢ 8 ($5.2) and GH¢10 ($6.5).

There are two main reasons why the Ghanaian buys the locally produced tilapia at a price about thrice that on the global market. The first is because tilapia is a delicacy in Ghana (Asmah, 2008). About 63% of those sampled preferred tilapia to any other fish species on the Ghanaian fish market (Fig. 6). The reason was its taste. Consumers who have an inelastic demand for a particular commodity will continue buying it no matter the increase in price (Begg et al., 2000). The demand for tilapia among a section of people in Ghana is seem to be fairly inelastic. The second is that there is no imported tilapia on the local market thus leaving locally produced tilapia to enjoy a sort of monopoly on 'the local tilapia market'. There is in the sense of tilapia no close substitute on the local market. The more substitute a good has, the more elastic is its demand (Colander, 2001). With demand being fairly inelastic those who consume tilapia have very little choice with respect to price vis-à-vis which seller to buy from. Prices through the main markets and shops are generally the same with very little disparities with respect to the geographical location of the market or shop. Over 86% of consumers interviewed bought their fresh or frozen tilapia at prices between GH¢ 8 ($5.2) and GH¢10 ($6.5) depending on the size while about 92% of farmers claimed they sold a kilogram of tilapia for between GH¢4.5 (US$ 2.9) and GH¢5 (US$ 3.3). There is currently a market that consumes whatever is brought to the market in terms of quantity, quality and size. It is however in the interest of the tilapia farmer that a regular and in-depth market studies are conducted as it is in Norway (NSEC), the Philippines (BFAR), Vietnam (VASEP) and other countries. This will enable the farmer understand the type of market he is producing for, the share tilapia controls in the fish market, the characteristics of his customers and how the structure of the market is changing over time.

6.3 Bottlenecks to growth in the Value Chain of Tilapia

There was a general indication from farmers, wholesalers and retailers of bottlenecks from production through to marketing and distribution. The SWOT analysis was constructed based on the challenges and bottlenecks respondents alluded to and from information acquired from other research works already done on aquaculture in Ghana.

6.3.1Strengths of the value chains

Research works by Pauly (1973, 1975 and 1976) and Rabanal (1985) among others as reported by Prein et al. (1996) concluded that Ghana has many lagoons and water bodies that are a potential for the development of large scale aquaculture. Apart from Lake Volta (largest man made lake in the world), there are numerous dams and rivers which as in countries like Egypt, the Philippines and China can be used for fish farming. A Geographic Information System (GIS) which will map out fish farming sites with high potential is to be introduced with funding from the United Nations (UN) and the Food and Agriculture Organization (FAO) (Real, 2011). All the countries sampled have the natural potential to produce at competitive cost.

Just as in the Philippines where tilapia consumption has gained prominence over milk fish and in China where about 50% of all tilapia produced is sold locally, there is a local market for tilapia in Ghana. It is estimated that Ghana currently has a fish deficit of over 460, 000 mt for human consumption alone (Asmah, 2008). The presence of a market as pointed out earlier is a necessary condition for commercial production (Cateora, 1987). Literature from their profiles suggests that apart from access to the international market, producers in China, the Philippines and Egypt produced for their local markets. If really there is a local market for tilapia (as suggested by the survey and other literature) then that should be a strength that tilapia value chain in Ghana should explore. This currently does not seem to be the case.

6.3.2 Weaknesses (Main Bottlenecks to Growth) of the value chains

As stated earlier, almost all fish feed used in Ghana is imported (Ofori et al., 2009). Most farmers interviewed preferred imported feed because that which was produced by the local company was sub standard. Farmers thus import all their feed at very high cost. Given that fish feed constitutes between 50% and 70% of farmer's cost of production (Partos, 2010), the cost advantage of the local tilapia value chain is weak. Comparing the cost of feed in countries like China, the Philippines, and Egypt show that cost in Ghana are exorbitantly high (Table 2). Apart from the advantage of local fish feed factories, China, Egypt and the others maintain a cost advantage over Ghana by feeding tilapia

juveniles with algae bloom. The price of their tilapia no doubt is more competitive than that of Ghana.

Apart from the excessive demands on collaterals that businesses must meet to acquire loans, the lending rate in Ghana currently averages between 25% and 30% (Yeboah 2011). The reluctance of banks and micro finance companies to give loans to farmers (which from the literature is characteristic of all the countries) may be informed by the risk factor and the rate of inflation which as at March 2011 is about 9.1% in Ghana (Dzawu, 2011). Just as in China, Egypt and the Philippines, government subsidized insurance schemes for farmers are unavailable in Ghana (The Katie School of Insurance, n. d.). The farmers in the other value chains unlike those in Ghana have turned to informal financing models like the 'company + base farm + farmers' model in China and the financier-caretaker arrangement in the Philippines. The interest rate factor that translates into price is minimized leading to a more competitive price for their tilapia.

One of the main reasons for low cost of tilapia production in China, Egypt and the Philippines (Chapter 3) was a result of research into faster growing strains. There has been over the years a purposeful public and private investment into developing quality fingerlings and improved farming techniques. Improved technology has effect on competitive advantage as the activities are changed or there are 'new configurations of the value chain' (NetMBA, 2010). The mortality rate of fingerlings in Ghana is about 40% to 70% because of the quality and poor handling during transportation (Ofori et al., 2009). This will have a direct effect on the cost of production. The unit cost of an adult tilapia from the value chain of China for instance is lesser than that from Ghana because of the effectiveness of the various structures in the value chain as a result of improved technology.

Basic infrastructures that will directly aid production or add value to the farmed tilapia are either absent or not easily accessible in Ghana. Electricity and roads are either not there or are in very bad state. Unlike in Egypt, China and the Philippines where there are tilapia processing factories that add value to the product, fish produced in Ghana had to

be sold fresh most of the time, smoked or dried. This the survey noticed, reduces the market value of the product as consumers prefer to pay relatively higher prices for the fresh and frozen or the grilled tilapia they buy from food vendors. Storage through freezing is weakened by regular power cuts.

The current consumer price of tilapia in Ghana ranges between GH¢ 8 ($5.2) and GH¢10 ($6.5) compared to that of world market which is between $1.0 and $3.0 (Table 2). This is currently very high relative to other fish species on the local market and tilapia price on the world market. Apart from the mark-up, the price the buyer pays is just an extension of the cost of the value chain. As stated earlier, a value chain remains competitive depending on its ability to have a cost advantage over other competitors (NetMBA, 2010). Price levels for tilapia in China for instance are low because the cost of production is low. Tilapia from Ghana will therefore be less competitive than those from China and Egypt. Statistics however suggest (Fig. 4 and 5) that over time, the current price of tilapia in Ghana may fall as production increases. Prices in Egypt and on the international market (USA) were very high but gradually decreased with the increase in production level. What Ghana needs at this stage is investment into research and the adoption of technologies that will reduce cost and increase production.

6.3.3 Opportunities of the value chains

The market size of tilapia may grow as the price of tilapia falls. As discussed earlier a reduction in price leads to an increase in demand (Begg et al., 2000). A reduction in price will not only increase the quantity of the commodity that consumers buy, but it brings the commodity within the reach of those who could not earlier afford it. Low income earners who are in the majority can now afford to consume tilapia. This will lead to an expansion in the market for tilapia.

6.3.4 Threat to the value chains

There may be the influx of tilapia from countries such as China and Egypt because their prices are cheaper and more competitive (Table 2). Chinese tilapia in the USA for

instance is more competitive than the locally produced. While a kilogram of fresh Chinese tilapia is about $10, the locally produced is between $16 and $22.[4] Unlike salmon and the other species imported, there may be reasons why tilapia is currently not being officially imported into Ghana. These may be a result of the absence of one or many of the conditions opined by Cateora (1987) as necessary for the establishment of international trade between countries.

The income of the consumer according to Mankiw (2011) is one of the determinants of demand. The daily minimum wage in Ghana currently is GH¢ 3.11 (MOFEP, 2011) while the price of a kilogram of fresh or frozen tilapia ranges between GH¢ 8 ($5.2) and GH¢10 ($6.5). Tilapia is thus priced out of the reach of the average worker in Ghana as result of high cost of production and low income levels.

One of the main threats to investment in the tilapia value chain in Ghana is a reduction in the current prices of tilapia as research and production technology increases. Evidence from the experience of other countries like Egypt, Norway and many more (Figures 4 and 5), suggest a fall in price levels as production of the commodity increases (Asche, 2010). This is currently one of the challenges for tilapia farmers in China (Einhorn, 2010) and Egypt (Nassr-Alla, 2008). All things being equal, as the management of the value chain becomes more efficient with improved technology, the current price of tilapia may fall leading to marginal decrease in profit levels (this however depends on the elasticity of demand for tilapia).

With the discovery of oil in Ghana, the problem of 'Dutch disease' may threaten primary production including fish farming. 'Dutch disease' describes 'a reduction in a country's export performance as a result of an appreciation of the exchange rate after a natural resource such as oil has been discovered' (Barder, 2006). Goods that were hitherto produced locally are now imported because of an appreciation of the real exchange rate. Fish farming in Ghana may become less lucrative though the consumption level of tilapia

[4] http://www.aquaticcommunity.com/tilapia/market.php

may remain the same or increase. This will create the need for imports of tilapia to supplement the market.

Table 3: SWOT Analysis of Supply Chain of Tilapia in Ghana

STRENGTHS	WEAKNESSES
• Available natural resources for tilapia farming • A ready demand on the local market	• Importation of floating feed • Poor infrastructure • High cost of loans • Poor quality fingerlings • Price in the domestic market is higher than on the international market (Europe and USA) • Weak storage and no value adding system
OPPORTUNITIES	THREATS
• Large low income group	• Current price may fall with increase in investment • Low minimum wage vis-à-vis price of tilapia • Tilapia import from other countries • Fluctuation in exchange rate • Oil price volatility • 'Dutch disease'

6.4 Global Markets and Local Production

There are certain conditions that enable the establishment of international trade as earlier discussed.

- Tariffs must not exist or must not exceed the difference in costs after transportation and profit are considered.

- No governmental or financial restrictions inhibit the products and trading of those products.

There are currently no tariffs on the export and import of fish into Ghana (Antwi, 2006). A levy of $2.20 per metric tonne as at 2006 was the only charge importers paid (Antwi, 2006). As a member of the World Trade Organization (WTO) and a signatory to the ACP-EC Partnership agreement, Ghana enjoys a zero tariff on its fish exports to the EU (Antwi, 2006). According to the Ghana Trade Policy, the government may apply import permits and other forms of tariffs to avoid unfair trade practices and dumping. There is to this extent no government policy inhibiting trade in imported fish including tilapia, The export of sea food contributed $78.5 million to the economy of Ghana in 2000 (Bank of Ghana, 2008) and US$170 million in 2007 (Henriksen, 2009). Fish imports totaled US$262 million in 2007 (Henriksen, 2009). There is however no official record on the export or import of tilapia. Given the differences in the price of tilapia on the local market and that of China and Egypt for instance, one can only assume the presence or absence of one or more of the other conditions posited by Cateora (1987) (that could not be investigated within the scope of this work) as reason(s) why tilapia is not currently being imported into Ghana. These include the following:

- Production gains must be greater than the costs of trading and shipping.
- Products must be identical or equally acceptable in the minds of middlemen and consumers, regardless of national origin.
- There must be a sufficiently effective market information network so that traders in both countries are aware of cost differentials.
- The differential must be sufficient to interest an entrepreneur in trading, i.e., provide a profit.

Apart from low productivity, the basic condition of profit maximization as necessary for the initiation of international trade (Cateora, 1987) cannot be satisfied in Ghana's quest to export tilapia. The main reason is the huge difference between tilapia prices in international markets (Europe and USA) and that on the Ghanaian local market. Comparing prices of tilapia in countries such as the Philippines, China, Egypt and Ghana

to tilapia world market prices over time (Fig. 3), suggest tilapia from Ghana cannot compete favorably with tilapia from these other countries. Given the facts and figures and barring any prejudicial issues relating to acceptability, tilapia from China, Egypt and the Philippines for instance will sell cheaper and be more competitive on the Ghanaian local market than the locally produced tilapia. This therefore defeats the idea of exporting tilapia from Ghana.

The second reason has to do with a poorly organized market (Onumah and Acquah, 2010). Unlike in Egypt (FAO, 2011) where aquaculture products are controlled by a number of large wholesalers, farmers in Ghana sell their products to anyone available and even sometimes directly to consumers. Organizations such EAGA in Egypt and VASEP in Vietnam, NSEC in Norway were formed to connect the farms to the markets and business world. Apart from helping farmers with technical training and the supply of farm inputs, they have the right 'facilities and marketing skills which are competitiveness-drivers on global markets' (ITC 2008). Companies of this nature operate in Ghana with regards to some other products. Some of these include the Cocoa Marketing Company (CMC) a subsidiary of Ghana Cocoa Board, formed by the government to facilitate the production and export of cocoa. Another is the Precious Mineral Marketing Company (PMMC) which was also formed by the state to deal in small scale gold and diamond production and marketing. There may be a challenge of initially resourcing such a company for aquaculture development in Ghana since the sector is currently not self supportive. Either as a statutory company or through a private investor initiative, the formation of such an organization will not only increase production in the aquaculture sector through exploring larger markets but will also help farmers reduce their cost of production and improve on fish quality through technical training and collective bargaining powers in the purchase of farm inputs and loan acquisition.

6.5 Validity of Data and Research Findings

There are two types of validity; internal and external. Internal validity is concerned with the extent to which findings in a research work is a result of the data collected. External

validity on the other hand is the degree to which findings can be generalized (Burns and Grove, 2003). Results from this work are solely based on primary data, secondary data and information acquired from documentary reviews. There is however a limit to the extent to which this work can be generalized. This is firstly because of the number of respondents that were interviewed in the field research. In all 44 consumers, 31 wholesalers/retailers and 14 tilapia farmers were sampled. Secondly, the interviews for farmers were mainly conducted in farms along the Volta Lake. Though this is the hub of most commercial farms, the views of those sampled may not represent that of tilapia farmers all over Ghana. The consumers and retailers/wholesalers were sampled in three towns where consumption patterns may not necessarily be the same as in rural areas of the country. The findings especially on the bottlenecks in the value chain correspond with findings in many research works already conducted on aquaculture in Ghana.

6.6 Conclusion and Recommendations

There is currently a local market for tilapia in Ghana though it seems to be patronized mainly by a section of high income earners. The role of the local market in the value chain of tilapia production in Ghana is currently not very important because what the farmer produces does not depend on how much the market demands. The current tilapia market takes everything produced rather than determine what is produced, how it is produced and how much of it is produced (Begg et al., 2000). Deducing from the results, it is clear that international trade in tilapia does not currently have any effect on local production since there are officially no export and import of tilapia from and into Ghana. Other fish species imported compete more favorably with tilapia among a section of consumers largely because these are relatively cheaper. Until production increases and tilapia producers struggle to win market share from other fish species, the role of the market in determining how much tilapia should be produced will remain weak and there will be no motivation in exploring an external market.

Despite the latent natural resources, aquaculture production in Ghana is stunted by bottlenecks that need to be tackled with well planned and executed programs from both the government and the private sector. The ineffectiveness of the value chain in achieving

cost advantage is largely due the bottlenecks in the production process. As earlier stated the weaknesses at the production stage of the chain are affecting the cost outcome of the whole chain (NetMBA, 2010). Aquaculture growth as in the Philippines (Toledo et al., 2008), China (Appendix 6), Egypt (Nassr-Alla, 2008) and others were initiated by governments and sometimes in partnership with the private sector. Bottlenecks such as importing fish feed at high cost, taking loans at high interest rates, buying fuel at high prices, poor production technology and poor quality fingerlings need government intervention.

Aquaculture production in Ghana has gone through what can be described as three phases of development as stated earlier. The first phase was an experimental phase where farmers were exposed to fish farming through government constructed experimental farms (Quagrainie et al, 2009). The second phase was in the 1980's when the government encouraged people by the help of loans from the banks to venture into fish farming (Prein et al, 1996). The third phase began about a decade ago with a shift from the pond system to the cage culture and a move from subsistence to commercial production (Quagrainie et al., 2009). The first two phases though created some awareness, failed to yield the desired results. The current phase (third) is faced with a high chance of, if not failing, remaining uncompetitive in both the local and the global market due to the bottlenecks in the value chain.

What this work proposes is a new phase of development in which there is an active intervention of the government in building support systems that will prop the industry until it can stand on its own. According to Pillay and Kutty (2005), aquaculture can only make a significant impact on national food production and sustainability if its planning is made an integral part of economic development policy. Apart from funding research programs through which faster growing strains and modern farm techniques will be made available to farmers as it was in the Philippines and China, government should set up a venture capital from which farmers can draw loans at minimal interest rates. Commercial farming in Ghana as discovered during the survey is capital intensive and its sustenance depends largely on the farmer's ability to meet the operational cost.

To enhance investor interest, forums should be organized in which the prospects of investing in fish farming in Ghana are communicated. Private investors interested in siting fish feed factories and hatcheries in Ghana could be motivated through tax cuts or tax holidays. The way forward for aquaculture development in Ghana is not to use it as a tool for poverty alleviation as it was in the 1980s but a commercial venture which demands large investor capital. It was discovered that three out of the 14 farms sampled which also happened to be among the most productive in the country, were funded with loans from external institutions like DANIDA and the World Bank.

Finally, government should facilitate the formation of organizations such as it is in the areas of cocoa and shea butter production to connect the farms to the markets and the business world. All these however should be part of a government development plan aimed at growing the aquaculture sector in Ghana as it was in the 10 year Arroyo government plan in the Philippines (BFAR, 2008).

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APPENDIX 1

DCA Results

No samples omitted
Number of samples 44
Number of species 3
Number of occurrences 132

No transformation of species data
No species-weights specified
No sample-weights specified
No downweighting of rare species

No. of active samples: 44
No. of passive samples: 0
No. of active species: 3

Total inertia in species data=
Sum of all eigenvalues of CA = 0.04844

**** Summary ****

Axes		1	2	3	4	Total inertia
Eigenvalues	:	0.039	0.007	0.000	0.000	0.048
Lengths of gradient	:	1.115	0.241	0.000	0.000	
Cumulative percentage variance of species data	:	80.8	95.0	0.0	0.0	

Sum of all eigenvalues 0.048

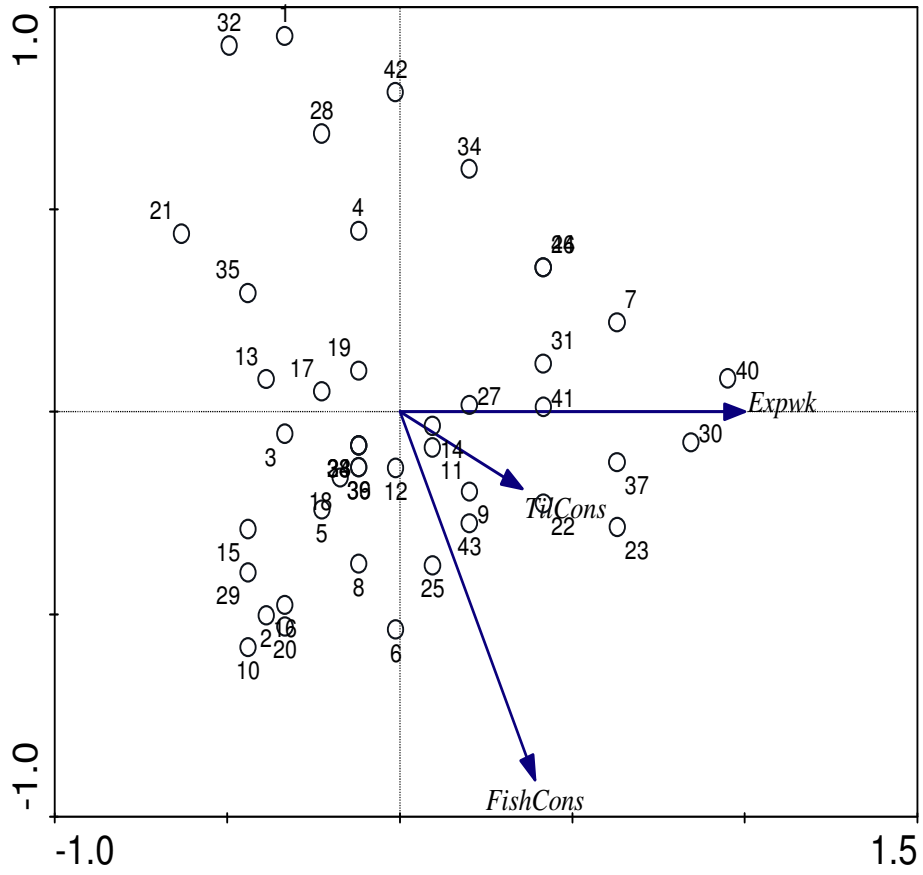
Appendix 2

PCA Summary and Biplot

**** Summary ****

Axes		1	2	3	4	Total variance
Eigenvalues	:	0.998	0.001	0.001	0.000	1.000
Cumulative percentage variance of species data	:	99.8	99.9	100.0	0.0	

Sum of all eigenvalues 1.000



Appendix 3

RDA for Tilapia Consumption

```
** Type of analysis ***
 Model            Gradient analysis
           indirect    direct    hybrid
linear       1=PCA      2= RDA      3
unimodal     4= CA      5= CCA      6
  ,,         7=DCA      8=DCCA      9
           10=non-standard analysis
Type analysis number
Answer =  2


*** Data files ***
Species data      : C:\Users\Audrey\Desktop\CANOCO Results-Eddie\spped1.dta
Covariable data   :
Environmental data : C:\Users\Audrey\Desktop\CANOCO Results-Eddie\enved 1.dta
Initialization file:

Forward selection of envi. variables =    1
Scaling of ordination scores       =    2
Diagnostics                        =    1

File   : C:\Users\Audrey\Desktop\CANOCO Results-Eddie\spped1.dta
Title  : Tilcons Fishcons Expwk
Format :  (I5,1X,3F4.0)
No. of couplets of species number and abundance per line :    0


No samples omitted
Number of samples          44
Number of species          3
Number of occurrences      132


File  : C:\Users\Audrey\Desktop\CANOCO Results-Eddie\enved 1.dta
Title : Famsize Lowinc Midinc Highinc Avail Price Other
Format :  (I5,1X,7F3.0)
No. of environmental variables :     7


No interaction terms defined


No transformation of species data
No species-weights specified
No  sample-weights specified
Centering/standardization by species  =    1
Centering/standardization by samples  =    0

No. of active  samples:     44
No. of passive samples:      0
No. of active  species:      3

Total sum of squares in species data =     55351.7
Total standard deviation in species data TAU =     20.4776
****** Collinearity detected when fitting variable     4 ******
****** Collinearity detected when fitting variable     7 ******
```

```
**** Start of forward selection of variables ****


*** Unrestricted permutation ***


Seeds:  23239   945

  N     Name   Extra fit

  6 Price       0.0056
  7 Other       0.0063
  5 Avail       0.0199
  2 Lowinc      0.0222
  1 Famsize     0.0438
  3 Midinc      0.0472
  4 Highinc     0.1812
Environmental variable     4 tested
Number of permutations=  499

*** Permutation under reduced model ***


P-value 0.0060 (variable   4; F-ratio=  9.30; number of permutations=   499)


Environmental variable     4 added to model
Variance explained by the variables selected:    0.18
  "         "      "       all variables    :    0.19

  N     Name   Extra fit

  5 Avail       0.0006
  3 Midinc      0.0008
  2 Lowinc      0.0008
  1 Famsize     0.0042
  6 Price       0.0060
  7 Other       0.0094
Environmental variable     7 tested
Number of permutations=  499

*** Permutation under reduced model ***


P-value 0.4520 (variable   7; F-ratio=  0.48; number of permutations=   499)


Environmental variable     7 added to model
Variance explained by the variables selected:    0.19
  "         "      "       all variables    :    0.19

  N     Name   Extra fit

  6 Price       0.0010
  5 Avail       0.0010
  3 Midinc      0.0015
  2 Lowinc      0.0015
  1 Famsize     0.0024
Environmental variable     1 tested
Number of permutations=  499
```

```
*** Permutation under reduced model ***


P-value 0.7560 (variable   1; F-ratio=  0.12; number of permutations=   499)


Environmental variable     1 added to model
Variance explained by the variables selected:    0.19
  "        "      "      all variables    :    0.19

  N     Name   Extra fit

  6 Price       0.0007
  5 Avail       0.0007
  3 Midinc      0.0014
  2 Lowinc      0.0014
Environmental variable     2 tested
Number of permutations=  499

*** Permutation under reduced model ***


P-value 0.8220 (variable   2; F-ratio=  0.07; number of permutations=   499)


Environmental variable     2 added to model
Variance explained by the variables selected:    0.19
  "        "      "      all variables    :    0.19

  N     Name   Extra fit

  6 Price       0.0003
  5 Avail       0.0003
Environmental variable     5 tested
Number of permutations=  499

*** Permutation under reduced model ***


P-value 0.9040 (variable   5; F-ratio=  0.01; number of permutations=   499)


Environmental variable     5 added to model
Variance explained by the variables selected:    0.19
  "        "      "      all variables    :    0.19

No more variables to improve fit
*** End of selection ***

****** Collinearity detected when fitting variable     4 ******
****** Collinearity detected when fitting variable     7 ******
1
**** Correlation matrix ****

SPEC AX1            1.0000
SPEC AX2            0.2023    1.0000
SPEC AX3           -0.4723   -0.1742    1.0000
SPEC AX4            0.8972    0.2258   -0.5270    1.0000
ENVI AX1            0.4416    0.0000    0.0000    0.0000    1.0000
ENVI AX2            0.0000    0.3336    0.0000    0.0000    0.0000    1.0000
ENVI AX3            0.0000    0.0000    0.1927    0.0000    0.0000    0.0000    1.0000
ENVI AX4            0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
```

Famsize	0.2093	-0.2089	-0.0782	0.0000	0.4741	-0.6261	-0.4059	0.0000
Lowinc	-0.1492	-0.0728	0.1313	0.0000	-0.3378	-0.2183	0.6816	0.0000
Midinc	-0.2174	0.0759	-0.1431	0.0000	-0.4922	0.2276	-0.7425	0.0000
Highinc	0.4263	-0.0055	0.0171	0.0000	0.9653	-0.0164	0.0888	0.0000
Avail	-0.1411	-0.0918	-0.0692	0.0000	-0.3196	-0.2751	-0.3590	0.0000
Price	0.0750	0.1664	0.0002	0.0000	0.1698	0.4987	0.0010	0.0000
Other	0.0790	-0.1352	0.0968	0.0000	0.1789	-0.4054	0.5022	0.0000

	SPEC AX1	SPEC AX2	SPEC AX3	SPEC AX4	ENVI AX1	ENVI AX2	ENVI AX3	ENVI AX4
Famsize	1.0000							
Lowinc	-0.1304	1.0000						
Midinc	-0.1707	-0.6290	1.0000					
Highinc	0.3500	-0.4100	-0.4512	1.0000				
Avail	-0.1763	-0.1491	0.3803	-0.2750	1.0000			
Price	0.1636	0.1789	-0.1704	-0.0054	-0.7831	1.0000		
Other	-0.0123	-0.0747	-0.2631	0.3944	-0.1604	-0.4883	1.0000	

	Famsize	Lowinc	Midinc	Highinc	Avail	Price	Other

N	name	(weighted) mean	stand. dev.	inflation factor
1	SPEC AX1	0.0000	2.2645	
2	SPEC AX2	0.0000	2.9976	
3	SPEC AX3	0.0000	5.1890	
4	SPEC AX4	0.0000	1.0000	
5	ENVI AX1	0.0000	1.0000	
6	ENVI AX2	0.0000	1.0000	
7	ENVI AX3	0.0000	1.0000	
8	ENVI AX4	0.0000	0.0000	
1	Famsize	5.5909	2.3386	1.1875
2	Lowinc	0.3636	0.4810	2.1092
3	Midinc	0.4091	0.4917	2.4796
4	Highinc	0.2273	0.4191	0.0000
5	Avail	0.2045	0.4034	3.4814
6	Price	0.7045	0.4562	3.1196
7	Other	0.0909	0.2875	0.0000

**** Summary ****

Axes	1	2	3	4	Total variance
Eigenvalues :	0.194	0.000	0.000	0.803	1.000
Species-environment correlations :	0.442	0.334	0.193	0.000	
Cumulative percentage variance					
of species data :	19.4	19.5	19.5	99.8	
of species-environment relation:	99.9	100.0	100.0	0.0	

Sum of all eigenvalues	1.000
Sum of all canonical eigenvalues	0.195

The first three eigenvalues reported above are canonical, the fourth is not since there are only 3 species.

Appendix 4

RDA for Fish only

```
* Type of analysis ***
 Model            Gradient analysis
           indirect    direct    hybrid
linear       1=PCA      2= RDA      3
unimodal     4= CA      5= CCA      6
  ,,         7=DCA      8=DCCA      9
           10=non-standard analysis
Type analysis number
Answer =  2


*** Data files ***
Species data      : C:\Users\Audrey\Desktop\CANOCO Results-Eddie\spped1.dta
Covariable data   :
Environmental data : C:\Users\Audrey\Desktop\CANOCO Results-Eddie\envfish.dta
Initialization file:

Forward selection of envi. variables =    1
Scaling of ordination scores       =    2
Diagnostics                        =    1

File   : C:\Users\Audrey\Desktop\CANOCO Results-Eddie\spped1.dta
Title  : Tilcons Fishcons Expwk
Format :  (I5,1X,3F4.0)
No. of couplets of species number and abundance per line :    0


No samples omitted
Number of samples          44
Number of species          3
Number of occurrences      132


File  : C:\Users\Audrey\Desktop\CANOCO Results-Eddie\envfish.dta
Title : Famsize Lowinc Midinc Highinc Taste Price Avail
Format :  (I5,1X,7F3.0)
No. of environmental variables :     7


No interaction terms defined


No transformation of species data
No species-weights specified
No  sample-weights specified
Centering/standardization by species  =    1
Centering/standardization by samples  =    0

No. of active  samples:     44
No. of passive samples:      0
No. of active  species:      3

Total sum of squares in species data =     55351.7
Total standard deviation in species data TAU =     20.4776
****** Collinearity detected when fitting variable     4 ******

****** Check on influence in covariable/environment data ******
```

```
The following sample(s) have extreme values
Sample Environmental        Covariable  + Environment space
       variable Influence   influence     influence

   42                                6.3x
****** End of check ******


**** Start of forward selection of variables ****


*** Unrestricted permutation ***


Seeds:  23239   945

   N     Name   Extra fit

   7 Avail       0.0150
   6 Price       0.0178
   2 Lowinc      0.0222
   5 Taste       0.0348
   1 Famsize     0.0438
   3 Midinc      0.0472
   4 Highinc     0.1812
Environmental variable     4 tested
Number of permutations=  499

*** Permutation under reduced model ***


P-value 0.0060 (variable   4; F-ratio=  9.30; number of permutations=   499)


Environmental variable     4 added to model
Variance explained by the variables selected:    0.18
   "         "      "      all variables    :    0.21

   N     Name   Extra fit

   3 Midinc      0.0008
   2 Lowinc      0.0008
   7 Avail       0.0025
   1 Famsize     0.0042
   5 Taste       0.0140
   6 Price       0.0153
Environmental variable     6 tested
Number of permutations=  499

*** Permutation under reduced model ***


P-value 0.4020 (variable   6; F-ratio=  0.78; number of permutations=   499)


Environmental variable     6 added to model
Variance explained by the variables selected:    0.20
   "         "      "      all variables    :    0.21

   N     Name   Extra fit

   3 Midinc      0.0010
```

```
  2 Lowinc      0.0010
  5 Taste       0.0024
  7 Avail       0.0043
  1 Famsize     0.0061
Environmental variable     1 tested
Number of permutations=  499

*** Permutation under reduced model ***


P-value 0.6400 (variable   1; F-ratio=  0.31; number of permutations=   499)


Environmental variable     1 added to model
Variance explained by the variables selected:    0.20
  "         "      "       all variables    :    0.21

  N     Name   Extra fit

  3 Midinc      0.0009
  2 Lowinc      0.0009
  5 Taste       0.0035
  7 Avail       0.0050
Environmental variable     7 tested
Number of permutations=  499

*** Permutation under reduced model ***


P-value 0.6460 (variable   7; F-ratio=  0.24; number of permutations=   499)


Environmental variable     7 added to model
Variance explained by the variables selected:    0.21
  "         "      "       all variables    :    0.21

  N     Name   Extra fit

  5 Taste       0.0002
  3 Midinc      0.0010
  2 Lowinc      0.0010
Environmental variable     2 tested
Number of permutations=  499

*** Permutation under reduced model ***


P-value 0.8320 (variable   2; F-ratio=  0.05; number of permutations=   499)


Environmental variable     2 added to model
Variance explained by the variables selected:    0.21
  "         "      "       all variables    :    0.21

  N     Name   Extra fit

  5 Taste       0.0003
Environmental variable     5 tested
Number of permutations=  499

*** Permutation under reduced model ***
```

```
P-value 0.9220 (variable   5; F-ratio=  0.01; number of permutations=   499)


 Environmental variable     5 added to model
 Variance explained by the variables selected:    0.21
   "         "      "      all variables    :    0.21

 No more variables to improve fit
*** End of selection ***

 ****** Collinearity detected when fitting variable     4 ******
1
 **** Correlation matrix ****

 SPEC AX1            1.0000
 SPEC AX2            0.1801    1.0000
 SPEC AX3            0.5339    0.1630    1.0000
 SPEC AX4            0.8893    0.2028    0.6010    1.0000
 ENVI AX1            0.4573    0.0000    0.0000    0.0000    1.0000
 ENVI AX2            0.0000    0.4732    0.0000    0.0000    0.0000    1.0000
 ENVI AX3            0.0000    0.0000    0.2147    0.0000    0.0000    0.0000    1.0000
 ENVI AX4            0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
 Famsize   0.2093   -0.2142    0.1070    0.0000    0.4578   -0.4527    0.4981    0.0000
 Lowinc   -0.1492   -0.0734   -0.1357    0.0000   -0.3262   -0.1551   -0.6321    0.0000
 Midinc   -0.2174    0.0965    0.1134    0.0000   -0.4754    0.2039    0.5281    0.0000
 Highinc   0.4263   -0.0290    0.0228    0.0000    0.9322   -0.0612    0.1060    0.0000
 Taste     0.1868    0.0131   -0.1272    0.0000    0.4086    0.0276   -0.5921    0.0000
 Price    -0.1333   -0.2715    0.0841    0.0000   -0.2915   -0.5738    0.3916    0.0000
 Avail    -0.1224    0.1276    0.0390    0.0000   -0.2677    0.2697    0.1817    0.0000

           SPEC AX1          SPEC AX2          SPEC AX3          SPEC AX4          ENVI AX1          ENVI
AX2       ENVI AX3          ENVI AX4

 Famsize   1.0000
 Lowinc   -0.1304    1.0000
 Midinc   -0.1707   -0.6290    1.0000
 Highinc   0.3500   -0.4100   -0.4512    1.0000
 Taste    -0.0949   -0.0410   -0.1003    0.1647    1.0000
 Price     0.0933    0.0271   -0.0066   -0.0233   -0.6602    1.0000
 Avail    -0.0123    0.0896    0.0585   -0.1715   -0.5831   -0.1132    1.0000

           Famsize  Lowinc   Midinc   Highinc  Taste    Price    Avail

   N       name          (weighted) mean     stand. dev.          inflation factor

   1       SPEC AX1                0.0000              2.1869
   2       SPEC AX2                0.0000              2.1134
   3       SPEC AX3                0.0000              4.6567
   4       SPEC AX4                0.0000              1.0000
   5       ENVI AX1                0.0000              1.0000
   6       ENVI AX2                0.0000              1.0000
   7       ENVI AX3                0.0000              1.0000
   8       ENVI AX4                0.0000              0.0000
   1       Famsize          5.5909              2.3386              1.1833
   2       Lowinc           0.3636              0.4810              1.9056
   3       Midinc           0.4091              0.4917              1.9834
   4       Highinc          0.2273              0.4191              0.0000
   5       Taste            0.7727              0.4191              8.4230
   6       Price            0.1136              0.3174              5.5119
   7       Avail            0.0909              0.2875              4.7009
```

**** Summary ****

Axes	1	2	3	4	Total variance
Eigenvalues :	0.209	0.000	0.000	0.789	1.000
Species-environment correlations :	0.457	0.473	0.215	0.000	
Cumulative percentage variance					
of species data :	20.9	20.9	20.9	99.8	
of species-environment relation:	99.8	100.0	100.0	0.0	

Sum of all eigenvalues	1.000
Sum of all canonical eigenvalues	0.209

The first three eigenvalues reported above are canonical, the fourth is not since there are only 3 species.

Appendix 5

Correspondence with Professor Kevin Fitzsimmons

From: Kevin Fitzsimmons (kevfitz@cals.arizona.edu)
To: edmondkorbie@yahoo.com;
Date: Thu, March 10, 2011 2:56:10 AM
Cc:
Subject: Re: Enquiry

Hi EDMOND,
Not sure how these rumors get started. My guess is that when fish are small, the nursery ponds may be fertilized
with chicken or duck manure to encourage an algae bloom, which the juvenile fish will filter feed. After about 80
to 100 grams, all large tilapia in China are fed pelleted feeds. There are hundreds of feedmills selling lots of
brands of tilapia feed. I have worked with many farms across China and can confirm that no mammalian feces
are used to feed the fish.
the reason the fish have been low cost in the past has to do with several factors.
First, fingerlings in the past were produced at state hatcheries and given to small farmers who grew the fish in
farm ponds in the spare time and used pond water irrigate field crops and gardens.
Second, there were govt supported extension specialists helping the farmers and processing plants
Third, the processing plants were given free land and low cost construction loans.
Fourth, fuel, feed ingredients, electricity, health care were all subsidized.
Finally, there was a govt backed marketing association.
Today much of this has changed. Hatcheries have been privatized, the extension specialists have been reassigned
to new species
The processing plants now have to pay their own way and many govt subsidies have been reduced or
eliminated. And the marketing association now collects dues.
Production costs have increased by 12-20% in each of the last four years.
Hope this answers the question.
Regards,
Kevin

EDMOND HAMENOO <edmondkorbie@yahoo.com> wrote ..
> Hi Sir,

> I am an M.Sc student in the University of Tromso, Norway. I have read a couple
> of your presentations especially on tilapia production and they were very
> exposing.
> We currently had a discussion in class about tilapia production in China. One
> issue that came up was tilapia feed in China. I have not yet read any paper of yours
> on
>
> China but as an authority in this field, I believe you will have an idea on what
> transpires
> there.
> My question is whether it is true Chinese tilapia is fed on faeces if not how
> are they able
> to keep their cost of production so low?
> Thank you.
>
> Edmond Hamenoo
> International Fisheries Management
> University of Tromso
> Norway
>
>
>
>