

RESEARCH INTO THE POTENTIAL FOR THE PRODUCTION, PROCESSING AND EXPORT OF TILAPIA FOR THE SOUTHERN AFRICAN MARKET

FINAL REPORT



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List of Abbreviations:

AASA	-	Aquaculture Association of South Africa
AIS	-	Alien and Invasive Species Regulations
APCF	-	Agro-Processing Competitiveness Fund
DAFF	-	South African Department of Agriculture, Forestry and Fisheries
DEA	-	South African Department of Environmental Affairs
DFR	-	Ugandan Department of Fisheries Resources
DTI	-	South African Department of Trade and Industry
DWA	-	South African Department of Water Affairs
EDD	-	South African Economic Development Department
EIA	-	Environmental Impact Assessment
FAO	-	United Nations Food and Agricultural Organisation
FCR	-	Feed Conversion Ratio
FIFO	-	Fish in Fish out
IDC	-	Industrial Development Corporation
IPAP	-	Industrial Policy Action Plan
ITAC	-	International Trade Administration Commission of South Africa
NAPF	-	National Aquaculture Policy Framework
NASF	-	National Aquaculture Strategic Framework for South Africa
NBS	-	Ugandan National Bureau of Standards
NDA	-	Ugandan National Drug Authority
NEMA	-	National Environment Management Act
NEMBA	-	National Environmental Management: Biodiversity Act
NGP	-	New Growth Path
NWA	-	National Water Act
MLRA	-	Marine Living Resources Act
RAS	-	Recirculating Aquaculture System

List of Abbreviations:

SACU	-	Southern African Customs Union
SADC	-	Southern African Development Community
TAASA	-	Tilapia Aquaculture Association of South Africa
TMI	-	Tilapia Marketing Institute
TOPS	-	Threatened or Protected Species Regulations
UNEMBA	-	Ugandan National Environmental Management Authority

Executive Summary

1. Background

Through the Agro-Processing Competitiveness Fund, Urban-Econ was appointed by the IDC to conduct a research project into the potential for the production, processing and export of Tilapia for the Southern African Market

2. Defining Aquaculture

According to the Food and Agricultural Organisation, aquaculture is defined as “the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc.” This is in contrast to fishing or gleaning which entails harvesting wild aquatic species.

The emergence of aquaculture has been traced to ancient China, at a time of around 2000 B.C.E., when common carp were reared for food, but no record of the methods of production have been found.

Today, aquaculture is a major supplier of food fish in the world. According to the FAO, total apparent food fish consumption for 2012 was 136.2 million tons. Of this total amount, wild captured fisheries accounted for 51% of the total and aquaculture contributing the remaining 49%.

3. Aquaculture Systems and Environments

Aquaculture production takes place in salt, fresh or brackish water. Designs for different systems of aquaculture production are numerous, and each type of water (fresh or salt) have unique aspects that must be accounted for in an aquaculture system. However, there are essentially three main aquaculture systems, being pond, tank or cage systems.

The use of these systems in aquaculture has seen fish production from fresh-water environments rising from less than 50% of total produced food fishes by volume in 2008 to 62% in 2010. Fresh-water aquaculture represented 58.1% of global aquaculture production by value in 2010. The production of fresh-water fishes is dominated by Carp, making up 71.9% of total fresh-water production by volume in 2010, and are mostly cultivated in ponds. Salmonid farming (mainly rainbow trout in fresh-water) make use of ponds, concrete raceways and other types of tank that provide higher flow rates of water to maintain good water quality. This also allows for higher stocking densities. Tilapia can be cultured in both pond and tank systems.

4. The Strengths and Weaknesses of Aquaculture

The sustainability of wild fisheries has become a major concern since the mid-1950s. The threat of over-fishing and the decimation of wild shoals from the world’s oceans has led to a raft of

environmental regulations designed to limit the amount of fish that is extracted from the world's oceans. Despite this, the world population continues to increase, while the per capita consumption of food fish has also increased, climbing from 17kg in 2000 to 19.2kg in 2010.

Aquaculture has thus provided a means of continuing to source food fish without increasing harvesting of wild fisheries beyond maximum sustainable yields. In addition, when compared with other sources of farmed protein such as from animal husbandry, aquaculture is relatively more efficient and environmentally friendly in many respects.

However, aquaculture has an impact on the natural environment when waste waters and excess chemicals and medicines are released into the natural environment. In addition, extensive changes to the natural landscape from extensive aquaculture operations can occur, especially when extensive pond aquaculture is pursued. Certain farmed species may also lead to a negative overall impact on food fish production when FFR ratios are greater than one.

5. Aquaculture in Context

On a global scale, aquaculture continues to grow faster than any other food sector, averaging an 8% growth rate over the past 20 years. Production of food fish from aquaculture grew at an annual average rate of 6.2% between 2000 and 2012.

Production from aquaculture is predominant in Asia, where 88% of world aquaculture production is located. In the Americas, aquaculture production contributed 4.3%, Europe, 4.3%, Africa 2.2% and Oceania contributed only 0.3% to global aquaculture production, respectively.

Aquaculture for food production in Africa was introduced over 50 years ago. Tilapia were successfully produced in ponds for the first time in Democratic Republic of Congo in 1946. Egypt is the largest producer of food fish through aquaculture on the continent, accounting for 71% of all African production. This is followed by Nigeria at 16% and Uganda at 7%. Kenya, Zambia, Ghana, Madagascar, Tunisia, Malawi and South Africa make up the rest of the top ten producers, but none of whom produce more than 1% of total production from Africa.

6. Global Tilapia Aquaculture

Tilapia is a commonly stocked food fish in aquaculture, due to its relatively fast growth rates and hardiness in production, allowing for high stocking densities. The texture and taste of Tilapia has been described as resembling that of South African Hake, with very bland flavours. This white fish has remarkable appeal to consumers all over the world, with the consumption of Tilapia being common on almost all continents. The USA remains the world's largest market for Tilapia, with Tilapia being the second most consumed food fish in the country. Africa has the fastest growing market for Tilapia, specifically for whole frozen Tilapia, which has become a major focus of Chinese exports to Africa in terms of food fish.

7. South African Aquaculture

According to DAFF, South Africa produced a total of 7 690 tons of product from aquaculture in 2011. Of this amount, 3 573 tons was food fish, with marine aquaculture contributing 1 883 tons (53%) and freshwater aquaculture contributing 1 690 tons (47%). South African aquaculture, however, remains a small scale industry relative to the rest of Africa and the World. South Africa is last in the top ten producers in Africa, representing only 0.24% of total aquaculture food fish production from the continent in 2010.

Access to land and water is restricted due to the unavailability of suitable land, compounded by the tedious rezoning process; onerous permitting requirements; and an obstructive bureaucracy in respect of compliance with environmental regulations, thus de-incentivizing investment in the industry. In terms of aquaculture technology, South Africa does possess a generally conducive infrastructure and supporting institutions environment for the development of large scale commercial aquaculture technology. However, there is a lack of sector level institutional coordination and strategy and certain specific infrastructure and capacity requirements that individual firms cannot overcome. Prior to the release of the National Aquaculture Strategic Framework and the National Aquaculture Policy Framework in 2012 and 2013 respectively, there has been a lack of a comprehensive set of national strategies and key action plans for aquaculture.

8. Tilapia Aquaculture in South Africa

South African Tilapia production is dominated by two main species, that being the alien invasive *Oreochromis niloticus* (Nile Tilapia) and the naturally occurring *Oreochromis mossambicus* (Mozambique Tilapia). The Nile Tilapia is more resilient than the Mozambique Tilapia and has a faster growth rate when exposed to similar conditions, reaching harvestable maturity in 6 – 10 months. According to TAASA, the common Nile Tilapia strain farmed in South Africa has a 30% faster growth rate than that of the Mozambique Tilapia, but has 2% greater bone mass. Prior to March 2014, it was illegal to farm with Nile Tilapia in South Africa due to the species being classified as alien invasive. However, through extensive lobbying and the development of a Tilapia Aquaculture Better Management Plan by TAASA, Nile Tilapia has now been included in the latest NEMBA legislation as an alien and invasive species requiring a permit for production.

The farming of Nile Tilapia has now been approved when used in RAS systems and proper permits from the relevant provincial environmental authorities can be secured. The use of Nile Tilapia is expected to significantly increase the viability of South African Tilapia production. However, despite the new regulations, the process of securing the necessary permits remains complicated and uncoordinated between government departments. The lack of clear policy for fresh water aquaculture and the lack of proper implementation of the existing policy framework has hampered the development of the South African industry.

9. Characteristics of the South African Tilapia Industry

In South Africa, there were a total of 53 registered producers of Tilapia in 2013. The majority of producers were located in the North-Eastern side of the country, with Limpopo, North West, Mpumalanga and Gauteng containing the majority of producers (42 out of 53 in total). This is due to the climatic conditions of the area being warmer and more tropical in nature than other areas of the country.

9.1. South African Tilapia Aquaculture Value Chain

The South African Tilapia aquaculture value chain can be described as underdeveloped when compared to developed Tilapia industries in countries such as China or Egypt.

- Support Services

What is clearly significant when comparing the typical Tilapia value chain to the South African case is the lack of support services for the South African Tilapia Industry.

- Primary Suppliers

Equipment is readily available and of a high quality. However, fish feed and seed stock has been a major stumbling block in the past

- Fish Grow-Out

Grow out of Tilapia in South Africa is somewhat restrictive when compared to major producers. Due to the South African climate, grow-out can only occur seasonally in some parts of the country, unless water is heated to maintain higher temperatures. However, in the North-Eastern parts of the country, the subtropical climate allows for year-round grow-out conditions without the need for water heating.

- Primary Intermediaries

In the South African value chain, primary intermediaries are restricted to marketing and transport and local collectors. Lack of volume has restricted the development of Tilapia processors

- Secondary Intermediaries

This sector is made up of individual retailers and informal markets.

10. Tilapia Market Demand

10.1. Local Tilapia Consumption and Trade

Local demand for Tilapia in South Africa equalled 1 491 tons in 2013. Local production satisfied 187 tons of this local demand (234 tons *less* 47 tons of exports) with imports satisfying 1 304 tons.

10.2. Demand from Local Fish Buyers

The majority of commercial buyers interviewed believed that Tilapia is moving into the mainstream of consumer conscience and acceptance. The willingness of major purchasers, such as Woolworths, I&J, SeaHarvest, Pick 'n Pay, Ocean Basket and The Fish and Chip Co, to take up Tilapia as a product shows that Tilapia is not an unknown product amongst commercial stakeholders. The general sentiment is that, should a reasonable price point be found, local consumers will take up consumption of Tilapia. However, other commercial buyers such as Checkers and SPAR did not feel that Tilapia was a viable sales product to the South African consumer. The majority of major commercial buyers, however, do entertain the viability of buying and selling Tilapia in their stores.

Critically, Pick 'n Pay also highlighted three significant positions. Firstly, that high quality Tilapia was a very close substitute for Baby Hake/Hake. Secondly, that Chinese imported Tilapia, while being significantly cheaper, at R16.50/kg Whole Frozen, was of very poor quality and could not be used as a substitute. Thirdly, that they would be very willing to purchase locally sourced Tilapia, provided the quality was high, and would even be willing to pay a premium above the imported Lake Harvest Tilapia prices. Local Tilapia farmers have approached Pick 'n Pay before, but they could not provide the quantities that were needed to maintain a constant supply to stores.

10.3. South African Tilapia Prices

The highest average farm-gate price received was R30/kg in Gauteng and the Free State, while the lowest farm-gate price received was R20/kg in Kwa-Zulu Natal. The national average farm-gate price in 2013 was R26/kg. These prices are for Whole Tilapia, as processing to fillets is currently not practiced in South Africa due to restraints created by insufficient production volumes available to make processing economically viable.

The import price for Tilapia varies considerably, depending on the exchange rate and market conditions prevalent at the time. However, as of August 2014, the average import price for frozen whole gutted Tilapia was R17/kg.

10.4. Tilapia as a Substitute Product

Engagement with local South African buyers of fish revealed that Tilapia can be considered a close substitute for locally caught Hake and Baby Hake. Given the substitutability of Hake and Tilapia, it is reasonable to consider then that they may compete in the same market space and, assuming perfect substitution in ideal circumstances, demand for Hake in South Africa could reasonably equate to potential demand for Tilapia.

Hake made up 18.1% of total South African capture fish production in 2011. This was second only to Anchovy (43.5%). What is clear is that Hake forms a relatively large portion of the local South African fish industry.

However, production of Hake has declined from a high of 91 000 tons in 1985 to a recorded low of 47 000 tons in 2009. Quotas were introduced in 1990 in an attempt to re-build the overexploited Hake stocks to their Maximum Sustainable Yield. This was initially successful, with indications of increasing stock levels and catch-rates and, as such, increases in the quota limits. However, in 2000 stock levels and catch-rates began to decline again and hence quotas were once again decreased.

Statistical forecasting for 2012 to 2022, based on the time period 2002 to 2011, continues to show a general fall in production of Hake for the next 10 years. Consumption has remained fairly consistent from the period 1976 to 2012 and statistical forecasting shows this to continue. Finally, the export trend shows a general decline in export volumes over the entire time period. The declining gap between production and consumption results in less product being available for export and hence a worsening current account.

10.5. Understanding the Market for Hake

Through discussions with local Hake buyers and sellers, it has been established that prices of Hake have been increasing dramatically over the last ten years. One seller of Hake revealed that the price of a 6-8 oz Hake fillet had increased from R17 per kg in 2005 to around R52-R58 per kg in 2014. The 2014 price of Whole Frozen Hake was R30 per kg from the processor. Prices of Hake are determined by international markets, where South Africa is one of many countries that supply Hake. Some differentiation exists, where South African Hake (known as Cape Hake) is of a different species to other countries Hake, but South Africa is generally a price taker in terms of both export, as we compete in an international market, and locally due to our open economy and non-use of import quotas.

The fact that consumption of Hake has remained relatively stable and slightly increasing, despite clear increase in price and a fall in production over time, indicates that the actual demand for Hake has been increasing while supply has been falling. Given that current reported prices for Whole Frozen Hake are around R30 per kg, it would seem that Tilapia and Hake prices are at a point of meeting in the local fish market.

10.6. Zambia, Zimbabwe and Malawi Tilapia Market Demand

Given that South Africa operates as an open economy, it is pertinent to consider the potential for exports, should a viable Tilapia industry be established locally. The main potential countries included in this regard are Zambia, Zimbabwe and Malawi, as per the terms of reference of this assignment.

Conservative estimates of demand for the key export regions of Zambia, Zimbabwe and Malawi for 2013 come to 55 328 tons in 2013

However, while the demand for Tilapia in these markets may be considerable, it is important to consider the type of product that is being demanded. Typically, consumers in Zambia and Malawi look for cheap, whole Tilapia and are not as concerned with Tilapia that has a muddy

taste. Essentially, the consumers in these countries are looking for a cheap form of protein. It is for this very reason that China has begun looking to markets such as these in Africa to export their Tilapia to, given that more discerning markets in the USA and Europe look for high quality, sustainably produced product that China may not be able to satisfy.

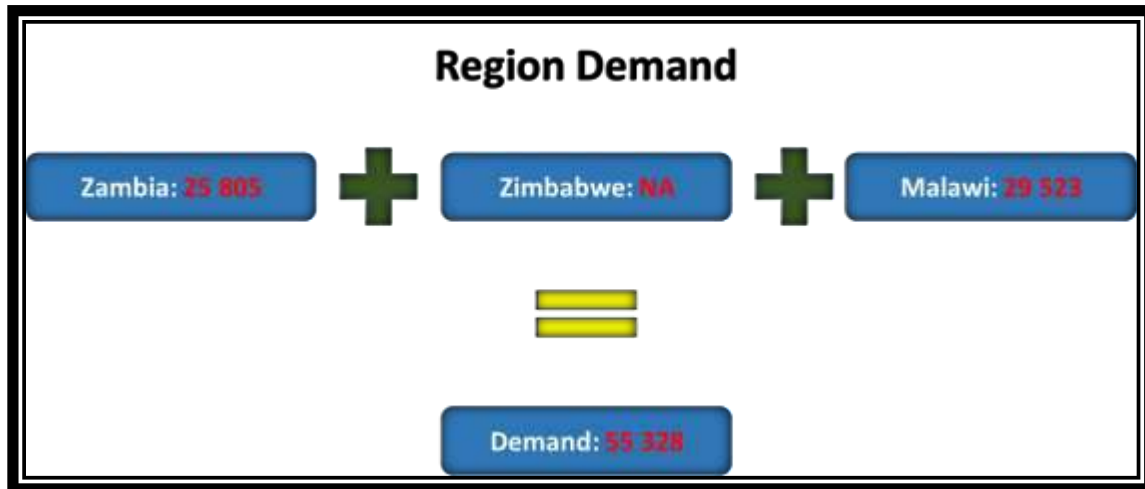
Due to the nature of the South African climate and legislation, production can only occur in RAS systems, which naturally produce a higher quality product than pond based Tilapia production. The corollary of this is that South African produced Tilapia will be of a higher price than the lower quality Asian/Chinese Tilapia. The extent of export potential to these countries by South African producers may thus be restricted to the high-end consumer and not the average consumer.

10.7. Conclusions on Demand for Tilapia

- The local South African market demand **has the future potential to support large-scale local Tilapia production.**
- Scope for export to regional markets is possible from a demand perspective, but **South African production cannot compete with Asian imports into regional African markets** due to the higher price of our product.

The diagrams below summarise the potential markets for South African Tilapia:

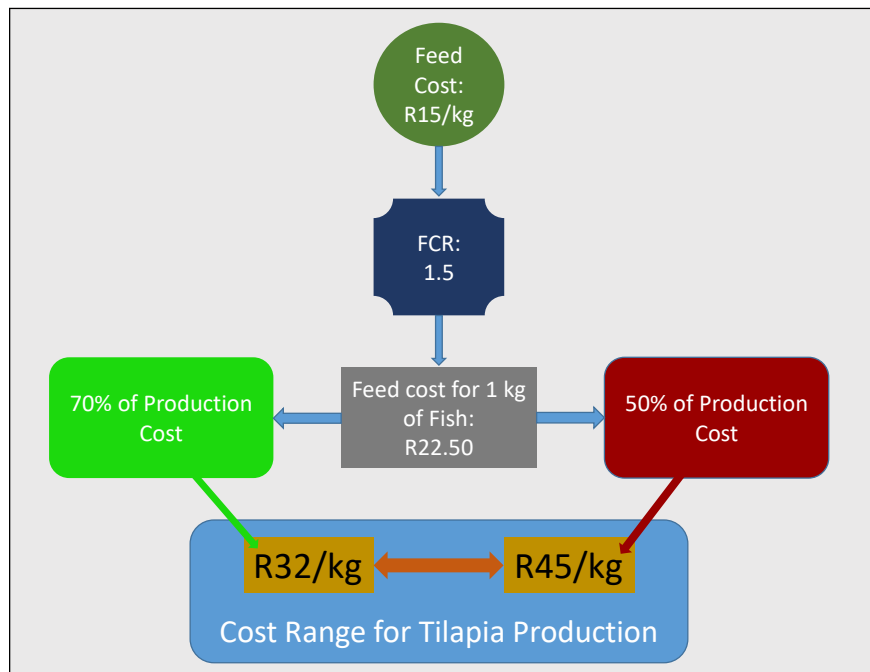




11. Implications for Commercialisation of Tilapia Production in South Africa

The question of commercialisation depends on the relationship between the cost of production and the prevailing market price. Due to a lack of on-the-ground experience in establishing a commercial size facility in South Africa, it was necessary to draw on established literature to determine potential production costs for Tilapia. In this regard, it was determined that feed is

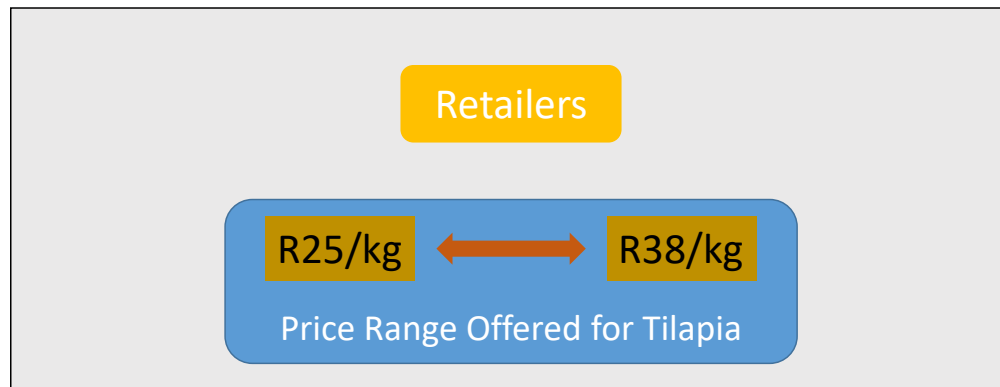
FIGURE 11-1: ESTIMATED PRODUCTION COST RANGE



the single greatest input cost into Tilapia production and that this typically makes up between 70% and 50% of total production costs (depending on the design of the system). Extrapolating from this and an average feed cost of R15/kg in South Africa, it was determined that a potential range for production costs was between R32/kg and R45/kg. This is illustrated in Figure 11-1.

In terms of market prices, it was determined from engagement with local buyers that retailers would be willing to offer between R25 and R38 per kg for Whole Tilapia (illustrated in Figure 11-2).

Figure 11-2: Retail Price Range Offering For Tilapia



It is thus clear that under current market conditions and allowing for variation in the given ranges, that commercial size Tilapia production is not viable until market prices increase and/or production costs fall.

The potential for rising Tilapia prices does exist, given the current restricted supply of wild caught fish in general and Hake in particular. However, reduced production costs would primarily depend on reduced feed costs (due to feed being the largest single input cost) and, secondary, would depend on cost reduction needed for the heating of water in RAS systems given South Africa's climatic conditions and methods of water oxygenation.

12. South African Tilapia Aquaculture Potential

The following matrix seeks to compare the potential of the South African Tilapia industry to that of benchmarks drawn from the research conducted as best practices. Each area is rated as either green (positive), yellow (area of concern) or red (major obstacle).

Area	South Africa	Notes
Species	√	Latest commercial strains (Most importantly Nile Tilapia) can be used.
Feed	X	Locally produced feed is of poor quality. Large scale commercialisation is not viable. However, the local feed industry is experiencing the entry of new producers and the potential for importing high quality, low cost feed has not been ruled out.
Technology	—	South Africa does not make use of pond or cage Tilapia

Area	South Africa	Notes
		aquaculture, but rather uses RAS technology. Entails higher capital and operational costs but greater stocking densities and better environmental protection.
Demand	—	South Africans do not have a strong culture of fish consumption in general and Tilapia in particular, as in other markets. However, demand has potential for significant growth due to increasing awareness of Tilapia and substitutability with Hake.
Market and Production Prices	X	Given the current indicative market price of between R25 and R38 per and the estimated local production costs between R26 and R36 per kg, the market currently cannot sustain large-scale Tilapia production.
Legislation	—	South African Legislation surrounding freshwater aquaculture in general and Tilapia in particular is progressing in a generally positive direction but has not matured enough as yet. Lack of coordination between government departments and no single all-encompassing Aquaculture Act has proven to be a hindrance to the development of the sector.
Climate	—	The majority of South Africa does not have a viable climate for the production of Tilapia without significant interventions in heating. However, certain areas of South Africa do have viable climates for Tilapia production.
Skills	√	South African tertiary institutions offer both formalised aquaculture courses and research-based learning opportunities, while Agri-Seta Learnerships are aiding in the development of a pool of skilled workers in Tilapia aquaculture.
Potential Threats	√	RAS has significantly reduced environmental and health hazards and positions the country as being able to offer a healthier, environmentally friendly and better quality product.

From the above matrix, it can be concluded that commercial scale Tilapia production in South Africa has the potential to be viable in the future. However, feed inputs need to improve in quality and reduce in price in order to reduce production costs and/or prices offered for Tilapia need to continue to display rapid rises before this can be fully realised.

13. Recommendations

The following four recommendations have been developed through consideration of the findings of the research exercise and the position of the IDC.

13.1. Communication and Co-operation with TAASA

The landscape of Tilapia aquaculture is a fast shifting one. Given this rapid change, it is imperative that the IDC should develop contact and maintain a relationship with the industry body TAASA, to keep informed on developments and potential areas of strategic partnership

that may present themselves. The continued involvement of the IDC in this would provide essential support to the industry.

13.2. Removal of Tilapia Feed Imports

Feed represents the single most significant operational cost in Tilapia aquaculture, accounting for between 70% and 50% of total input costs. The access to good quality, well-priced feed is essential to the viability of a commercial-scale Tilapia aquaculture enterprise. Given the issues experienced with local feed, importing feed is an option but currently faces high prices with a 20% Ad Valorem import tariff.

Removal of the tariff will reduce the price of imported feed from R16.56/kg to R13.69/kg, below that of the current R15/kg for locally produced feed. The result of using imported feed *less* the 20% tariff would entail a production cost range of R29.34/kg to R41.08/kg. This is significantly closer, from R25/kg to R38/kg being offered by retailers for Whole Tilapia, but is not yet at a commercially viable level. It is therefore recommended that this option be pursued once local Tilapia prices rise further

However, this intervention should be thoroughly investigated first so as to ensure that potential new local feed producers that may be able to supply feed at a viable price and quality are not locked out of the market due to lower import prices.

13.3. Establishment of a Research/Demonstration Facility

Current production in South Africa is characterised by many small-scale facilities. The result of which is a lack of information as to the potential economies of scale that could be achieved with a commercial-scale operation. The IDC, together with tertiary institutions and/or private sector, should explore the potential for the establishment of a research and demonstration facility that would allow for current South African RAS technologies to be tested on a commercial scale and allow for potential economies of scale to be identified. Additionally, this facility could serve as a testing ground for new feed formulas, explore methods for low-cost production, research impacts on quality of Tilapia or alternative Tilapia species. The facility could also be used as an additional practical training facility for prospective commercial Tilapia farmers. However, current market prices of Tilapia must be taken into consideration. Once the market price for Tilapia has increased to a more reasonable level, in excess of around R45/kg for Whole Tilapia, *ceterus paribus*, or high quality feed can be sourced at around R12/kg, *ceterus paribus*, a commercial demonstration facility could be a viable option.

13.4. Investing in Tilapia Feed Production and Research

The IDC should consider the potential of investing in local feed production. This can be achieved through either establishing a new facility or investing in a current producer. Given the mandate of the IDC to support government's objectives of growing a vibrant aquaculture sector, investing in feed production represents an indirect means of achieving this. Investment in feed production represents an investment in supporting infrastructure and can benefit not only the

Tilapia industry but other aquaculture industries, such as the Catfish aquaculture industry. The effect of supplying high-quality, well-priced feed will have the result of crowding in private investment in primary production. The result would potentially have a far greater impact on the local Tilapia industry for the investment size than if invested in a primary production facility.

Feed could potentially not only be produced for local Tilapia producers, but the possibility of exporting the high-quality feed to other countries in Africa may also exist. With South Africa's superior transport infrastructure and access to multiple African markets through its participation in trade agreements such as SACU and SADC, South African produced Tilapia feed could enter a niche market that imported feed from outside of Africa either could not penetrate or would prove too expensive to import for other African producers.

13.5. Summation of Recommendations

The table below provides a summation of four recommendations. It identifies the area of the interventions, the key stakeholders that should be engaged and the role of the IDC.

Area	Key Stakeholder(s)	Recommended IDC Action
Communication and Co-operations	TAASA	Establish communication channels for regular information sharing
Feed Imports	ITAC/TAASA	Explore potential for removing import tariffs
Research/Demonstration	TAASA/Tertiary Institutions/Private Sector	Establish commercial scale demonstration project
Feed Production	TAASA/Tertiary Institutions/Private Sector Feed Producers	Investment in Tilapia and other fish feed production and research for local and export markets

Section A:

Aquaculture Framework

1. Introduction

Through the Agro-Processing Competitiveness Fund, Urban-Econ was appointed by the IDC to conduct a research project into the potential for the production, processing and export of Tilapia for the Southern African Market. The following sections provide a background for the research project and detail the contents of this first deliverable of the research report.

1.1. Background

The South African Government has, through its National Development Plan (NDP), clearly set out its intentions and objectives of the eradication of poverty, lowering of inequality, the creation of jobs and the development of rural communities. With job creation as a key outcome, the New Growth Path (NGP) identifies a number of jobs drivers, with focus being placed on targeting more labour-absorbing activities across the main economic sectors, including the agricultural value-chain and its linkages to manufacturing. The fostering of rural development and regional integration is also highlighted. Agro-processing and aquaculture is also specifically targeted as a key economic sector and employment cluster in DTI's IPAP.

As part of the drive to develop new agro industries in rural areas, IDC, together with the Economic Development Department (EDD), entered into an agreement for the IDC to manage the Agro-Processing Competitiveness Fund (APCF). The objective of the fund is to facilitate increased competitiveness, growth, job creation and development in the agro-processing and beverage sectors through funding targeted research in these areas. The research is envisioned to deal with the issues of identifying key challenges and opportunities within the rural agro-processing field so as to provide beneficial insight into the industry as a whole.

Aquaculture, as a globally recognised and growing industry, has the potential to contribute significantly to rural development through improving food security, job creation and wealth creation. Within aquaculture, the production of Tilapia has become widely practised around the world but remains a very small sub-sector of the South African aquaculture industry. The potential for the growth of the production of Tilapia within the country thus needs to be explored further in order to determine if a large Tilapia industry is possible in South Africa and whether this industry has the potential to export to other Southern African markets.

1.2. Purpose of the Research Study

The key purpose of the research project is to, firstly, understand the dynamics of the aquaculture industry and potential risks, challenges and success factors present in the South Africa. Following this, focus will be placed on business aspects of farmed Tilapia in the Southern

African region. Through desktop research and stakeholder engagement, the demand for farmed Tilapia will be established along with establishing the existing supply to provide for the expected demand as well as identifying potential competitors to farmed Tilapia. The business and regulatory environment for the export of farmed Tilapia into Malawi, Zambia and Zimbabwe will also need to be determined in order to establish the ease of access to these potential markets. The culmination of this research will result in the determination of the potential for the establishment of a large-scale Tilapia aquaculture enterprise in South Africa.

1.3. Report Contents

This report contains the following sections:

➤ **Introduction**

This section introduces the research project, including background information as to why the research is necessary, a summary of the purpose of the study and an overview of this report's contents.

➤ **Defining Aquaculture**

Here, a definition of aquaculture is provided along with a brief history of the industry globally and the reason for its relevance today.

➤ **Aquaculture Systems and Environments**

Differing forms of aquaculture are explored and discussed in this section, providing an overview of the broad aquaculture industry production process.

➤ **Strengths and Weaknesses of Aquaculture**

The various strengths and weaknesses of aquaculture are discussed, specifically in terms of environmental sustainability and protein production.

➤ **Aquaculture in Context**

The context of aquaculture is unpacked, firstly at a global level and then at an African level. Production numbers and historical trajectories are explored and specific company case studies are analysed.

➤ **Global Tilapia Aquaculture**

The section sets out Tilapia aquaculture in general, looking at global production and Tilapia products. A specific focus is then placed on the Chinese and Ugandan Tilapia aquaculture industries and a performance matrix is constructed from these.

➤ **South African Aquaculture**

The South African Aquaculture industry is analysed. The historical development of the industry is explored and its current status analysed. Further, the current policy and legislative environment is laid out.

➤ **Tilapia Aquaculture in South Africa**

The South African Tilapia aquaculture industry is analysed in terms of the species, technology, culture, legislation, climate and skills currently used in the industry.

➤ **Characteristics of the South African Tilapia Industry**

The current characteristics of the South African Tilapia industry are unpacked, showing production volumes and distribution. A South African value chain is also constructed.

➤ **Tilapia Market Demand**

The demand for Tilapia is analysed in South Africa, where trade statistics, engagement with buyers and exploration of substitute products informed the level of local demand. Coupled with this, a look at demand in Zambia, Zimbabwe and Malawi was also considered.

➤ **South African Tilapia Aquaculture Value Chain Potential**

A matrix of the South African Potential for Tilapia production is constructed and evaluated against benchmarks established from the research conducted.

➤ **Conclusion**

The conclusion section of this report provides a summation of the findings and a conclusion as to the potential for Tilapia aquaculture in South Africa.

➤ **Recommendations**

Finally, recommendations based on the findings of the report are presented.

2. Defining Aquaculture

According to the Food and Agricultural Organisation (FAO), aquaculture is defined as “the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc.” (Van Houtte, *et al*, 1989). This is in contrast to fishing or gleaning which entails harvesting wild aquatic species.

2.1. Brief History of Aquaculture

The emergence of aquaculture has been traced to ancient China, at a time of around 2000 B.C.E., when common carp were reared for food, but no record of the methods of production have been found (Rabanal, 1988)

The first detailed publication of aquaculture was in 500 B.C.E. in China, when Fan Lai wrote his book titled “The Classic of Fish Aquaculture”, and was the first record of production methods used in the propagation of carp and the rearing of fry. Between 500 B.C.E. and 500 C.E., aquaculture spread from China to the rest of Asia, with records of how fish were kept in reservoirs in India first emerging in 300 C.E. From 500 C.E., aquaculture quickly spread to Europe where fish were reared in palaces and monasteries (Rabanal, 1988)

Around 1700, a breakthrough in seed production was realised, allowing for the rapid propagation of large numbers of fish for stocking. Coupled with the colonial expansion and development of international institutions, aquaculture rapidly spread throughout the world by the 1900s and became a recognised practice in many countries (Rabanal, 1988). Since 1900, aquaculture production has increased dramatically, especially in recent times as world wild fisheries have reached their maximum sustainable yield. Aquaculture is now seen as the only sustainable means of continuing to supply the world’s population with more food fish.

2.2. Aquaculture Today

Today, aquaculture is a major supplier of food fish in the world. According to the FAO, total apparent food fish consumption for 2012 was 136.2 million tons. Of this total amount, wild captured fisheries accounted for 51% of the total and aquaculture contributing the remaining 49% (FAO, 2013; FAO, 2014).

Farmed food fish from aquaculture can include in following species:

- finfishes
- crustaceans
- molluscs
- amphibians
- aquatic reptiles
- And, to a far lesser degree, other aquatic organisms such as sea cucumbers, sea urchins, sea squirts and jellyfishes.

About 600 aquatic species are raised in captivity worldwide for aquaculture production, with the vast majority of these species being used to provide food for human consumption. More detailed analysis of global aquaculture is contained in Section 5.

Aquaculture has thus emerged as a key contributor in providing the global population with a sustainable source of food fish, especially as world wild fisheries reach their maximum sustainable yields and hence growth in production from traditional fishing of the world's oceans will remain severely restricted.

3. Aquaculture Systems and Environments

Aquaculture production takes place in salt, fresh or brackish water. Designs for different systems of aquaculture production are numerous, and each type of water (Fresh or salt) has unique aspects that must be accounted for in an aquaculture system, but essentially there are either of the following three: pond, tank or cage systems, as can be seen in Figure 3-1 below. The following section explores these three separate systems.

Figure 3-1: From left to right, Aquaculture Ponds, Tanks and Cages



The use of ponds, tanks and cages lends itself to different stocking rates and means of production.

- Ponds typically have low stocking densities but lower capital costs, lending itself to production that is extensive rather than intensive (Bostock, *et al.* 2010). This is useful in areas with large available tracks of land, large volumes of water and a suitable climate.
- Tanks, on the other hand, typically have higher stocking densities but higher capital costs. This form of production is typically intensive, and best suited when little land is available. The re-use of water through filtration allows water to be conserved and temperature controlled, allowing production to occur where water is not as abundant and the environment not as conducive (Bostock, *et al.* 2010).
- Cages also allow for high stocking densities but require constant maintenance so as not to lose any of the stock. Cages do not require a filtration system, as in tanks, as the natural flow in rivers, dams or oceans removes waste and brings in fresh water (Bostock, *et al.* 2010). However, the environmental risk of stock escaping into the natural environment is much greater and can have a devastating impact on the biodiversity and ecology of the area if the species being farmed is invasive.

The use of these systems in aquaculture has seen production from fresh-water environments rising from less than 50% of total produced food fishes by volume in 2008 to 62% in 2010. Fresh-water aquaculture represented 58.1% of global aquaculture production by value in 2010 (FAO, 2012). The production of fresh-water fishes is dominated by Carp, making up 71.9% of total fresh-water production by volume in 2010, and are mostly cultivated in ponds. Salmonid farming (mainly rainbow trout in fresh-water) make use of ponds, concrete raceways and other types of tank that provide higher flow rates of water to maintain good water quality. This also allows for higher stocking densities. Tilapia can be cultured in both pond and tank systems (Bostock *et al.* 2010).

The use of coastal ponds and lagoons for the cultivation of marine food fish has been used for centuries, however expansion of production has occurred rapidly in recent times. In warmer countries, crustacean production, such as shrimp, has dominated brackish-water culture due to the high-value of the final product, short production cycles and accessible technologies. Production of crustaceans has increased dramatically since the 1970s and now accounts for 57.2% of total production in brackish-water by volume globally (FAO, 2012).

Coastal aquaculture using tanks has developed notably in countries such as South Korea, Spain and Iceland. Most use pumped water that passes through the tanks once before being discharged back into the environment. However, an increasing number of operations treat and reuse the water to provide greater isolation from the environment (Bostock, *et al.* 2010).

4. The Strengths and Weaknesses of Aquaculture

Aquaculture farming as a source of protein has been shown to have a number of positive externalities when compared with traditional capturing of wild food fish and traditional animal husbandry.

The sustainability of wild fisheries has become a major concern since the mid 1950's. The threat of over-fishing and the decimation of wild shoals from the world's oceans has led to a raft of environmental regulations designed to limit the amount of fish that is extracted from the world oceans. This is to ensure that species are not threatened with extinction, and to maintain the highest rate of sustainable extraction possible. The result is that world wild fisheries output has levelled off in the last decade, showing little or no growth in production (FAO, 2014). Despite this, the world population continues to increase while the per capita consumption of food fish has also increased, climbing from 17 kg in 2000 to 19.2 kg in 2010 (FAO, 2014). Aquaculture has thus provided a means of continuing to source food fish without increasing harvesting of wild fisheries beyond maximum sustainable yields.

In addition, when compared with other sources of farmed protein such as from animal husbandry, aquaculture is relatively more efficient and environmentally friendly in many respects. This is primarily because fish require less nourishment to build body mass than land based animals as they use energy derived from their food sources more efficiently (World

Ocean Review, 2013). The reason for this efficiency is that fish are cold-blooded creatures, with body temperature reflecting their environment. Compared to land based animals, who are warm-blooded, fish do not need to waste energy on generating body heat. Fish also expend far less energy for movement. As water is denser than air, fish are supported and so do not need to develop heavy skeletal body mass for movement.

Fish are also able to release surplus nitrogen into the water without having to convert it into urea or uric acid like land based animals, saving energy. The result is that a lot less feed is required to produce one kg of carp than to produce one kg of chicken, pork or beef. Also as a result of this improved efficiency, aquaculture emits much less nitrogen and phosphorus per ton of produced protein than livestock farming. Bi-valves, such as muscles and oysters, even lower nitrogen and phosphorus levels in their environments. A comparison of nitrogen and phosphorus emissions per protein source can be seen in Table 4-1, below.

Table 4-1: Nitrogen and Phosphorus Emissions in kg/ton of Protein Produced by Protein Source

PROTEIN SOURCE	NITROGEN EMISSIONS	PHOSPHORUS EMISSIONS
Beef	1 200	180
Pork	800	120
Chicken	300	40
Carp	471	148
Catfish	415	122
Salmonids	284	71
Shrimp and Prawn	309	78
Tilapia	593	172
Bivalves	-27	-29
Other Finfish	474	153

Source: World Ocean Review, 2013

As can be seen in Table 4-1, food fish from aquaculture produce lower emissions of Nitrogen and Phosphorus than Beef or Pork, with chicken being the only animal protein that can compete with food fish in terms of lower emissions.

However, aquaculture has also been known to produce negative externalities. According to Whitmarsh and Palmieri (2007), some of these externalities are:

- Shoreline aquaculture has resulted in a loss of natural habitat where shoreline mangroves have been converted into shrimp farms, reducing biodiversity and removing the natural services that the mangroves provided (e.g. water filtration).
- Marine cage aquaculture has also been shown to negatively impact the growth of natural sea grass in the Mediterranean, thereby negatively impacting on organisms that rely on sea grass, and hence reducing biodiversity and the natural carrying capacity of the environment.

- Intense fish aquaculture also results in a significant amount of waste. If the waste water is not treated, it can lead to eutrophication when returned to natural water sources.
- In the case of fresh-water cage aquaculture, this waste is released directly into the water source and so cannot be treated. Intensive cage aquaculture can lead to eutrophication and impact on water-users further down the water course.
- Finally, organisms farmed in tank or pond aquaculture often require large amounts of anti-biotics due to the intense nature of stocking. The result is that these anti-biotics can be released into the natural environment, impacting on wild organisms. Human consumption of farmed fish treated with anti-biotics may also carry a health risk.

Certain farmed species may also lead to a negative overall impact on food fish production. Species such as Salmon, Tilapia and Sea Bass that are farmed intensively are fed a processed pellet feed that contains a mixture of grains, fishmeal and fish oil. The result is that some species may require more wild fish in their diet than they produce themselves (World Ocean Review, 2013). With a FIFO¹ ratio greater than one, the net production is a fall in available food fish. This is due to fish used in feed primarily being sourced from wild fisheries of Anchovies, Sardines and Herring, all food fish that are also consumed by humans

FOR EXAMPLE, THE FIFO RATIO OF SALMON WAS 7.5 IN THE 1990'S BUT HAS SINCE BEEN BROUGHT DOWN TO BETWEEN 3 AND 0.5. HOWEVER, FOOD FISH SUCH AS CATFISH, TILAPIA AND MILKFISH HAVE FIFO RATIOS OF LESS THAN ONE (0.5, 0.4 AND 0.2 RESPECTIVELY), INDICATING A NET INCREASE IN FOOD FISH AVAILABILITY WHEN FARMED.

5. Aquaculture in Context

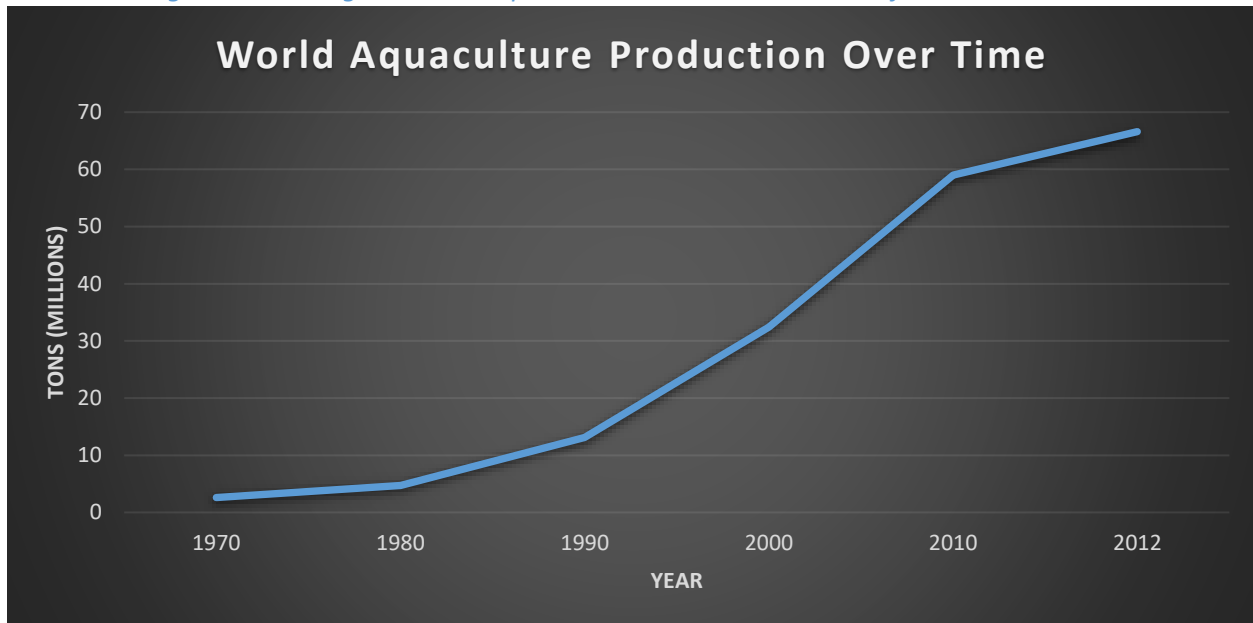
The following section seeks to deconstruct the context of aquaculture, starting at the global level and then moving to the African continent. Production volumes and the historical growth trajectories of aquaculture are tracked.

5.1. Global Aquaculture

On a global scale, aquaculture continues to grow faster than any other food sector, averaging an 8% growth rate over the past 20 years. Production of food fish from aquaculture grew at an annual average rate of 6.2% between 2000 and 2012, more slowly than between 1980 and 1990, at 10.8%, and between 1990 and 2000, at 9.5% (World Ocean Review, 2013; FAO, 2014). This can be seen in Figure 5-1.

¹ The Fish In Fish Out (FIFO) ratio is the measurement of the amount of fish that must be used in feed to produce one kg of farmed fish. If the FIFO ratio is one, then one kg of fish was needed in feed to produce one kg of farmed fish. If the FIFO ratio is two, then two kg of fish was used in feed to produce one kg of farmed fish.

Figure 5-1: Change in World Aquaculture Food Fish Production from 1970 to 2012



Source: FAO, 2012; FAO, 2014

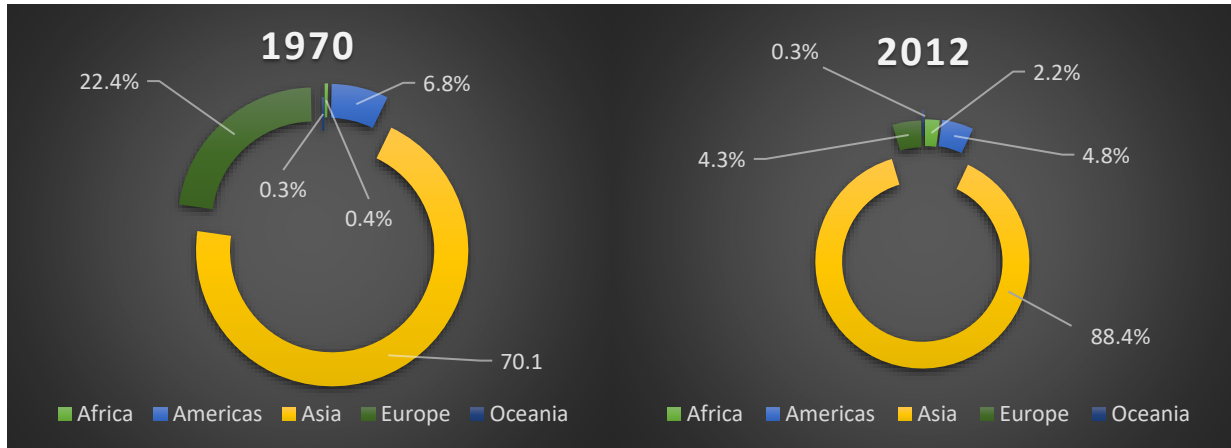
As can be seen in Figure 5-1, aquaculture production accelerated dramatically between 1990 and 2010. In the two years since 2010, production had already increased by 7.8% on top of 2010 levels. According to the OECD-FAO Agricultural Outlook for 2013-2022 (OECD/FAO, 2013), it is anticipated that aquaculture output will increase by 35% between 2013 and 2022, with aquaculture expected to surpass capture fisheries as main source of fish for human consumption by 2015.

The growth rate in farmed food fish production from 1980 to 2010 far outpaced the growth in global population. This led to an increase in the average annual per capita consumption of farmed fish, rising from 1.1kg in 1980 to 8.7kg in 2010. The rapid rise of aquaculture production has seen it move from being almost negligible in comparison to traditional captured food fish production to making up 49% of total food fish production in 2012 with a total of 66.6 million tonnes of farmed food fish compared to 69.6 million tonnes of captured fish (World Ocean Review, 2013; FAO, 2014). The value of production of food protein from aquaculture totalled US\$119 billion in 2010 but the distribution of this production remains imbalanced.

Production from aquaculture is predominant in Asia, where 88% of world aquaculture production is located. This production is dominated by finfishes at 64.6% with molluscs making up 24.2% and crustaceans 9.7%. China alone contributed 61.4% of the world aquaculture production for 2010 (FAO, 2012). In the Americas, aquaculture production contributed 4.3% to world production with North American aquaculture ceasing to expand in the period between 2005 and 2010 and declining by 9.8% in the period between 2010 and 2012 while growth in Latin America has continued, expanding by 36% in the period between 2010 and 2012. In

Europe, production contributes 4.3% to global production. This has fallen from 22.4% in 1970 and currently major producers have ceased expanding, with total production only increasing by 24,000 tonnes between 2009 and 2010. Africa contributed 2.2% to global production with North Africa producing 69.4% of the total production of Africa. Finally, Oceania contributed only 0.3% to global aquaculture production. Figure 5-2 below shows the change in the share of world production from 1970 to 2012 by region.

Figure 5-2: Change in Share of Global Aquaculture Production by Region from 1970 to 2012



Source: FAO, 2012; FAO, 2014

As can be seen in Figure 5-2, Asia has dominated global production since 1970 and has increased its share of global production until 2012, while Europe's share of global production has declined dramatically. Africa's share has notably increased from 1970. A breakdown of aquaculture production by weight and share for each year can be found in Annexure 1.

5.2. African Aquaculture

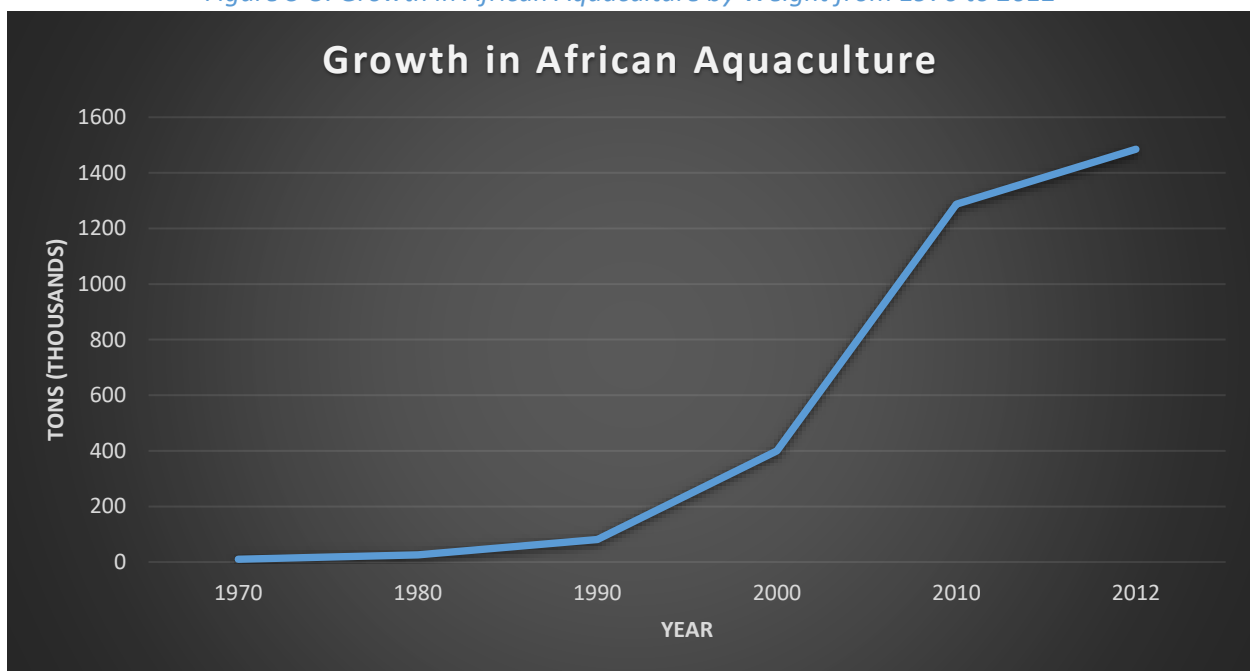
Aquaculture for food production in Africa was introduced over 50 years ago. Tilapia were successfully produced in ponds for the first time in Democratic Republic of Congo (DRC) in 1946 (Vincke, 1995). By the end of the 1950s, there were almost 300 000 ponds in production in Africa (Satia, 1989). Raising fish for sport purposes has even a longer history, with trout introduced in South Africa in 1859 and the construction of the first trout hatcheries in the 1890s. According to Vincke (1995), rice/fish farming has existed in Madagascar since the early 1900s. Initial production was based on fish that naturally found their way into rice fields through waters supplying these fields; these were captured and raised in cages (Randriamiaran et al., 1995).

During the early 1960s, as many colonial regimes were coming to an end and resources were becoming scarce, aquaculture development slowed substantially (Aguilar-Manjarrez & Nath, 1998). In many areas, ponds were abandoned due to low yields, poor location and/or lack of government support (Vincke, 1995). After the slow-down of the early 1960s, aquaculture

development in Africa accelerated in the late 1960s again as a result of increased donor aid and technical assistance (Vincke, 1995).

The 1970s and 1980s were a boom time for African aquaculture, as numerous projects were undertaken to fill a growing food fish supply gap. However, the boom was not to last as questions around the sustainability of the industry began to emerge. The result was a slump in aquaculture development in the 1990s, but by the end of the 1990s aquaculture development picked up again due to increased demand and the realisation of the limitation of wild captured fish food (Machena and Moehl, 2001). The growth in African aquaculture can be seen in Figure 5-3.

Figure 5-3: Growth in African Aquaculture by Weight from 1970 to 2012



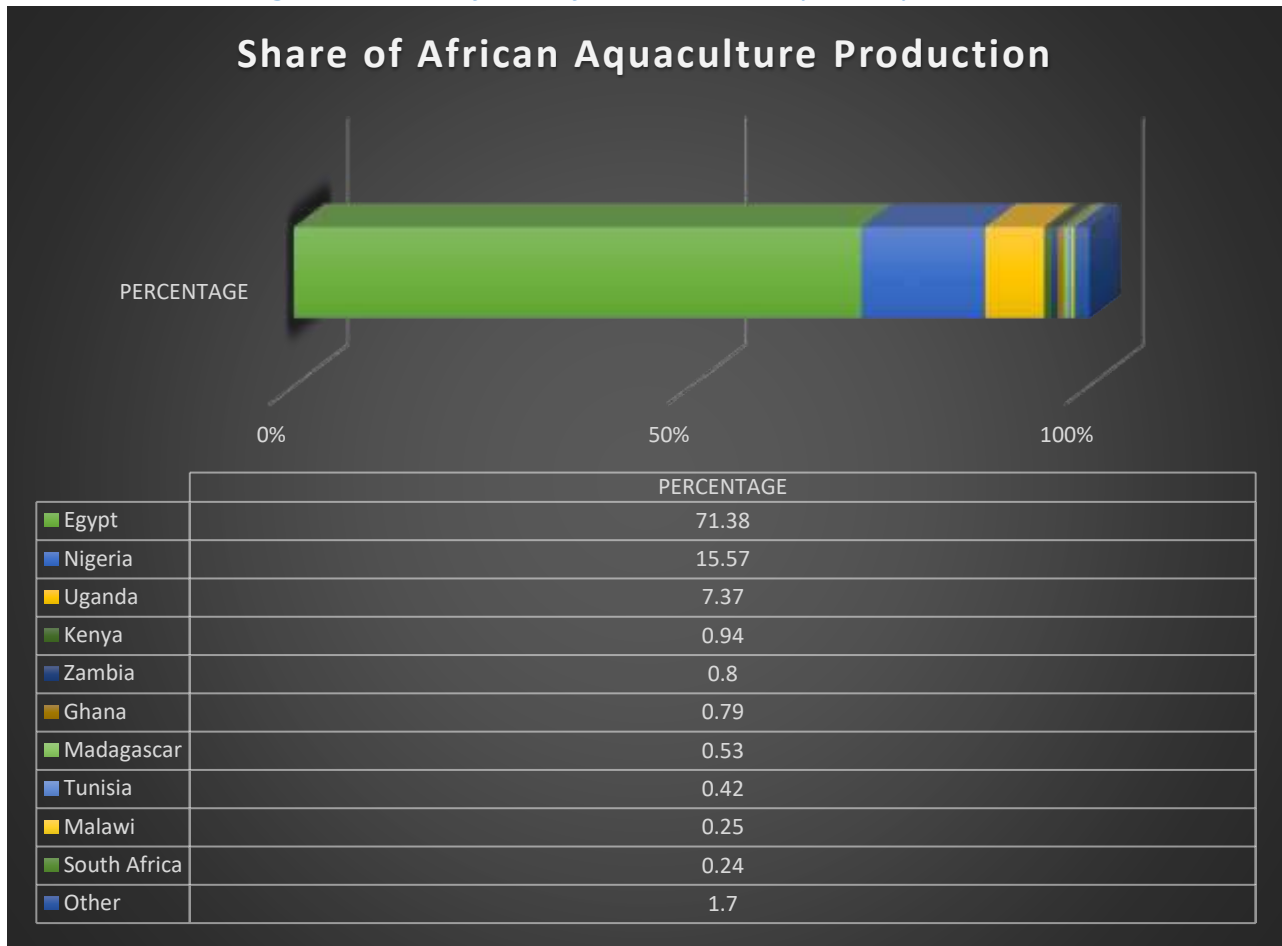
Source: FAO, 2012

As can be seen in Figure 5-3, African aquaculture has experienced a dramatic increase in production since 1970, with the period 2000 to 2010 being the most rapid of increases. Despite only contributing 2.2% of global food fish aquaculture production today, Africa has experienced the fastest growth rate in aquaculture in the period 2000 to 2012 out of all regions, with growth of 11.7% (FAO, 2012). This trend is expected to continue, especially in countries where fish is a traditional food, but where insufficient wild fish will be available to meet the needs of the growing population.

When deconstructing production by country, Egypt is the largest producer of food fish through aquaculture on the continent, accounting for 71% of all African production. This is followed by Nigeria at 16% and Uganda at 7%. Kenya, Zambia, Ghana, Madagascar, Tunisia, Malawi and

South Africa make up the rest of the top ten producers but none of whom produce more than 1% of total production from Africa. This information is contained in Figure 5-4, below.

Figure 5-4: Share of Total African Production by Country in 2010



Source: FAO, 2012

As can be seen in Figure 5-4, the aquaculture industry in Africa is dominated by Egypt, Nigeria and Uganda. Just these three countries account for 94% of total aquaculture production by weight in Africa.

Section A Summation:

Aquaculture Framework

Aquaculture Background

- Defined as the “farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants”.
- First recorded use of aquaculture dates to 2 000 B.C.E.
- Today, aquaculture supplies around half of total food fish across the globe

Aquaculture Systems

- There are three main systems used in aquaculture:
- Ponds: Low stocking densities, low capital costs, high environmental costs
- Tanks: High stocking densities, high capital costs, low environmental costs
- Cages: High stocking densities, moderate capital costs, high environmental costs

Strengths and Weaknesses of Aquaculture

- Sustainable source of fish protein for human consumption.
- More efficient conversion of energy into protean than land-based farmed animals.
- Lower nitrogen and phosphorus emissions per kg of protein produced

- Loss of natural habitat
- Reduced bio-diversity
- Waste water can lead to eutrophication

Aquaculture in Context

- Globally, aquaculture is the fastest growing food sector
- Asia accounts for 88% of world aquaculture production
- Africa accounts for 2.2% of world production
- Africa has the fastest growing aquaculture sector
- Egypt produces 71% of African aquaculture output
- South Africa produces 0.24% of African output

Section B:

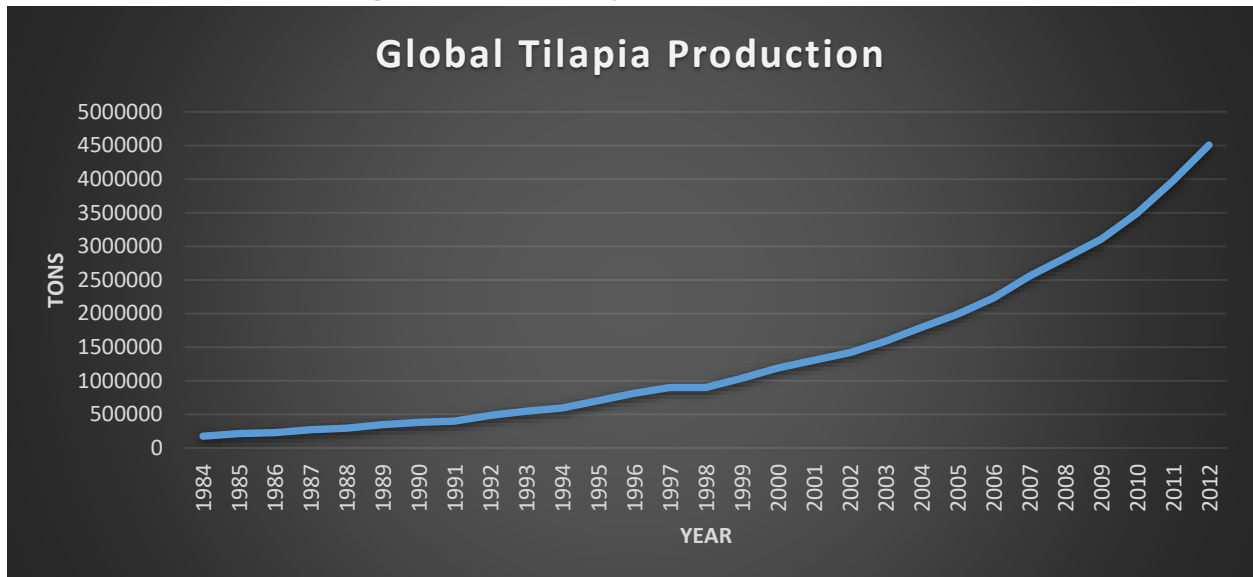
Tilapia Aquaculture

5. Global Tilapia Aquaculture

Tilapia is a commonly stocked food fish in aquaculture, due to its relative fast growth rates and hardiness in production, allowing for high stocking densities. The texture and taste of Tilapia has been described as resembling that of South African Hake, with very bland flavours. This white fish has remarkable appeal to consumers all over the world, with the consumption of Tilapia being common on almost all continents. The USA remains the world's largest market for Tilapia, with Tilapia being the second most consumed food fish in the country. Africa has the fastest growing market for Tilapia, specifically for whole frozen Tilapia, which has become a major focus of Chinese exports to Africa in terms of food fish. (Globefish, 2014).

As can be seen in Figure 6-1, global Tilapia production has risen steadily since 1984.

Figure 6-1: Global Tilapia Production over Time

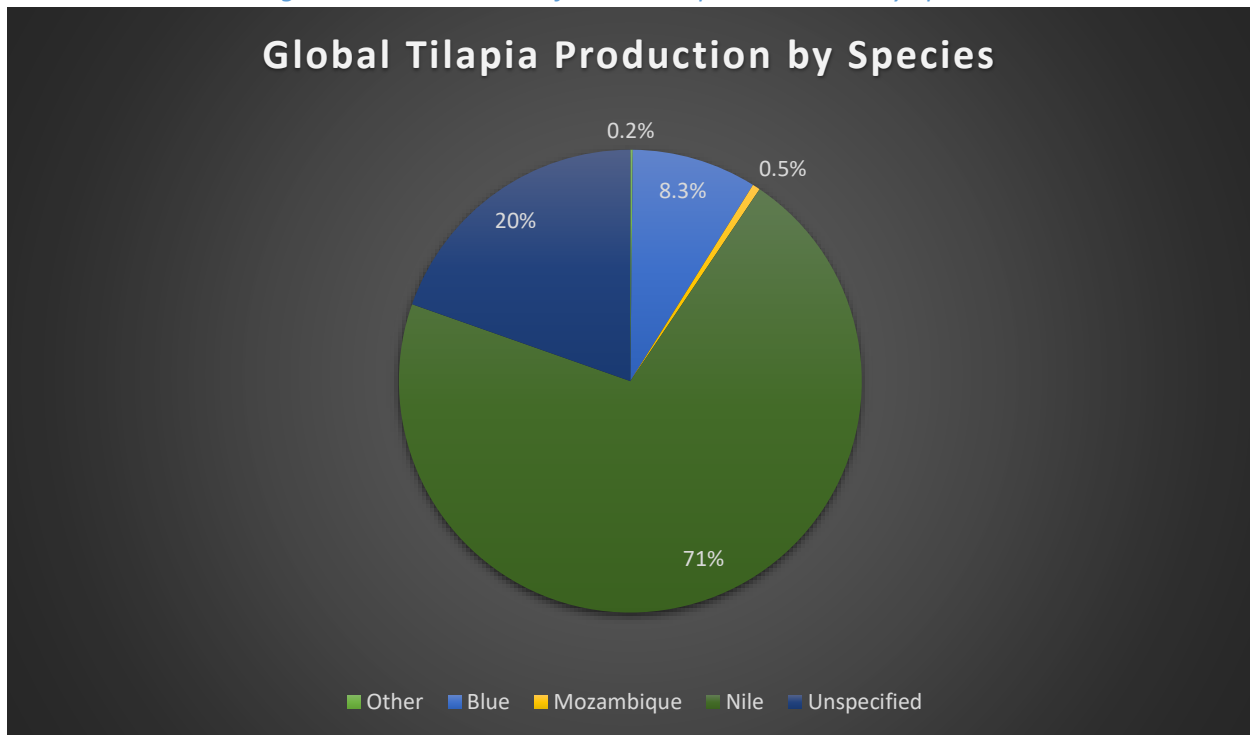


Source: FAO, 2014

Tilapia production has been growing at an increasing rate since 1998, reaching an all-time production high of 4.5 million tons in 2012. This represented 12.32% of the total freshwater fish aquaculture production in 2012 (FAO, 2014).

There are also many differing species of Tilapia. The FAO (2014) recorded production volumes for 21 different species of Tilapia. The distribution of production volumes of these Tilapia species can be seen in Figure 6-2.

Figure 6-2: Distribution of Global Tilapia Production by Species



Source: FAO, 2014

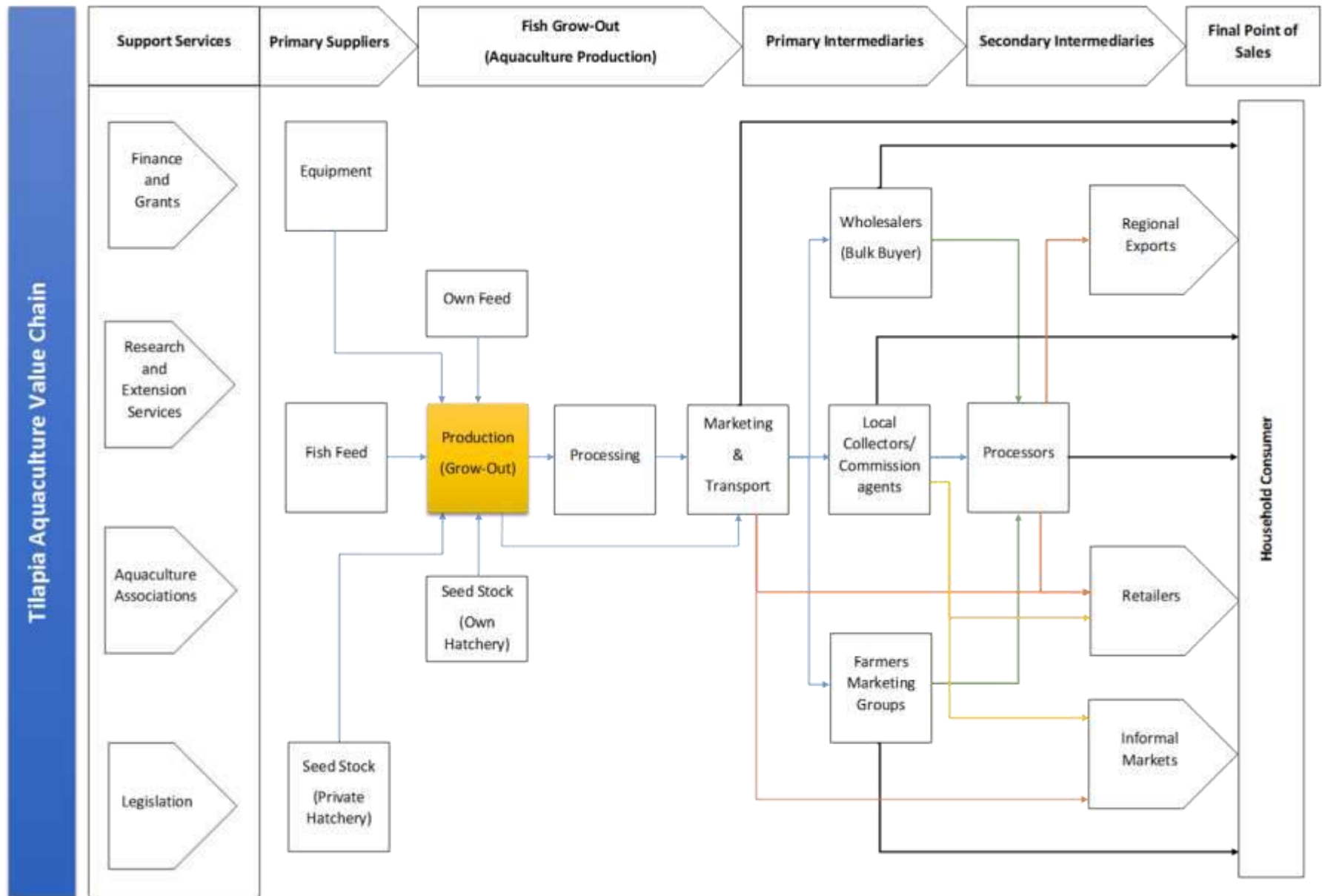
What is very clear from this figure is that the Nile Tilapia is the most used species in Tilapia aquaculture, followed by Blue Tilapia and then Mozambique Tilapia. The large distribution of unspecified production relates to issues in reporting of species by government departments, particularly from developing countries.

6.1. Tilapia Value Chain and Product Analysis

The following section explores the Tilapia industry at a very high level. Firstly, a well-developed Tilapia production value chain is mapped and unpacked. This value chain is representative of the Tilapia industry in a country such as China or Egypt and provides a picture of the industry benchmark for a developed value chain. This section will then explore different Tilapia products and levels of value addition for each.

6.1.1. Value Chain

The Tilapia value chain, Figure 6-3, is constructed from best-case scenarios observed to date. It is separated into Support Services, Primary Suppliers, Fish Grow-Out, Primary Intermediaries, Secondary Intermediaries and Final Point of Sales.



➤ **Support Services**

Support services provide the background and environment for the success or failure of the Tilapia industry. These support services are Finance and Grants, Research and Extension Services, Aquaculture Associations and Legislation.

- **Finance and Grants**

Aquaculture is a relatively capital intensive operation compared to other forms of agriculture. Due to this, the sourcing of financing and grants for seed capital and initial operational expenses is incredibly critical for a successful aquaculture enterprise.

- **Research and Extension Services**

Aquaculture is also a relatively knowledge intensive farming practice, requiring a large number of expertise in order to develop a successful operation. Inputs from scientific disciplines such as physiology, genetics, biotechnology, ecology, nutrition, economics, engineering and veterinary science. For one operation to be able to bring together all of these specialities would require a very large operation and would present too large a barrier to entry for small and medium sized enterprises. The centralisation of these support services would thus allow small and medium sized operations to access the necessary skills.

- **Aquaculture Associations**

Groups of producers and processors forming associations provide invaluable support to the industry. These associations often assist in funding research into new technologies and developing markets while also form a lobbying group to regulating institutions to help advance the development of the industry. New entrants are also assisted through these associations which often provide information for obtaining of permits or recommendations for farming practices that may be useful in certain areas.

- **Legislation**

The institutional environment created through government legislation can provide a support to the industry, where that legislation ensures high quality products and safe, nutritious, food for the consumer. Legislation can also ensure that the over-all environmental concerns are accounted for and ensuring that conflicts over water and land use are resolved through properly assigned property rights.

➤ **Primary Suppliers**

These provide the primary inputs into the aquaculture operation for production to commence.

- Equipment

The equipment used by the aquaculture farmer is directly related to the environment in which the farming is to occur and the availability of water resources. There are four primary production methods used in Tilapia farming. These being the Recirculating Aquaculture System (RAS), Raceway Ponds, Earthen Ponds and Cages. Examples of these systems can be seen in Figure 6-1, below. RAS and Raceway systems are relatively capital intensive but allow for intensive stocking densities while earthen ponds are relatively less capital intensive but stocking densities are far lower than the other systems. Cages are moderately capital intensive but allow for high stocking densities. However, cages can be extremely harmful to the local environment through release of fish waste directly into natural water courses and threat of escaping stock is high. RAS systems are more environmentally friendly than raceway ponds and cages as they filter and re-use the majority of the water but must be closely monitored as changes in water quality can quickly lead to the loss of the fish stock. The optimisation of water temperature and quality for maximum growth rates is also easier in RAS systems than in Raceway Earthen pond and Cage systems.

Figure 6-1: From left to right, examples of RAS, Raceway, Earthen Pond and Cage systems respectively



- Fish Feed

Fish feed is an essential input into the Tilapia aquaculture value chain not purely because it is the source of food for the fish but also because it forms a significant part of the input costs and determines the sustainability of the Tilapia product in terms of the FFO ratio and the quality of the product in terms of nutritional value. Feed is also either sourced externally from commercial feed suppliers, produced internally by the farmer or a combination of the two.

- Hatcheries (Seed Stock)

Hatcheries are the life-blood of the Tilapia value chain. Hatcheries produce the seed and fingerlings that are supplied to farmers for grow-out and value addition. Hatcheries are also the store of the genetic foundation of the Tilapia species, where certain species are better suited to certain areas, the hatcheries provide the relevant species for the farmer. Hatcheries can be stand-alone entities, concentrating solely on the provision of seed and fingerlings to farmers or can form part of the farming operations, allowing farmers to grow their own seed and

fingerlings to reduce reliance on stand-alone hatcheries or even sell excess seed and fingerlings to other farmers.

➤ **Fish Grow-Out**

The grow-out stage of the Tilapia value chain is the most time consuming and precarious. The constant monitoring of temperature, water quality and disease is required throughout. At this stage, the Tilapia are taken from fingerlings to full size harvestable fish over a period of 6 to 10 months, depending on species, stocking rates, feeding scheme and temperatures.

- **Processing**

Once the Tilapia have reached a harvestable size, on-farm processing may be undertaken. This usually involves very low-level processing, with the fish being gutted and sometimes filleted before proceeding further down the value chain.

- **Marketing and Transport**

The harvested and/or processed Tilapia are then marketed and transported off-farm by the farmer either directly to the household consumer or to primary and/or secondary intermediaries.

➤ **Primary Intermediaries**

These entities are usually involved in the purchase of product from the farmer and then the sale onto the household consumer or onto secondary intermediaries.

- **Wholesalers**

The wholesaler purchases the product directly from a number of farmers and then markets and sells the product in bulk onto the household consumer or onto a secondary intermediary, such as a processor.

- **Local Collectors/Commission Agents**

These agents will purchase or sell product from farmers, earning a commission from the sale of the product. The product is sold directly to the consumer or to secondary intermediaries such as processors, retailers or informal markets.

- **Farmers Marketing Groups**

A number of farmers may form marketing groups through which they sell their Tilapia. This allows for improved market access and product awareness as a single brand may be developed under which the farmers product can be marketed. They then sell the product on to the consumer or secondary intermediaries such as processors.

➤ **Secondary Intermediaries**

These entities are concerned with final value addition of the Tilapia product and then sale to the final consumer or exports to foreign markets.

- **Processors**

The processing of farmed Tilapia is a value addition activity that produces many different forms of Tilapia product. Processing can go from simple gutting and freezing of fresh Tilapia to extensive processing into crumbed fillets, canned food and even the production of Tilapia leather (specific Tilapia products are discussed later). This off-farm processing is usually carried out in a facility managed by groups of fish farmers or external-off-farm by companies who have purchased the fresh product from farmers, wholesalers or farmer marketing groups and seek to process and add value to the product to realise a profit. The processors then sell their product on to the consumer directly, or through retailers. Product can also be exported to foreign markets due to the product being frozen allowing for long-distance transportation.

6.1.2. Product Analysis

The following are products derived from Tilapia, ranging from no processing to highly processed and Tilapia by-products.

➤ **Fresh**



The most basic Tilapia product. Freshly harvested Tilapia are transported directly to market and sold to consumers without any processing or value addition.

➤ **Frozen Whole**



Low level processing of Tilapia for value addition. The simplest form of processed Tilapia product. The Tilapia are gutted and frozen for transport to market or wholesalers.

➤ **Fillet**



Low to medium processing of Tilapia for value addition. Fish is gutted and filleted then sold fresh or frozen.

➤ **Frozen Processed**



Medium to high processing of Tilapia for value addition. Tilapia fillets are further processed and packaged to create differentiated products.

➤ **Canned Tilapia**



Tilapia processing by-products are further processed and combined with additional ingredients to produce canned domestic cat food.

➤ **Tilapia Leather**



The skin by-product of Tilapia can be tanned and coloured into a leather used in the fashion industry to make an assortment of belts, wallets, handbags, shoes, etcetera.

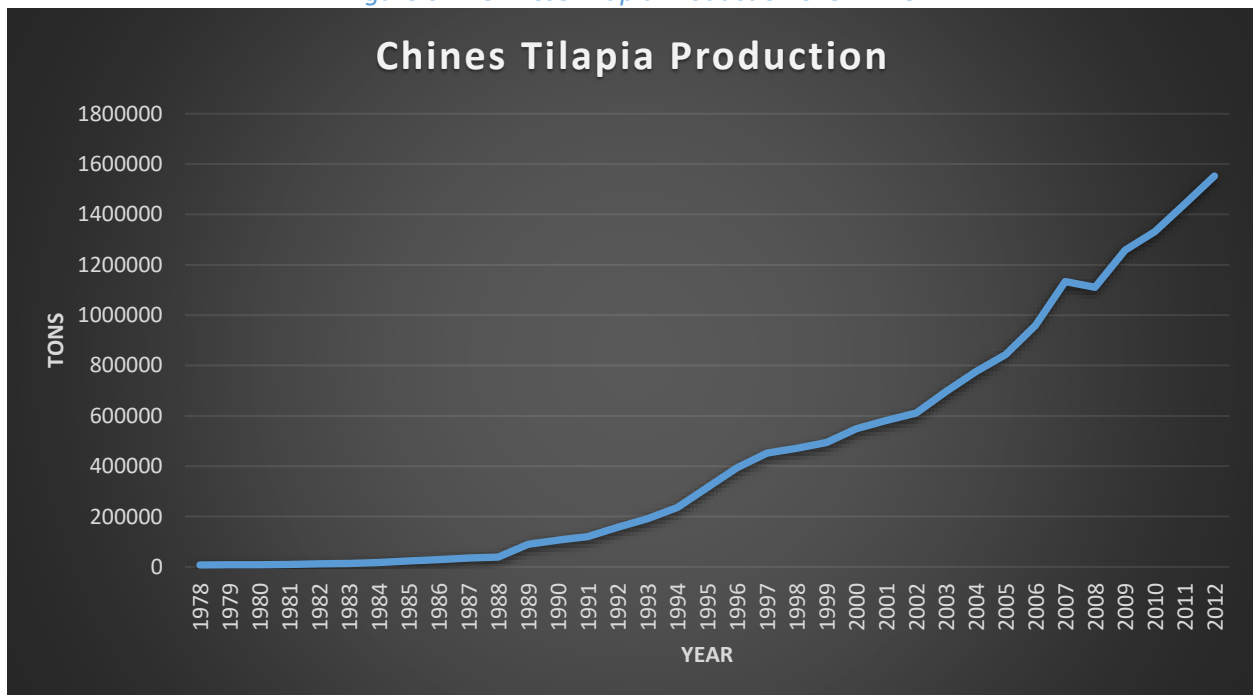


6.2. Chinese Tilapia Industry

The Tilapia industry in China is the largest in the world, accounting for over 30% of global Tilapia production. In 2012 alone, China produced 1.5 million tons and exported 329 000 tons of Tilapia, with the largest export destination in order of export volume being the USA. The Chinese Tilapia industry was worth around \$2.3 billion in 2012, with exports of Tilapia netting China \$1.1 billion in 2011 (FAO, 2014).

However, Tilapia is not a native fish found in China. Tilapia was first introduced into the country in 1957, with *Oreochromis mossambicus* being introduced from Vietnam. The farming of Tilapia remained a relatively small industry until 1978, when the first hybrids of *Oreochromis mossambicus* and *Oreochromis niloticus* were produced, increasing growth rates substantially. In 1994, a further enhanced strain of *Oreochromis niloticus* was introduced, commonly referred to as GIFT (Genetically Improved Farmed Tilapia). These advances in the genetic profile of the cultivar in China propelled the Tilapia industry from the world's 4th biggest producer in 1978, at 7 600 tons, to the world largest producer in 1988, at 89 000 tons, all the way to 1.5 million tons in 2012 (NBSO, 2010; SFP, 2012; FAO, 2014). This rapid growth can be seen in Figure 6-4.

Figure 6-4: Chinese Tilapia Production over Time



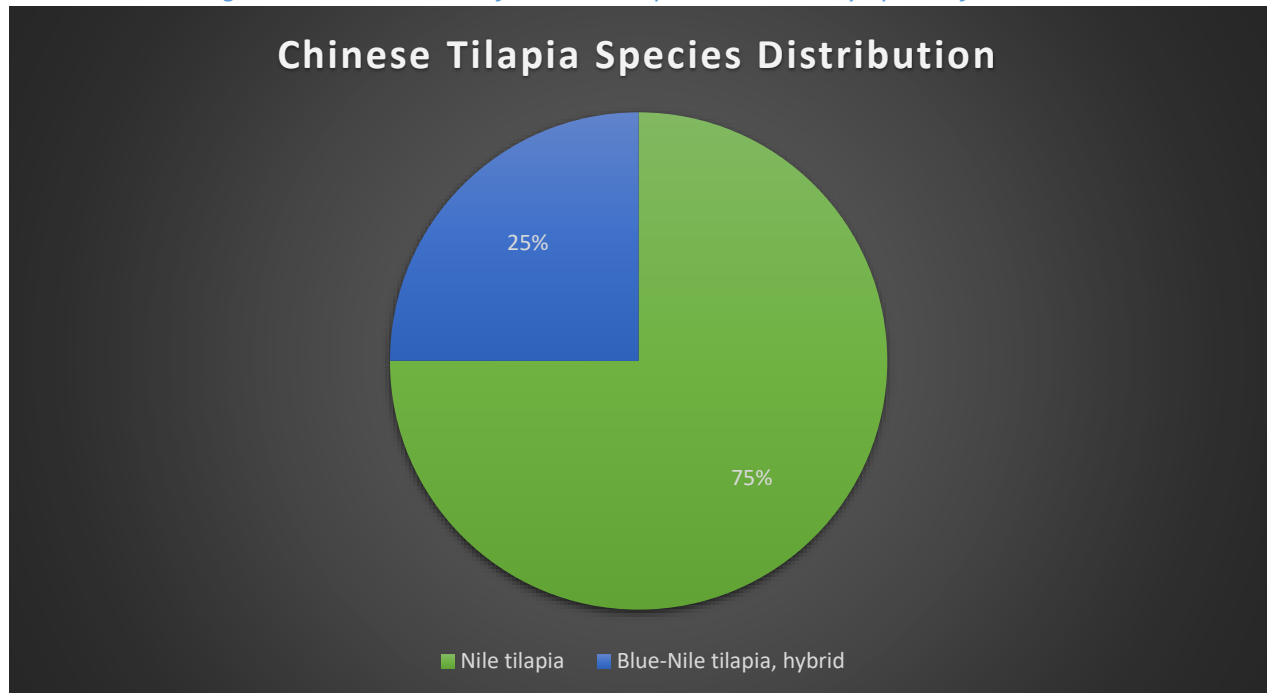
Source: FAO, 2014

As can be seen in the above figure, production rose slowly until 1988. After this, Tilapia production has increased dramatically, only showing a decline in 2006/7 due to extreme climatic conditions in the primary Tilapia producing provinces that severely hampered production.

6.2.1. Species

The Chinese Tilapia industry today makes use of two primary species of Tilapia, that being the Nile Tilapia and the Blue-Nile Tilapia hybrid. Figure 6-5 shows the distribution of these two species in production.

Figure 6-5: Distribution of Chinese Tilapia Production by Species for 2012



Source: FAO, 2014

The Nile Tilapia makes up two thirds of the cultivar used in Chinese Tilapia aquaculture. This is due to the species being extremely fast growing and hardy, showing remarkable resistance to fluctuating water qualities and disease, both of which are characteristic of Chinese aquaculture as a result of the prevalent production technologies and poor environmental regulation. This species also makes up the majority of exports.

The Blue-Nile hybrid makes up the remainder of the production. This hybrid grows to a much larger size than the Nile Tilapia, but at a slower rate. It is also more resistant to colder water temperatures, thus being primarily farmed in the colder regions of China. This species is primarily grown for domestic sale.

6.2.2. Technology

Despite being the largest producer of Tilapia in the world, the technological level of China's production methods is considerably low. Production is dominated by the use of earthen ponds and cage aquaculture, with the vast majority of producers being small-scale rural farmers who then sell their product in local markets or on to large regional processors. These processors

then add value through processing and packaging for export regionally and internationally (NBSO, 2010).

However, while China's production methods may be relatively low tech, the quality of their cultivar, feeds and vaccines are of a very high level, due to considerable investment in research and development in these areas. The Chinese government's 11th 5 Year Plan for aquaculture, released in 2010, set out very specific targets for the development of improved aquaculture strains, improved feed and better designed medicines for aquaculture species (NBSO, 2010). The result of this investment is a highly developed and technologically advanced research programme that continuously improves on current strains of cultivar used in aquaculture and the simultaneous development of improved feeds to maximise rates of growth.

6.2.3. Fish Consumption Culture

The consumption of fish in Chinese dietary culture is heavily ingrained. China boasts one of the world's largest per capita fish consumption rates in the world (31kgs per capita, second only to Japan at 57kgs per capita).

This strong culture of fish consumption is particularly evident in the Tilapia industry. Chinese production of Tilapia was just short of 1.5 million tons in 2012 but of this amount, only 329 000 tons was exported (FAO, 2014). This means that almost 80% of production is consumed locally despite the fact that Tilapia is not a native fish to the country. The strong local culture of consumption of Tilapia provides a robust base for the Chinese Tilapia industry.

6.2.4. Legislation

In China, the Fisheries Law (2000) seeks to enhance the production, development and reasonable utilization of the nation's fishery resources. It requires the state to adopt a policy that calls for simultaneous development of aquaculture, fishing and processing, with special emphasis on aquaculture. The Law is implemented by the Regulation for the Implementation of the Fisheries Law (1987).

The Bureau of Fisheries, falling under the Ministry of Agriculture, is the main administrative body governing the fisheries and aquaculture sector. The major functions assigned to the Bureau are to formulate plans, strategies, policies and programmes for fisheries development, to guide fisheries economic reform, to implement and monitor fisheries laws, regulations and international/bilateral fisheries agreements, to strengthen fisheries management so as to ensure proper utilization of fisheries and aquatic resources and to protect the fisheries environment, to support fisheries education and scientific research and to administer the fisheries processing industry.

The Constitution divides China administratively into provinces, autonomous regions and centrally administered municipalities. Under the province or the autonomous region are autonomous prefectures, counties and cities. The fisheries departments in the provinces, autonomous regions, municipalities and counties have more or less the same functions as the

Bureau of Fisheries in their respective geographical areas. They are under direct leadership of their provincial, autonomous region, municipal and county governments, and guided by the Bureau of Fisheries.

According to the Fisheries Law and its implementing Regulation, the people's governments at or above the county level may grant licenses to use state-owned water surfaces and tidal flats to state and collectively-owned units to develop aquaculture. Companies or individuals, who wish to use those designated areas, must apply for an aquaculture permit through the competent fisheries administration at or above the county level, and the aquaculture permit will be granted by the people's government at the same level to allow using the area for aquaculture activities. In terms of Environmental Impact Assessments, over the last two decades EIA requirements have focused mainly on construction and large-scale development projects. Small-scale projects are exempt from such regulations, hence the growth in small-scale fisheries aquaculture in China.

6.2.5. Climate

Many parts of China have ideal climates for the production of Tilapia. The hot temperate climates of the southern provinces produce the majority of Chinese Tilapia. This allows for extensive use of pond aquaculture without the need to control water temperatures. A downfall of this is that the southern provinces are also the most heavily industrialised areas of China and as such polluted waters and contaminants are a concern (NSBO, 2010).

Colder areas of China also produce Tilapia, focusing on the Blue-Nile hybrid which handles colder weather better than the Nile Tilapia.

6.2.6. Skills

Aquaculture skills development follows two paths in China; tertiary institutions have dedicated aquaculture programs for training students and for research and development. These students often enter the more corporate and large aquaculture producers. The other stream is the traditional transfer of skills from the older farmer on to their children who then assist in running a farm. This is often more associated with the rural/small scale aquaculture farmers in China (NSBO, 2010).

6.2.7. Potential Threats

There has been a rising backlash to Chinese produced Tilapia in their primary export markets of the USA and Europe recently. Environmental and health conscious consumers in these developed markets have begun to question the environmental sustainability of the Chinese production methods and the nutritional value/health impacts of Tilapia farmed in Chinese pond

systems. Environmental and healthcare websites have become awash with anti-Chinese Tilapia sentiments (Cartier, 2013; Snopes, 2014; McCarthy, 2014)².

A 2012 report by Seafood Watch (Zajdband, 2012) analysed the Chinese Tilapia industry in terms of eight criterion. These criterion are as follows:

1) Data Quality and Availability

Evaluated on the quality and availability of data on production methods and volumes.

2) Effluents

Evaluation of the practices followed in discharging of waste water and their impact on the environment.

3) Habitat

Analysis of the impact of the farms on the local ecosystem and the degree of alteration that occurs in the local habitat.

4) Evidence or Risk of Chemical Use

Monitoring the extent of the use of chemicals in production methods

5) Feed

Analysis of the sustainability of the feed used in production with a heavy emphasis on the FIFO ratio achieved.

6) Escapes

Incidence of escape of farmed species into the natural environment and their impact on the local ecosystem.

7) Disease

The extent of amplification of disease and pathogens in the fish farms and their impact on wild populations.

8) Source of Stock

The degree to which wild stocks are caught and then grown in fish farms for harvesting.

Each criterion was evaluated on a scale between 0 and 10, with 0 indicating poor performance and 10 indicating perfect performance. The results are seen in Table 6-1.

² Many more examples are available but for the purposes of being concise, they have been omitted.

Table 6-1: Seafood Watch Report Results for Chinese Tilapia Production

Criterion	Score (0-10)	Rank
Data Quality and Availability	2.50	RED
Effluent	6.00	YELLOW
Habitat	4.82	YELLOW
Evidence or Risk of Chemical Use	0.00	RED
Feed	9.39	GREEN
Escapes	5.00	YELLOW
Disease	5.00	YELLOW
Source of Stock	10.00	GREEN

Source: Zajdband, 2012

As can be seen in Table 6-1, the Chinese Tilapia industry scored very poorly in data quality and availability and in evidence or risk of chemical use. A score of 0.00 for chemical use was the worst out of all producers analysed, indicating a heavy presence of heavy metals and chemicals in the water used for farming and in the Tilapia product itself. Feed scored very highly, primarily due to the low FIFO ratios achieved (a result of the heavy investment in R&D into feed and cultivar in China). The industry also scored moderately in the environmental category (effluent and habitat), as waste water is often not treated and released directly back into the natural water systems causing eutrophication and exposing wild species to residual anti-biotics while the building of earthen ponds has significantly altered the natural landscape and water systems.

The push-back from consumers has resulted in European and American Tilapia importers seeking new sources of Tilapia that are far more environmentally friendly and have fewer question marks surrounding the health impacts of the Tilapia. Companies such as Regal Springs in South America and the Nan Ying Aquaculture Association in Taiwan have stepped up to meet this market gap by attaining Aquaculture Stewardship Council (ASC) accreditation. ASC accreditation ensures that production is carried out in a sustainable way, producing a healthy and consumer friendly product. Currently no Chinese firms have achieved ASC accreditation (ASC, 2014).

Due to this push-back, Chinese Tilapia producers are attempting to improve the environmental and health status of their production, but years of entrenchment of production methods and large amounts of pollution in natural water ways from industrialisation and the decentralised nature of the small-scale production regime are hampering these efforts. As such, many exporters are looking towards less environmentally and healthcare conscious markets, with

particular focus on Africa, where consumers are more concerned with price than quality (Globefish, 2014).

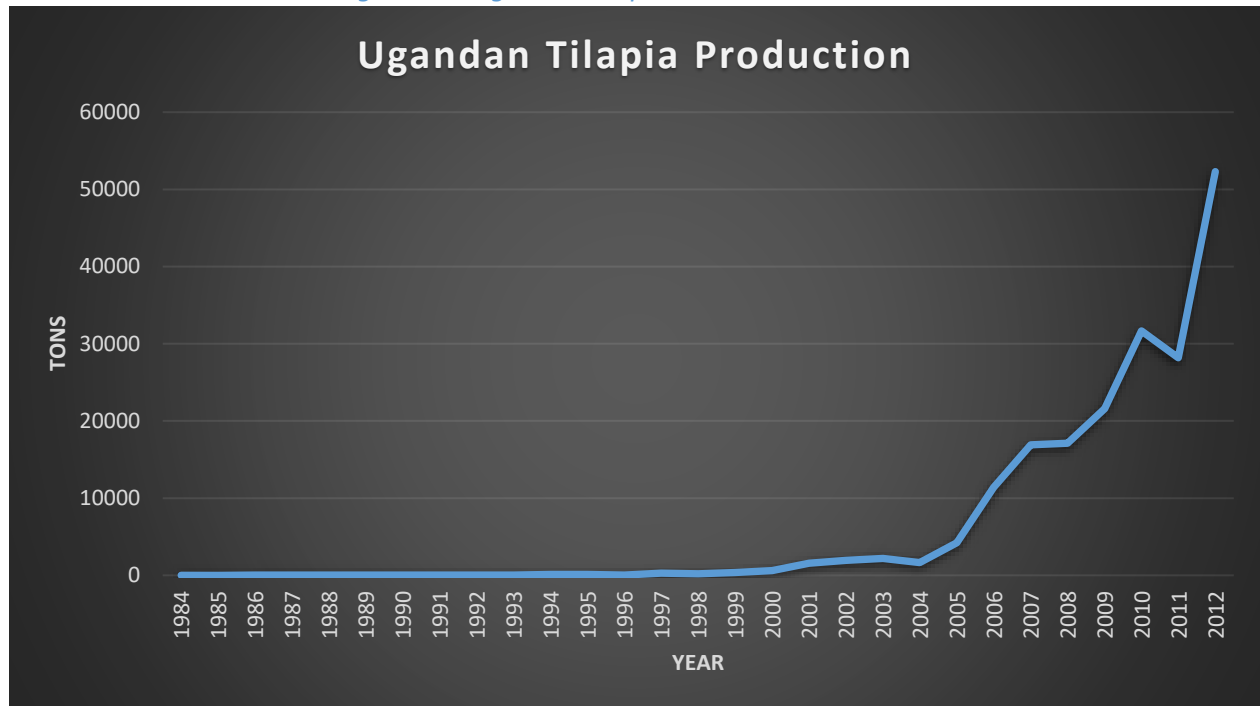
6.3. Uganda

Aquaculture in Uganda is recorded to have started in 1941, after Carp was imported into the country. Fish farming was officially proposed by the colonial authorities and the Kajjansi Fish Experimental Station was established in 1947. However, the introduction of Carp was embroiled in controversies due to differences among the lead scientists on the possible adverse impact of common Carp on the indigenous aquatic environment, should they escape from the confines of the fishponds. Because of this, it was decided to use Tilapia for stocking purposes. A vigorous fish farming extension programme resulted in the construction of 1 500 ponds by 1956. These were concentrated in the central region (Buganda) and the most south-western part of the country (Kigezi) (FAO, 2006).

In 1959-1960 an FAO supported comparative evaluation of Carp and Tilapia endorsed the use of Carp and resulted in further expansion of aquaculture in Uganda. Aquaculture was further promoted under the drive for rural development, and by late 1968 the Department of Fisheries recorded up to 11 000 ponds mostly producing fish for subsistence. However, subsistence farming was largely based on the supply of seed from farmer to farmer and/or from the government station, which hampered the expansion of the aquaculture sub-sector, as the genetic make-up of the fish stock remained poor and advantage was not taken of improved strains. Changing policies under successive governments also led to uneven support and many farmers abandoned ponds due to lack of stocking materials, limited technical guidance and excessive government regulatory regimes. The Fisheries Master Plan study of 1999 established that Uganda had only 4 500 functioning ponds at that time with only a portion stocked, producing 285 tonnes of fish annually (FAO, 2006)

However, from 2005 the Ugandan government intervened heavily in the freshwater aquaculture industry. The government provided strategic support in the form of extension services, production technology, financial support and harmonised aquaculture regulations in the country. Coupled with support from strategic development partners such as the FAO, production has expanded dramatically, particularly for Tilapia, as can be seen in Figure 6-6.

Figure 6-6: Ugandan Tilapia Production over Time



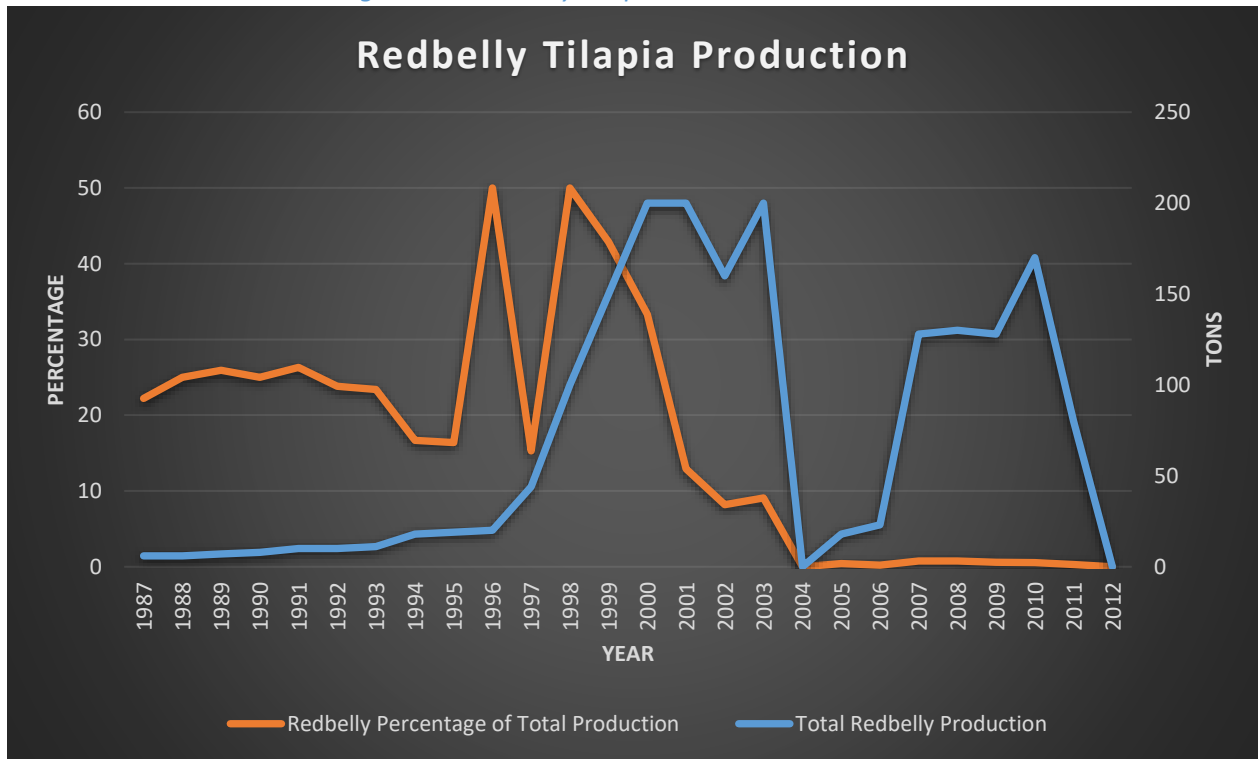
Source: FAO, 2014

The strategic intervention has led to Tilapia production increasing from 4 240 tons in 2005 to 31 670 in just 5 years, an increase of 647% from 2005. From 2010, production has further increased to 52 300 tons in 2012. This prolific growth in Tilapia production propelled Uganda to Africa's 3rd largest producer, after Nigeria and Egypt, in 2012 (FAO, 2014)

6.3.1. Species

Ugandan Tilapia aquaculture makes almost exclusive use of the *Oreochromis niloticus* (Nile) species of Tilapia in domestic production. A secondary species, *Tilapia zillii* (commonly known as Redbelly Tilapia), is also farmed in Uganda. Redbelly Tilapia was a prominently farmed species in Uganda up until 1998, accounting for over half of total Tilapia production. After 1998, new farmers started to use the Nile Tilapia and, while production of Redbelly remained stable, its share of total production fell rapidly. Today, production volumes of *Tilapia zillii* are almost negligible, making up only 80 tons in 2011, compared to *Oreochromis niloticus*, which accounted for 28 101 tons in the same year (FAO, 2006; FAO, 2014). This is illustrated in Figure 6-7.

Figure 6-7: Redbelly Tilapia Production over Time



Source: FAO, 2014

As can be seen in Figure 6-7, total Redbelly Tilapia production fluctuated between around 20% and 50% of total Tilapia production from 1987 to the early 2000's. However, in the mid-early 2000's, production declined dramatically. This coincided with a dramatic rise in Tilapia production in general. As is seen in the above figure, Redbelly Tilapia production reached its highest total tons of production in 2000, 2001 and 2003 but as a percentage of total Tilapia production, it declined dramatically in these years and has remained stagnant despite a recovery in total production between 2004 and 2010.

It is very clear that the Nile Tilapia is the main production species in Ugandan Tilapia aquaculture, with Nile Tilapia being the only recorded species of production in 2012.

6.3.2. Technology

Ugandan Tilapia production is dominated by pond technology. The propagation of Tilapia through the use of ponds was promoted by government due to its low capital cost and easy availability of water. Most producers are subsistence farmers with small ponds, averaging between 50m² and 200m² by area. Farmers who have become semi-commercial have increased their pond sizes to around 500m² (FAO, 2006). Emerging commercial farmers have begun to make use of cage aquaculture in local water courses, smaller lakes and Lake Victoria in particular. The Tilapia Aquaculture Association of South Africa (TAASA) also indicated that local

South African Tilapia farmers have been contracted to assist Ugandan farmers in the establishment of RAS systems, however it is expected that this is on a small scale only.

Tilapia production methods in Uganda are thus of a low technology, extensive rather than intensive nature. Pond aquaculture is dominant with an emerging interest in cage aquaculture for commercial use.

6.3.3. Fish Consumption Culture

Contrary to popular perception, Uganda is not a major consumer of fish. According to a 2012 report by the Ugandan Ministry of Agriculture, Animal Industry and Fisheries, Ugandan per capita consumption of fish was only 5.7kgs (DFR, 2012). This is well below the World Health Organisation recommended diet of 12.5Kgs and below the African average of 9kgs per capita.

In terms of Tilapia specifically, the report claims that most production is exported regionally and to the European Union. This is an interesting outcome given the large amounts of water bodies in the country, one would assume that consumption of fish as a protean source would be a natural part of the culture of the country.

6.3.4. Legislation

The main piece of legislation regulating the aquaculture sector in Uganda is the Fish (Aquaculture) Rules of 19 May 2003 (No.81 of 2003) (FAO, 2014b) The Rules set forth the different permits that are required to engage in aquaculture, the prescribed offences and penalties under the Rules. They specify aquaculture inspector's powers, promote responsible aquaculture activities, and prescribe conditions for fish seed production, fish transfers, live fish imports and exports.

The Department of Fisheries Resources (DFR) is the competent authority responsible for inspection, certification and approval of aquaculture establishments. It is guided by the National Development Plan 2010/11-2014/15 and the Agriculture Sector Development Strategy and Investment Plan 2010/11-2014/15, giving the DFR a mandate to promote, guide and support the aquaculture sector and ensure sustainable development of the sector. The Fish (Aquaculture) Rules provide for the DFR to work in collaboration with other bodies, such as the Ugandan National Environment Management Authority (UNEMA), the National Drug Authority (NDA), the National Bureau of Standards (NBS) to ensure that practices in aquaculture comply with national legislation and standards.

EIA's are administered by UNEMA. In terms of aquaculture projects, developers first make a submission to the Authority detailing the following information:

- The nature of the project.
- The projected area of land, air and water that may be affected.
- The activities that shall be undertaken during and after the development of the project.
- The design of the project.

- The materials that the project shall use, including both construction materials and inputs.
- The possible products and by-products, including waste generation of the project.
- The number of people that the project will employ, the economic and social benefits to the local community and the nation in general.
- The environmental effects of the materials, methods, products and by-products of the project, and how they will be eliminated or mitigated

Following this submission, UNEMA will then decide if an EIA is necessary or not, depending on the possible impacts on the environment. If no EIA is required, a license is granted and final approval from the DFR is required, along with a water license from the Director of Water Resources. If an EIA is required, a full EIA is conducted and submitted to the Authority for consideration and possible approval.

6.3.5. Climate

Uganda is ideally located on the equator to experience tropical warm climates. Almost the entire country has ideal temperature conditions for the production of Tilapia without the need for water temperature conditioning or green housing. This allows for the use of pond and cage aquaculture.

6.3.6. Skills

In 2006, the FAO estimated there were 12 000 farmers involved in aquaculture in Uganda (FAO, 2006). These farmers developed their skills largely from handed down knowledge and learning-by doing. However, the government also maintains a service of 150 extension officers who provide technical guidance and management specifically for the aquaculture sub-sector. A further 100 officials are directly employed to conduct training in aquaculture practice for local farmers.

The government also maintains an Aquaculture Unit within the DFR through which extension programs and aquaculture development initiatives are coordinated. A specialised youth services is also maintained, with groups of youth taking up the building of ponds and water ways in exchange for learning new skills and developing their aquaculture knowledge.

6.3.7. Potential Threats

Potential threats to the Ugandan Tilapia industry are considerably low at this stage. Ample supplies of water and land ensure there is sufficient room to expand the industry along extensive lines.

However, similar conditions were prevalent in China and, given the use of similar production technologies between the two countries, Uganda may need to guard against excessive polluting of its water ways from aquaculture and the use of excessive amounts of chemicals to maintain healthy fish stocks.

6.4. Performance Matrix

The following Matrix pulls together the characteristics of the Chinese and Ugandan Tilapia aquaculture industries in order to identify similarities and differences in the industries that may have led to their respective successful growth and development and provide a benchmark against which the South African industry can be measured.

Table 6-2: Performance Matrix for China and Uganda

Area	China	Uganda
Species	Nile Tilapia + Blue-Nile Hybrid	Nile Tilapia
Technology	Mostly Pond and some Cage	Mostly Pond and some Cage
Culture	Strong culture of fish consumption in general and Tilapia in particular.	Weak culture of fish consumption in general compared to the rest of Africa and poor culture of consumption of Tilapia, which is mainly exported.
Legislation	Decentralised administration with loose small-scale regulations.	Centralised administration but with developmental/practical focus.
Climate	Primary production in the South-eastern provinces due to ideal climatic conditions.	Ideal climate for Tilapia production throughout country.
Skills	Dedicated tertiary skills development programs coupled with traditional on-site learning.	Large pool of skilled aquaculture farmers, supported by government skills development programs and extension services.
Potential Threats	Environmental and Health concerns	Environmental concerns

6.5. Summation

Global Tilapia Aquaculture

- Accounts for 12.32% of total fresh water aquaculture
- Nile Tilapia is the most common used strain (71% of production)

Chinese Tilapia Aquaculture

- Largest Tilapia industry in the world
- Production split between Nile Tilapia (75%) and Blue-Nile Tilapia (25%)
- Primarily makes use of low-tech pond systems
- Has a strong culture of fish consumption
- Has clear legislation governing Tilapia aquaculture
- Southern provinces have a good climate for Tilapia production
- Have vast government funded research and development programmes
- Has a poor environmental and food safety reputation

Ugandan Tilapia Aquaculture

- Second largest Tilapia producer in Africa
- Today, makes almost exclusive use of Nile Tilapia
- Makes use of low-tech pond aquaculture
- Uganda has a low per capita rate of fish consumption and exports majority of its production
- Has specific legislation governing the aquaculture sector
- Has an ideal climate for Tilapia aquaculture
- Has dedicated extension officers to transfer aquaculture skills to local farmers
- Expanding aquaculture is leading to environmental degradation

7. South African Aquaculture

The following sections will track the South African aquaculture industry, providing a brief history of the industry and its current status. Following which, the current policy and legislative environment is considered.

7.1. Local Aquaculture Development

Aquaculture in South Africa began in the late 19th century with the establishment of the Jonkershoek Hatchery in Stellenbosch and the Pirie Hatchery near King Williamstown in the 1890s (Hecht and Britz, 1990). These hatcheries were used to stock suitable waters in the Cape Colony with trout for game fishing. This formed part of Government policy at the time to establish inland sport angling. The focus was on the production of exotic salmonid fishes, such as rainbow and brown trout, which were not native to South Africa, as these were the most desirable. In addition, other exotic species such as bass and carp were also produced and stocked in inland waters. Over the course of the next 100 years, additional provincial hatcheries were built to stock inland waters with exotic fish species to promote and spread sport angling. However, in the late 1980s and early 1990s, national and provincial governments stopped promoting the production and stocking of exotic fish species into inland waters, effectively withdrawing government support of the local aquaculture industry and resulting in the closure or privatisation of government facilities. The lack of clear policy and funding during the political transition of the 1990s further compounded the withdrawal of support and resulted in the very slow development of the South African aquaculture industry compared to other parts of Africa and the world (Rouhani and Britz, 2004).

In the 1980s, the South African government developed a policy to promote aquaculture for food production in the then homelands of South Africa. These aquaculture projects were to help enhance the viability of the hopeful homeland states through improving food security. Aquaculture programmes were established at the University of the North in the former Lebowa homeland, University of Venda in the former Venda homeland, University of Zululand in the former Kwazulu homeland and University of Transkei in the former Transkei homeland. These university programmes were to provide support to aquaculture projects in their areas but these programmes and projects associated with them have mostly fallen away since the 1990s following the democratic transition.

At a commercial level, the production of carp, trout and catfish as a source of food was promoted by government during the 1980s and 1990s but with mixed success. Carp farming was established by the former Transvaal Nature Conservation Department as a culture species in the early 1980s. The Marble Hall fish hatchery, established by the department, formed the centre of commercialisation through providing commercial farmers in the area with fingerlings. Many commercial farmer entered the aquaculture industry through this program but

production crashed from 30.3 tons in 1985 to only 1.2 tons in 1988 (Hecht and Britz, 1990). This was due to the low demand and market price for carp.

Catfish farming was started in the late 1980s after the Foundation for Research Development supported research into catfish farming at Rhodes University. This led to the establishment of commercial farming of catfish in the Lowveld region where production rapidly grew to over 1 000 tons per annum. However, by 1992 production had ceased due to low market demand and prices.

Trout farming emerged as an offshoot of the government policy of promoting inland sport angling. The government hatcheries of de Kuilen and Lydenberg supported the development of a strong commercial trout farming industry in the Lydenburg area. The commercial farmers developed new products through downward processing, increasing market prices and value while successful marketing strategies allowed for sufficient demand to emerge to sustain the industry.

The commercial farming of ornamental fish (live fish used in fish tanks for display purposes) emerged in the early 1990s without government support. Previously, the majority of ornamental fish were imported into South Africa. The high value of these fish thus presented an opportunity for import substitution through local production. Production started as a backyard hobby but has grown into a fully commercialized sub-sector of the aquaculture industry. The success of the establishment of ornamental fish farming in South Africa has been linked to the high value of the fish being produced and the already well developed market which allowed local producers to undercut importers and offer a better product due to trade in ornamental fish being a live trade (Britz and de Kock, 1994; Rouhani and Britz, 2004).

7.2. Current Status of South African Aquaculture

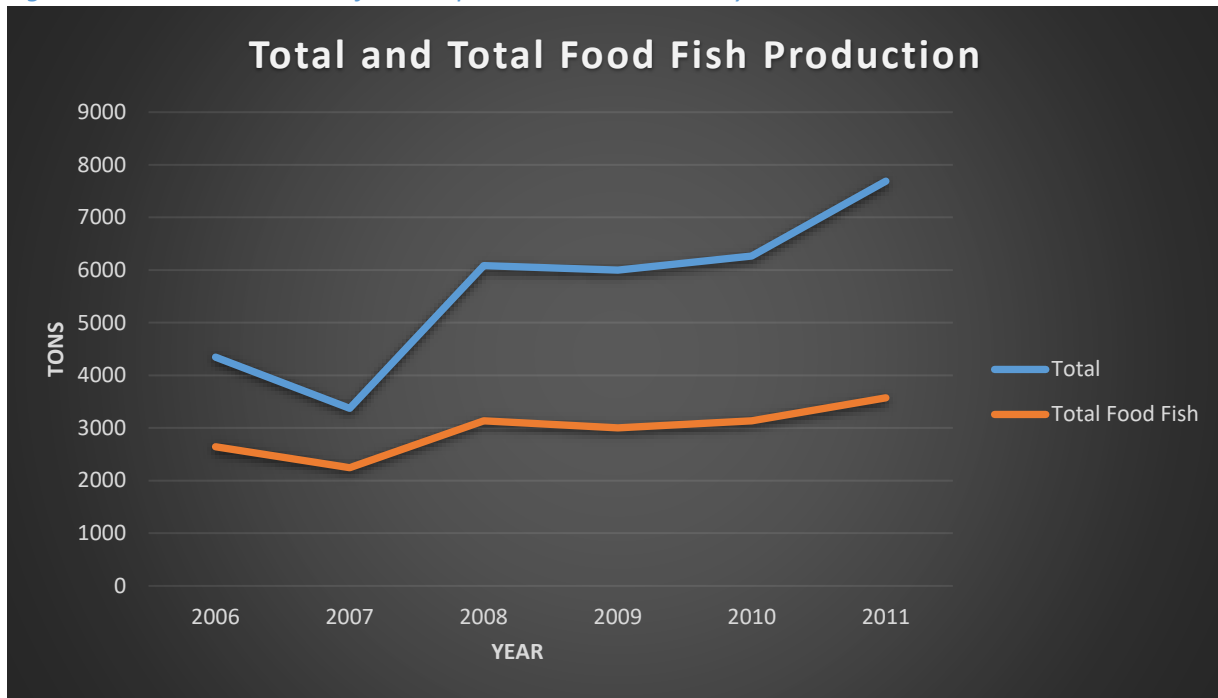
According to the South African Department of Agriculture, Forestry and Fisheries (DAFF), South Africa produced a total of 7 690 tons of product from aquaculture in 2011. Of this amount, 3 573 tons was food fish with marine aquaculture contributing 1 883 (53%) tons and freshwater aquaculture contributing 1 690 tons (47%). South African aquaculture, however, remains a small scale industry relative to the rest of Africa and the World. South Africa is last in the top ten producers in Africa, representing only 0.24% of total aquaculture food fish production from the continent in 2010 (FAO, 2012).

The growth in South African aquaculture production and the growth of marine vs. freshwater aquaculture can be seen in Figure 7-1 and Figure 7-2, respectively.

From Figure 7-1, it can be seen that Total production has increased from 2006 to 2011. This increase has been slow, but the acceleration in increased production from 2009/10 to 2010/11 shows the industry entering a possible growth stage. The large spike in Total production from 2007 to 2008 is due to a relatively large increase in seaweed aquaculture. Total Food Fish has

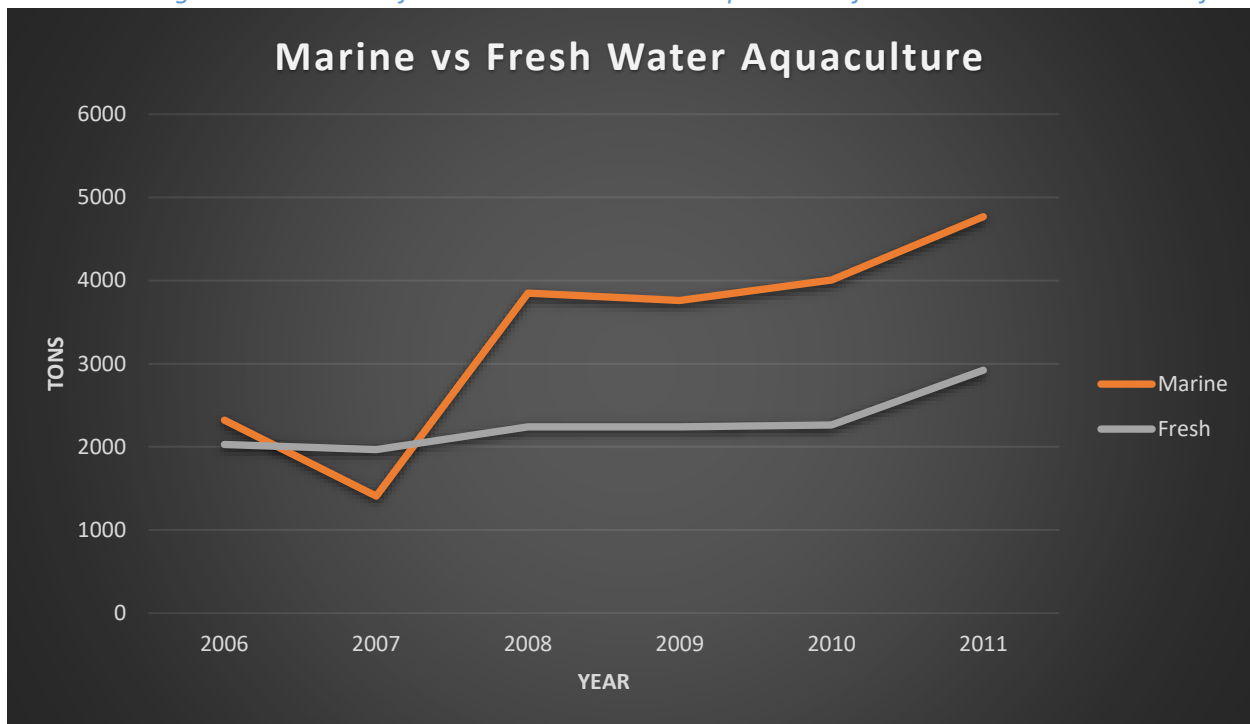
increased far slower than Total production, indicating that the majority of increased production has come from non-food sectors of aquaculture (seaweed, ornamentals, and etcetera).

Figure 7-1: Growth in South African Aquaculture Production by Total and Total Food Fish



Source: Daff, 2012a

Figure 7-2: Growth of Marine vs. Fresh-Water Aquaculture from 2006 to 2011 in South Africa

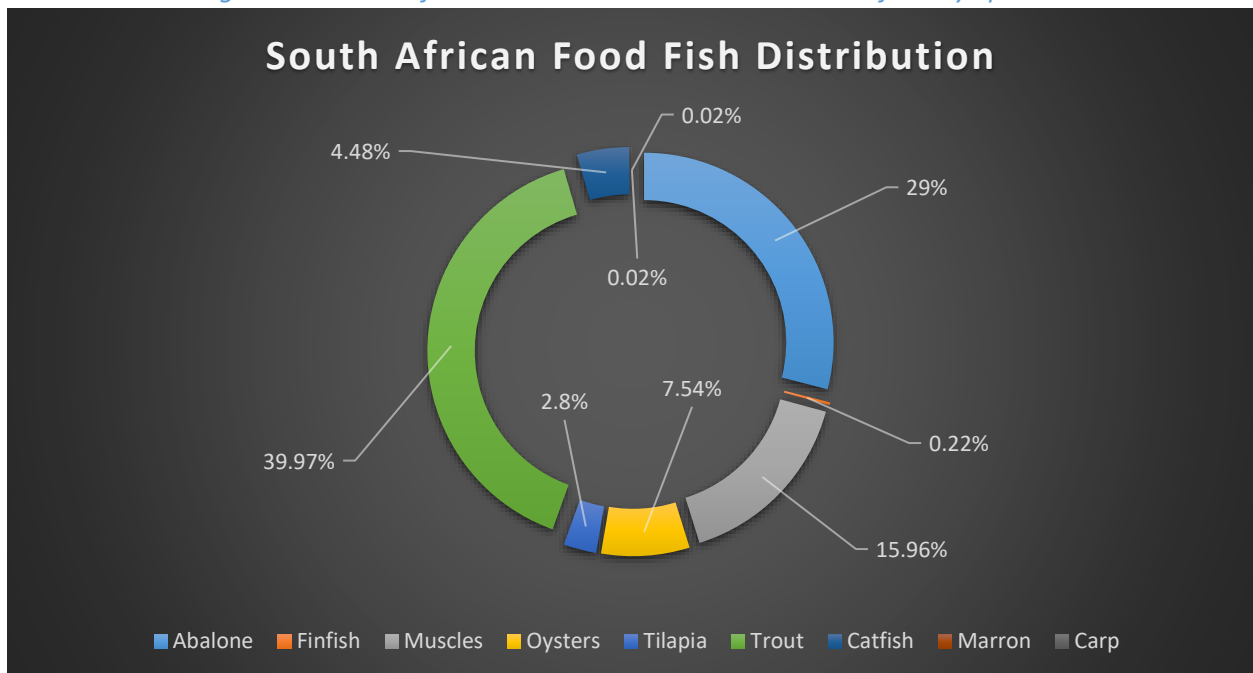


Source: Daff, 2012a

As can be seen in Figure 7-2, marine aquaculture³ produces more production by weight than fresh-water⁴. The significant spike in marine production from 2007 to 2008 is attributed to a large increase in sea-weed production as well as a large increase in Abalone after poor conditions had restricted the previous year's harvest substantially. What is notable is the combined rise in production in the period from 2010 to 2011 for both marine and fresh-water aquaculture. This is due to increases in production for all species except for small declines in Muscles, Oysters and Catfish.

The major species that were cultivated in 2011 for food fish were Abalone (1 036 tons), Muscles (570 tons), Oysters (269 tons), Tilapia (100 tons), Trout (1 428 tons), Catfish (160 tons), Marron (0.8 tons) and Carp (0.8 tons). This is represented in Figure 7-3.

Figure 7-3: Share of Total Food Fish Production in South Africa by Species



Source: Daff, 2012a

As can be seen in Figure 7-3, Abalone and Trout are the largest contributors to food fish production in South Africa, with muscles the third largest contributor. Tilapia represents a very small share of total production.

The slow rate of growth in the South African aquaculture industry when compared with the rest of Africa and the World has been put down to a number of factors, chief of which are issues

³ Marine aquaculture refers to the aquaculture of marine species, be it in off-shore or on-shore/inland facilities.

⁴ Fresh-water aquaculture refers to the aquaculture of freshwater species in on-shore/inland facilities.

around access to land, water, technology, high transaction costs, a lack of supporting policy and legislation, and barriers to entry (Shipton and Britz, 2007).

Access to suitable land and water is restricted due to difficulties experienced by potential investors. These difficulties include the rezoning process, onerous permitting requirements, and an obstructive bureaucracy in respect of compliance with environmental regulations. In terms of aquaculture technology, South Africa does possess a generally conducive infrastructure and supporting institutions environment for the development of large scale commercial aquaculture technology. However, there is a lack of sector level institutional coordination and strategy and certain specific infrastructure and capacity requirements that individual firms cannot overcome. Prior to the release of the National Aquaculture Strategic Framework (NASF) and the National Aquaculture Policy Framework (NAPF) in 2012 and 2013 respectively, there has been a lack of a comprehensive set of national strategies and key action plans for aquaculture.

7.2.1. South African Aquaculture Policy Landscape

In 2009, DAFF was appointed as the lead agency for aquaculture development in South Africa. Subsequent to this, DAFF published the NASF in 2012, followed by the NAPF at the end of 2013. This represented the first complete framework for South African aquaculture since the democratic transition of 1994. The NASF and NAPF emerged after aquaculture was identified as a targeted industry for development in the NGP and the DTI's first IPAP. The latest IPAP (2013/14 – 2015/16) highlights the need to increase investment in the aquaculture sector in general and increase commercialisation of the freshwater sector in particular, with the DTI and DAFF as the lead agencies in achieving this. The NASF and NAPF will be discussed, below.

➤ The NASF

The vision of the NASF is as follows:

“An expanding sustainable and competitive aquaculture sector that meaningfully contributes to job creation, economic development and transformation, through increased production, and a diversity of production systems that produce safe and nutritious food while safeguarding sustainable environmental integrity” (NASF, 2012: 21).

In order to realise this vision, the NASF sets out a number of goals to be achieved:

- I. Establish a flexible and pragmatic approach to respond to current shortcomings for aquaculture uptake.
- II. Develop transferable technology enabling producers to be profitable.
- III. Prioritise employment and wealth creation activities.
- IV. Develop efficient dissemination and transfer of relevant scientific and technical knowledge to make the aquaculture sector profitable and competitive in the global marketplace in an economically and socially responsible manner.

- V. Ensure the transformation and increased social cohesion with emphasis on youth.
- VI. Prioritise production and food security
- VII. Engage in regional aquaculture development
- VIII. Promote responsible aquaculture operations that are premised on all pillars of sustainable development.

The NASF highlights a central role for government in driving the process and achieving the goals as set out above. The development of aquaculture is seen as a priority of government due to the socio-economic opportunities that it presents in helping to meet government's key constitutional obligations for a fair and more equitable society.

The strategic approach set out by the NASF for aquaculture development in South Africa is set up into 17 elements/areas. These areas are:

1. Developmental Focus
2. Policy
3. Legislation and Regulatory Framework
4. Financial Services and Incentives
5. Access to Land and Water
6. Access to Seed
7. Access to Feed
8. Research and Technology
9. Technology Transfer and Demonstrations
10. Training, Education and Extension Services
11. Stock Enhancement
12. Aquatic Organisms Health Management
13. Product Quality and Safety
14. Marketing and Trade
15. Transformation
16. Information Management and Dissemination
17. Monitoring and Evaluation

The NASF thus represents a very holistic and all-encompassing approach to aquaculture in South Africa, something that has been cited as a key requirement to unlocking growth potential in the industry. It places government at the forefront of developing and expanding the sector with the private sector expected to respond to government incentives through private sector investment and transformation.

➤ **The NAPF**

The NAPF is a continuation of the lead role that DAFF has been tasked with playing in the development of aquaculture in South Africa. The NAPF's key target is to facilitate the development of the emergent and smallholder sectors as well as the development of aquaculture for food security, either by way of fish for food, or fish for sale to generate an income to buy food. The policy will also provide guidance on the quality and promotion of aquaculture products to export markets, the promotion and regulation of foreign investment in South African aquaculture and its role in achieving compliance with international treaties, protocols and policies to which South Africa is a signatory on behalf of the aquaculture industry.

To accomplish this, the NAPF identifies seven key policy focus areas:

1) Legal and Regulatory Framework

- a) Marine aquaculture is regulated by the Marine Living Resources Act (MLRA), 1998 (Act No. 18 of 1998) but no main legislation governing fresh-water aquaculture currently exists, with fresh-water aquaculture being regulated by different government departments implementing different pieces of legislation, creating a fragmented fresh-water aquaculture regulatory framework.

The NAPF will thus seek to develop an entire new Aquaculture Act which will regulate both marine and fresh-water aquaculture to remove fragmentation and create a coherent regulatory framework that assists in the development of a sustainable aquaculture industry that uses natural resources responsibly and ensure conservation and reduced environmental degradation.

2) Environmental Integrity

- a) Aquaculture has been associated with environmental hazards such as biological, organic and chemical pollution, eutrophication and habitat modification. The development of sound environmental regulations for aquaculture is essential in order to ensure the maintenance of biodiversity and environmental integrity. The NAPF thus seeks to administer a compliance, fish health and environmental framework that provides confidence to industry, investors and the broader community.

3) Aquaculture Research, Technology Development and Transfer

- a) As aquaculture is a technology driven sector, it requires a wide range of inputs from a range of scientific disciplines in order to develop efficient and cost-competitive production systems. Because of this, research is often beyond the means of most small and medium sized enterprises. As such, the NAPF highlights the need to ensure that sector development organisations must be responsive to the development requirements.

4) Aquaculture Authorisations

- a) The application assessment, authorisation and licensing/permitting of all aquaculture in South Africa will be managed by the new Aquaculture Act. Licenses will be granted for a period not exceeding 25 years. Once a license has been granted, a permit will be issued subject to conditions, for a specified period not exceeding two years.

Applications for marine aquaculture will be lodged directly with DAFF, while applications for fresh-water aquaculture will be run through the respective provincial department responsible for aquaculture within which the proposed farm is located. A joint Provincial Aquaculture Management Working Group will be established from which the provincial authorities may seek advice on applications. Until the new Aquaculture Act is promulgated, marine aquaculture will continue to be regulated through MLRA, 1998 (Act No. 18 of 1998), while fresh-water aquaculture will be regulated through the National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998), the National Environmental Management: Biodiversity Act (NEMBA), 2004 (Act No. 10 of 2004) and the water licensing requirement as per the National Water Act (NWA), 1998 (Act No 36 of 1998).

- b) The authorisation process, under the new Aquaculture Act, will be streamlined by providing for an integrated permitting process with DAFF taking the lead in the issuing of permits in consultation with the relevant departments, such as the Department of Environmental Affairs (DEA) and Department of Water Affairs (DWA). This will reduce red tape, thus improving efficiency and effectiveness of the authorisation process.
- c) Proper EIA must be conducted, as provided by NEMA, to ensure proper site selection and planning to minimise environmental degradation and biodiversity loss. Norms and standards for sustainable aquaculture and operational guidelines and permit conditions will also be developed.

5) Aquaculture Development Support

- a) Support is to be provided in the development of the aquaculture sector through the implementation of aquaculture starter packs to develop SMMEs. The role of hatcheries will be placed as the center for the support services, acting not only for the provision of seed but also as centers for advisory services to local farmers. DAFF, in partnership

with the DTI and other departments, will also take a central role in developing and unlocking markets for aquaculture products.

6) Transformation and Broadening of Participation

- a) DAFF will promote the transformation of existing aquaculture entities to increase the representation of previously disadvantaged individuals in the aquaculture industry. Access to finance will be extended to emerging farmers while community based development vehicles, such as co-operatives, will be assisted through government departments. The participation of women and youth will also be prioritised.

7) Monitoring and Enforcement of Authorization Conditions

- a) Licenses and permits shall be issued with conditions designed to avoid conflict with other users and to protect the environment. These will be enforced through monitoring programmes, with physical inspections of sites annually.

7.2.2. South African Aquaculture Legislation

A number of legislations that govern aquaculture in South Africa exist, but with no integrated framework for administering these legislations. While the NASF and NAPF seek the integration of the regulation of aquaculture under one Aquaculture Act, this has not been done to date, and as such the following primary regulations still apply to aquaculture in south Africa: MLRA for marine aquaculture, NEMA, NEMBA and the NWA for fresh-water aquaculture. Other Acts that may impact on aquaculture include the National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003), the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), the National Environmental Management: Integrated Coastal Management Act, 2008 (Act No. 24 of 2008), the National Heritage Resources Act, 1999 (Act No. 25 of 1999), the Animal Disease Act, 1984 (Act No. 35 of 1984) and the Animal Health Act, 2002 (Act No. 7 of 2004). These additional Acts are not, however, major in terms of aquaculture authorisation, as such, only the MLRA, NEMA, NEMBA and NWA will be discussed, below.

➤ **MLRA**

The MLRA applies to mariculture (aquaculture in marine environments) that is undertaken for commercial, experimental or research purposes. The MLRA provides for the conservation of the marine ecosystem, the long term utilisation of marine living resources and the orderly access to exploitation, utilisation and protection of certain marine resources.

The MLRA indicated the need for the issue of a permit for any person wishing to engage in mariculture or operate a fish processing establishment. This permit is obtained through an application to DAFF and is valid for 15 years

➤ **NEMA**

NEMA sets out the broad outlines for the management of activities that may have an impact on the environment. In relation to aquaculture, NEMA provides for the activities that will trigger the requirement of authorisation and an EIA to undertake aquaculture. These are:

- Where the construction or expansion of facilities for aquaculture with the intention of production exceeding 20 tons per annum of finfish, crustaceans, reptiles or amphibians, 30 tons of molluscs per annum or 60 tons of aquatic plants per annum is planned.

➤ **NEMBA**

NEMBA provides for the management and conservation of biological diversity and the components of that biological diversity, the sustainable use of indigenous biological resources, and the fair and equitable sharing of benefits arising from bio-prospecting. To this end, NEMBA impacts on aquaculture through the following two regulations: the Threatened or Protected Species Regulations, 2007 (TOPS) and the Alien and Invasive Species Regulations, 2009 (AIS).

The TOPS regulations govern the activities associated with listed threatened or protected species. These activities in relation to aquaculture include the import, export, possession, breeding, killing, transport and trade of these species. A TOPS permit is required if any activities are to be undertaken with these species and a risk assessment may be required as part of the application to the DEA. In addition, each provincial authority may have additional requirements for permitting.

The AIS regulations govern activities undertaken with alien and listed invasive species to South Africa. In relation to aquaculture, the restricted activities include the propagation, movement, trade and release of these species. A permit is required for any activities that involve activities related to alien and invasive species through the relevant provincial authority and/or the DEA. The application must include a risk assessment as per the AIS guidelines in addition to any additional provincial requirements.

➤ **NWA**

The NWA acknowledges that water is a scarce resources and is unevenly distributed across South Africa. It is, however, a resource that belongs to all the people living in the country. As such, the NWA seeks to equitably allocate this scarce resource within a water resource management framework that promoted the sustainable use of water for the benefit of all. The management of this resource must thus ensure the meeting of basic human needs while facilitating social and economic development.

Water is a primary input in the aquaculture production process and as such the NWA regulations are critical to any aquaculture venture. The situations when water use requires authorisation which are relevant to aquaculture are covered in section 21 of the NWA, while

section 22 details the relevant authorisations applicable to aquaculture. The section 22 authorisations are:

- Allowing water to be used by virtue of being classified as a Schedule 1 use, where this use is for basic domestic needs such as very small scale aquaculture.
- Allowing water to be used by virtue of the fact that it is an existing lawful use before the NWA was defined
- Allowing water use through general authorisation by the DWA
- Allowing water to be used by means of a licence which can be applied for through the DWA

7.3. Summation

South African Aquaculture

- First aquaculture operation dates back to 1890
- Industry characterised by periods of growth and then periods of stagnation
- Trout, abalone and muscles are the most prominent species used in aquaculture
- Aquaculture is now a major focus of government
- South African aquaculture policy is rapidly developing to be supportive as opposed to restrictive

8. Tilapia Aquaculture in South Africa

This section will provide an insight into the Tilapia aquaculture industry in South Africa. The industry is analysed in terms of species, technology, culture, legislation, climate and skills.

8.1. Species

South African Tilapia production is dominated by two main species, that being the alien invasive *Oreochromis niloticus* (Nile Tilapia) and the naturally occurring *Oreochromis mossambicus* (Mozambique Tilapia).

The Mozambique Tilapia is found naturally in the coastal regions of Southern Africa, concentrated mostly on the Eastern side of the region. The species home range stretches from the Zambezi River Delta in Mozambique to the Bushman's River in the Eastern Cape Province of South Africa. This is primarily due to the warmer and more stable temperatures found in these areas arising from the warm Agulhas current

FIGURE 8-2: MOZAMBIQUE TILAPIA



flowing down the side of the continent in the Indian Ocean.

Relative to the Nile Tilapia, the Mozambique Tilapia is slower growing, reaching full harvestable size in approximately 10 – 12 months (depending on temperatures, feeding regimes, etcetera). The Mozambique Tilapia also grows to a larger size than the Nile Tilapia, but over a longer period.

The Nile Tilapia, on the other hand, is naturally found in Southern Egypt, Central and Eastern Africa. However, human interventions have seen the species spread to many parts of the world. In South Africa, the Nile Tilapia was first introduced in the 1950s by the then Cape Nature Conservation Department for breeding and production experiments. The species was introduced to selected dams where they have continued to persist, especially in Northern Kwa-Zulu Natal. Today, the Nile Tilapia has invaded part of the Limpopo river system and has begun to force out the native Mozambique Tilapia.

FIGURE 8-3: NILE TILAPIA



The Nile Tilapia is more resilient than the Mozambique Tilapia and has a faster growth rate when exposed to similar conditions, reaching harvestable maturity in 6 – 10 months. According to TAASA, the common Nile Tilapia strain farmed in South Africa has a 30% faster growth rate than the Mozambique Tilapia but has 2% greater bone mass. Comparisons of Mozambique and Nile Tilapia can be seen in Table 8-3.

Table 8-3: Mozambique vs. Nile Tilapia

Category	Mozambique Tilapia	Nile Tilapia
Home Region	Eastern Coastal Regions of Southern Africa	Southern Egypt, Central and Eastern Africa
Growth Rates	Harvestable size (+- 800g) in 10-12 months	Harvestable Size (+-800g) in 6-10 months
Adaptability	High	High
Legality of Production	Allowed	Allowed with Permits

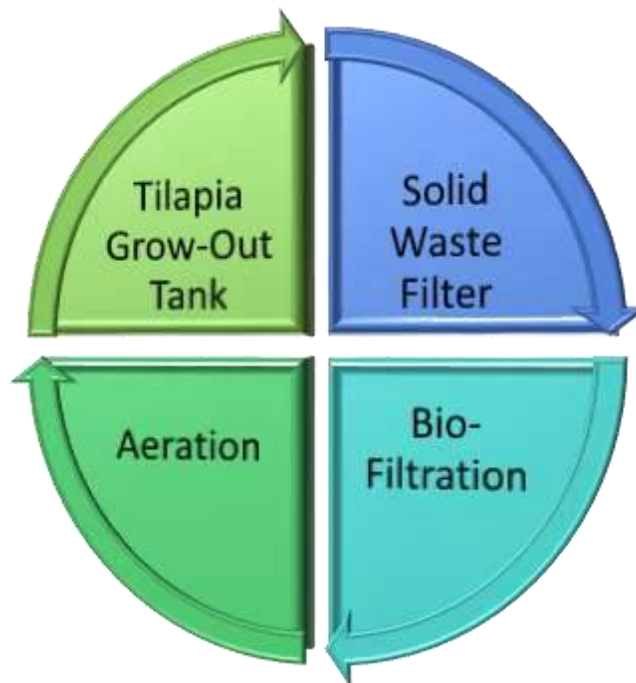
Prior to March 2014, it was illegal to farm with Nile Tilapia in South Africa due to the species being classified as alien invasive. However, through extensive lobbying and the development of a Tilapia Aquaculture Better Management Plan by TAASA, Nile Tilapia has now been included in the latest NEMBA legislation as an alien and invasive species requiring a permit for production (See Annexure 2: Extract from NEMBA Regulations Published 1 August 2013). The farming of Nile Tilapia has now been approved when used in RAS systems and proper permits from the relevant provincial environmental authorities is secured. The use of Nile Tilapia is expected to significantly increase the viability of South African Tilapia production.

8.2. Technology

The technology used in the production of Tilapia in South Africa is fairly advanced relative to the average technology used in the rest of the continent, but South Africa continues to lag in production to many of our African counterparts. According to a country-wide survey carried out by TAASA, the primary technology used in commercial production in South Africa is RAS. This is a tank based system widely used across the world in intensive Tilapia aquaculture production. This system is primarily used in South Africa as it is one of the best methods of controlling water temperatures, quality and minimising water use. The control of water temperature is critical in South African Tilapia aquaculture as climatic conditions in most parts of the country and over the changes in season are not ideal for Tilapia. As such, it is necessary to artificially raise the water temperatures when farming Tilapia, through water heating, green housing or a combination of the two. RAS also ensures a completely bio-secure production process, providing the safest means of ensuring that Tilapia do not escape into the natural environment, leading to a potential bio-hazard.

A RAS system is typically made up of four critical units, as is shown in Figure 8-4.

FIGURE 8-4: RAS SYSTEM COMPONENTS



- The first component of the RAS system is that of the Tilapia Grow-Out Tank. This component is typically constituted with a large tank of

FIGURE 8-5: GROW-OUT TANKS



water within which the Tilapia are kept and feed is introduced into the system. The Tilapia then consume the feed and release solid waste and ammonia into the water. Water containing the solid waste and ammonia is continuously pumped out of the tank and into the second component of the system.

- The second component of the system is the Solid Waste Filter. Water from the Tilapia

Grow-Out Tank is passed through a specialised sieve or sand filter which removes the solid fish waste, leaving only the dissolved ammonia in the water. This then passes onto the third component of the system.

FIGURE 8-6: SOLID WASTE



- The third component of the system is the Bio-Filtration. At this stage, the water contains dissolved ammonia which is toxic to the Tilapia. The water then

passes through a specialised medium, often made up of charcoal or another specialised micro-pore substance, on which bacteria grow. These bacteria convert the dissolved ammonia into nitrites and then into nitrates. At this point, the water then either passes into a more advanced secondary bio-filter where the nitrates are converted into nitrogen gas, and hence bubble out of the water, or some of the water is removed as waste water and fresh water is added. When removing water, approximately 10-15% is removed and replaced with fresh water. The filtered water then passes onto the final component of the system.

FIGURE 8-7: BIO-FILTER



- The fourth component is the Aeration system. Oxygen levels in the tank need to be maximised in order to accommodate the intensive nature of the tank aquaculture. Aeration can make use of mechanical surface aerators, subsurface air bubblers or pure oxygen injection. This then completes the RAS cycle.

FIGURE 8-8: SURFACE AERATORS



The use of RAS in Tilapia aquaculture has also formed a cornerstone of the Better Management Plan developed by TAASA. The Better Management Plan has been a foundational component in the issuing of permits for the propagation of Nile Tilapia in the North-West Province, a key species identified by TAASA in ensuring commercial viability of Tilapia cultivation.

Additional to this, a new form of RAS technology was also developed in South Africa. This technology compresses the RAS model into a 12 meter shipping container, capable of producing between 2 and 4 tons of Tilapia per year (depending on the species of Tilapia used) (The Fish Farm, 2014). The business model for this container fish farm is one of broad based community development and income generation rather than maximising commercial returns. As such, it does not represent a major leap in commercial viability of Tilapia farming in South Africa, but rather is an indication that technological innovation around freshwater aquaculture is ongoing and strides are being made in its development.

South African public institutions are also intricately involved in research and development around Tilapia production methods and feeds, while privately owned hatcheries continue to breed new strains and advance the genetics of the locally produced species. Rhodes University's Ichthyology Department, together with the South African Institute for Aquatic Biodiversity, run extensive research and development programs for aquaculture production methods and production protocols. North-West University is also heavily involved in developing new and improved feed production technologies. Privately owned hatcheries, such as the Rivendell Hatchery in the Eastern Cape, have been actively breeding and crossing different strains of the Mozambique Tilapia in order to develop the most commercially viable strains possible.

8.3. Culture

The culture of fish consumption is limited in South African society. Primary consumption of fish is found in white urban middle/upper class structures of society in rural coastal communities and among immigrant populations in South Africa. Certain types of fish consumption are common, however. South Africa cannot produce enough pilchards, for example, and imports significant amounts, with canned pilchards being a commonly consumed fish product among many households. South Africa's per capita consumption of fish, however, remains low at only 6.5kgs per capita. This is less than the African average of 9kgs per capita (FAO, 2014).

The wide consumption of canned fish, however, suggests that the South African consumer is not averse to fish consumption but is rather more price sensitive in terms of fish relative to other protean sources such as beef or chicken.

8.4. Legislation

The freshwater aquaculture legislative environment in South Africa is currently entering a transformative phase. Aquaculture has been identified as a key industry in the latest DTI IPAP and in the governments New Growth Path and National Development Plan. In response to this,

DAFF has been named as the lead department in the development and administration of regulations surrounding aquaculture. The culmination of this process is an intended Aquaculture Act which will regulate all forms of aquaculture, both marine and freshwater. However, the Aquaculture Act does not currently exist and no time frame as to its intended publication can be found.

As was previously discussed, current production of Tilapia is governed by three primary Acts, these being the NEMA, the NEMBA, and NWA⁵. Table 8-9. Shows the relevant regulations for each Act and the practical issues experienced by Tilapia producers in complying with the Acts.

TABLE 8-9: RELEVANT TILAPIA AQUACULTURE REGULATIONS AND PRACTICAL SITUATION

Act	Key Regulations	Practical Situation
NEMA	<p>Section 24J(a), Environmental Impact Assessment Guidelines:</p> <ul style="list-style-type: none"> ➤ Producers are required to conduct an Environmental Impact Assessment: Basic Assessment (EIA: BA) if production is intended to exceed 20 tons per annum. ➤ Producers are required to conduct an Environmental Impact Assessment: Scoping and Environmental Impact Report (EIA: S&EIR) if production is to be 200 tons or more per annum 	<p>Producers and hatchery owners have objected to these guidelines on two grounds:</p> <ol style="list-style-type: none"> 1) The guidelines do not take into account the positioning of the production facilities. It is argued that if a production facility is not located near a natural water-course or located in an industrial area, for example, an EIA may not be necessary. 2) The production level that triggers an EIA: Basic Assessment is too low. According to TAASA, a production facility that would produce 50 tons of Tilapia per year would cost about R700 000 while an EIA: BA would cost about R200 000, representing almost 30% of the set up costs for an average sized facility and hence a significant barrier to entry. <p>Upon extensive interrogation of objection 1, it was concluded that the guidelines are too broad. The guidelines fail to take into account the positioning of the potential facility relative to the environment. Freshwater aquaculture in general has the potential to bring barren marginal lands into production as aquaculture does not rely on traditional farming conditions (soil fertility, rainfall) in order to successfully produce while production can also occur in urban environments, improving urban food security and reducing transportation costs. Should certain areas not require an EIA, this could be seen as something of an incentive/subsidy to production. The</p>

⁵ Other legislation may also play a part in establishing an aquaculture venture, but these are standard and applicable to many other industries outside of aquaculture.

		<p>current guidelines miss this opportunity, applying a blanket smothering approach as opposed to a developmental approach. However, this does not in itself constitute a significant barrier to entry, but more a missed developmental opportunity.</p> <p>As to objection 2, according to a number of Environmental Assessment Practitioners that were engaged, an EIA: BA would cost between R60 000 and R140 000 depending on whether specialist studies were required. If specialist studies were to be included, an EIA: BA could cost between R150 000 and R250 000+. Thus the claims made by TAASA as to the cost of EIA studies may be true.</p>
NEMBA	<p>The Threatened or Protected Species Regulations, 2007 (TOPS)</p> <ul style="list-style-type: none"> • A TOPS permit will be required to engage in activities where the species is listed as threatened or protected <p>The Alien and Invasive Species Regulations, 2014 (AIS)</p> <ul style="list-style-type: none"> • Production involving the use of an alien and/or invasive species is prohibited in areas designated by the Protected Areas Act and the Fish Sanctuary Act. A permit is required for production in other areas. 	<p>The TOPS regulations do not currently have any practical impact on current production of Tilapia in South Africa. The native Mozambique Tilapia is not currently listed as a threatened or protected species. However, movements are being made in academia and among environmentalists to look into listing the species as threatened due to the more aggressive Nile Tilapia invading the Limpopo river basin, forcing out the native Mozambique Tilapia. This development, while not having any practical implications at this stage, may have an impact at a later stage should production using the Mozambique Tilapia be essential.</p> <p>With regards to the AIS regulations, prior to March 2014, the use of Nile Tilapia in Tilapia production was strictly prohibited. This constituted a significant barrier to efficient production as the Nile Tilapia is widely regarded as a faster growing and hardier species than its Mozambique cousin. However, through extensive lobbying and the development of a Better Management Plan for Nile Tilapia by TAASA, the NEMBA regulations were revised to include Nile Tilapia as a Category 2 species. This re-classification allows for the Nile Tilapia to be used in Tilapia production, provided a permit is issued by the relevant provincial authority. The issuing of a permit is conditional upon the producer being able to present a full taxonomy, persistent attributes, invasive tendencies, dietary requirements, history of domestic propagation, ability of the species to create a change in the local ecosystem and a detailed risk assessment.</p>

		<p>From a practical perspective, the new AIS regulations have led to the successful issuing of permits for the production of Tilapia using the Nile species in the North West province through the North West Department of Economic Development, Environment, Conservation and Tourism, provided the Better Management Plan developed by TAASA is followed and production is carried out in a bio-secure RAS system. However, other provincial departments have not been as forth coming. Producers in other provinces have been unable to secure the relevant permits from provincial authorities. Producers, hatchery owners and TAASA have identified a lack of coordination between the provincial and national level in terms of the regulations. The lack of co-ordination between national regulations and provincial authorities is a major bottleneck in establishing the more-productive Nile Tilapia as the primary cultivar in Tilapia aquaculture in South Africa</p>
NWA	Section 21, Water Use	<p>Production of Tilapia in South Africa will require a water use license. No stakeholders engaged indicated any problems in securing water use licenses from provincial authorities. As such, this is not deemed to be a significant barrier to Tilapia production.</p>

8.5. Climate

The prevailing climatic conditions play a vital role in the successful production of Tilapia. Specifically, there are certain temperature ranges at which Tilapia will grow at an optimal level and with low Feed Conversion Ratio (FCR⁶). Tilapia will survive in a temperature range of between 10°C and 37°C, but optimal growth is experienced between 23°C and 33°C (Baras, *et al.*, 2001; Azaza, 2008).

Most of South Africa, however, does not have a year-round temperature within the required 'optimal' growth range for Tilapia (reported to be between 25-35 degrees Celsius (FAO, 2014e)), with temperatures falling below the lower threshold for Tilapia survival during the winter months in much of the country. Optimal temperatures are reached during the summer months, but this is restricted to areas on the North-Eastern side of South Africa where a more sub-tropical climate prevails. Wild strains of Mozambique Tilapia are found in areas outside of this North-Eastern area, but growth rates are below optimal and present a major hurdle to commercial production.

⁶ The FCR is the ratio of how many kilograms of feed is required to produce one kilogram of fish mass. The lower the FCR, the more efficient your feed is and hence the lower feed cost will be.

The poor climatic conditions for Tilapia in most of the country severely restricts production areas and efficiency of production without intervention in artificially raising water temperatures. In order to overcome these climatic restrictions, producers make use of RAS production methods, which allow for the active heating of waters in the most efficient manner, and green housing, allowing for the passive heating of waters above ambient temperatures. However, the active heating of waters raises operating costs and the initial capital outlay. This is particularly an issue due to the current South African climate of rapidly rising costs of energy. Such costs can present a significant barrier to entry. Green housing may be a more viable option as this represents an initial capital outlay but with no operational costs and only small maintenance costs. Green housing, however, is only able to raise temperatures by a few degrees and as such will only be able to bring marginal areas with low temperatures into production viability.

Climatic conditions in South Africa thus pose a significant obstacle to the establishment Tilapia production enterprises. However, climatic obstacles are not country-wide and can be overcome through technological and practical solutions.

8.6. Skills

Skills development in general aquaculture in South Africa is centred at the public Universities. Most notably, Stellenbosch University and Rhodes University. Stellenbosch University has a dedicated Division of Aquaculture within its Faculty of Agrisciences. The division offers a number of short courses, workshops, certificates, diplomas and full graduate programs in aquaculture. The division provides considerable training and expertise to aquaculture farmers in the Western Cape region. However, training is focused on species that are successful in the area, mostly Trout and Abalone. Rhodes University follows a more research orientated approach to aquaculture, with training of students focused more on research of marine and freshwater aquaculture as opposed to specific aquaculture courses. Other public universities are also engaged in aquaculture skills development, but this is more at a project specific level than offering dedicated courses and research into aquaculture.

Additional to the highlighted public institutions, skills development is also carried out by privately owned hatcheries, existing producers and TAASA. Hatchery owners and producers are often actively involved in mentoring new entrants to the industry while some hatcheries offer weekend courses to would-be entrants into the aquaculture industry. TAASA also offer Tilapia specific workshops and provide an archive of Tilapia related research to members through their database. TAASA was also able to secure ten Agri-SETA learnerships for Tilapia production in 2014.

8.7. Summation

South African Tilapia Aquaculture

- Species used in production focused on Mozambique and Nile Tilapia
- Primary production technology is RAS systems
- Limited extent of fish consumption in South Africa but suggestions are that this is due to price sensitivity
- Legislation has changed, allowing the use of more productive Nile Tilapia
- South Africa does not have a conducive climate to commercial tilapia production
- Skills for tilapia aquaculture are present and public institutions provide educational and research services

9. Characteristics of the South African Tilapia Industry

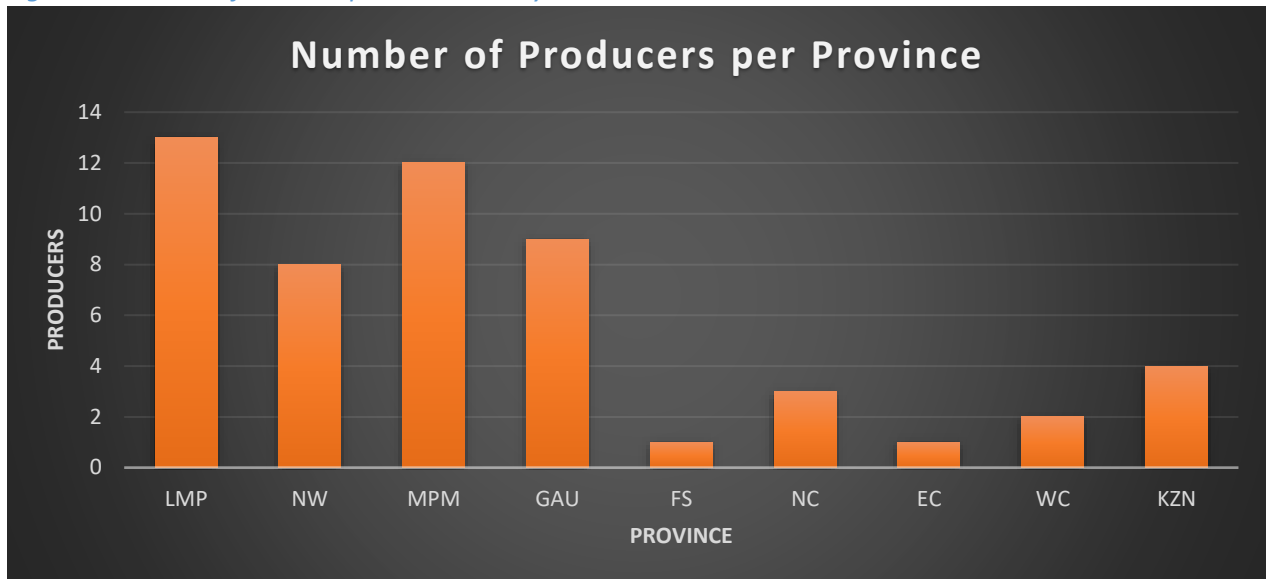
Information for this section is primarily provided by TAASA. The association provides support services to Tilapia growers in South Africa through lobbying of government departments, providing information to prospective Tilapia growers and continuously engaging and exploring new technological improvements in the Tilapia industry, both locally and globally, and disseminating this information to members.

This section will provide an overview of the current status of the Tilapia industry in South Africa and provide the current value chain.

9.1. Tilapia Producers

Information supplied by TAASA indicated that there were a total of 53 producers of Tilapia in South Africa registered with the association as of September 2013. The distribution of these producers by province can be seen in Figure 9-1.

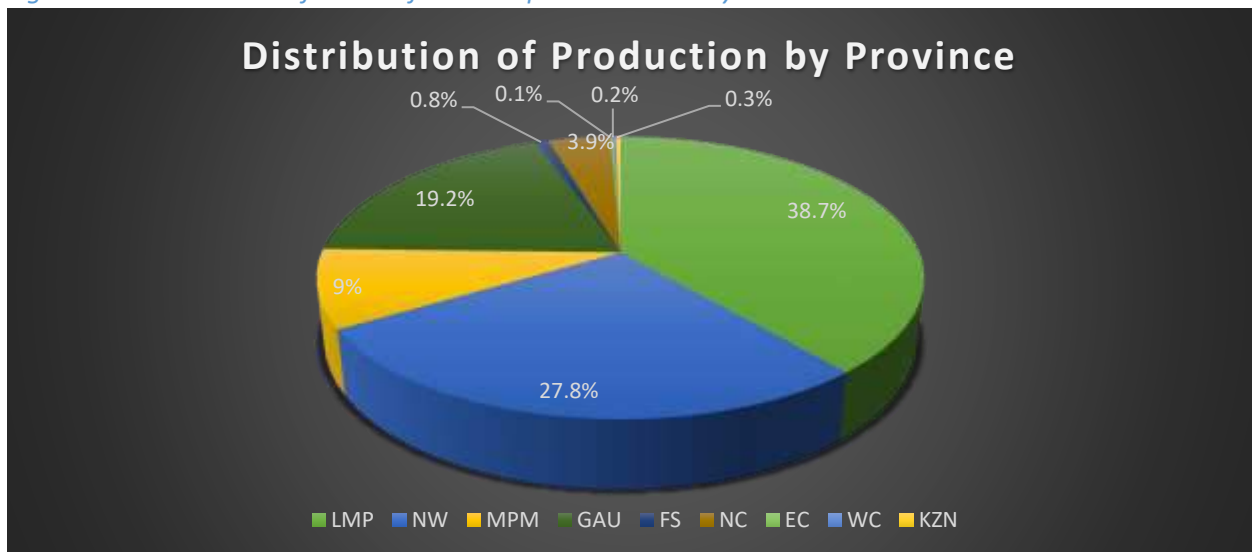
Figure 9-1: South African Tilapia Producers by Province



Source: TAASA, 2013

What emerges strongly from this data is that the majority of producers are located in the North-Eastern side of the country, with Limpopo, North West, Mpumalanga and Gauteng containing the majority of producers (42 out of 53 in total). This is due to the climatic conditions of the area being warmer and more tropical in nature than other areas of the country.

Figure 9-2: Distribution of South African Tilapia Production by Province

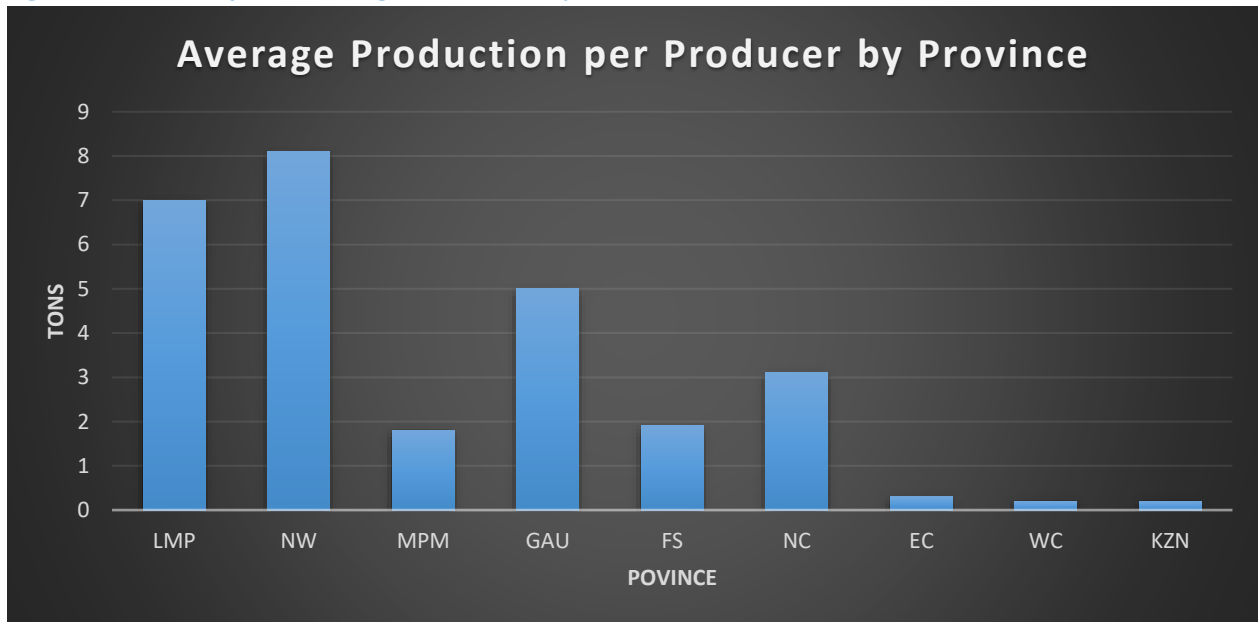


Source: TAASA, 2013

When considering the average production volume of producers in each province, the nature of the industry is revealed to an extent. While Mpumalanga had the second highest number of producers, sitting at 12, it ranked only sixth in terms of average production volumes, coming in at just under two tons per year per producer. This indicated that production in the province is characterised by a large number of small scale producers, typically existing farmers who have included Tilapia production as an additional activity to their mainstream farming activities.

Limpopo and North West, on the other hand, have relatively higher average production volumes (7t and 8.1t respectively). Most notable, North West ranked fourth in terms of number of producers, with eight, but ranks highest in terms of average production. This indicated that the industry in North West is characterised by larger producers but, at 8.1t, is still relatively small-scale, with a few relatively large producers. Average production per province can be seen in Figure 9-3.

Figure 9-3: South African Average Production by Province

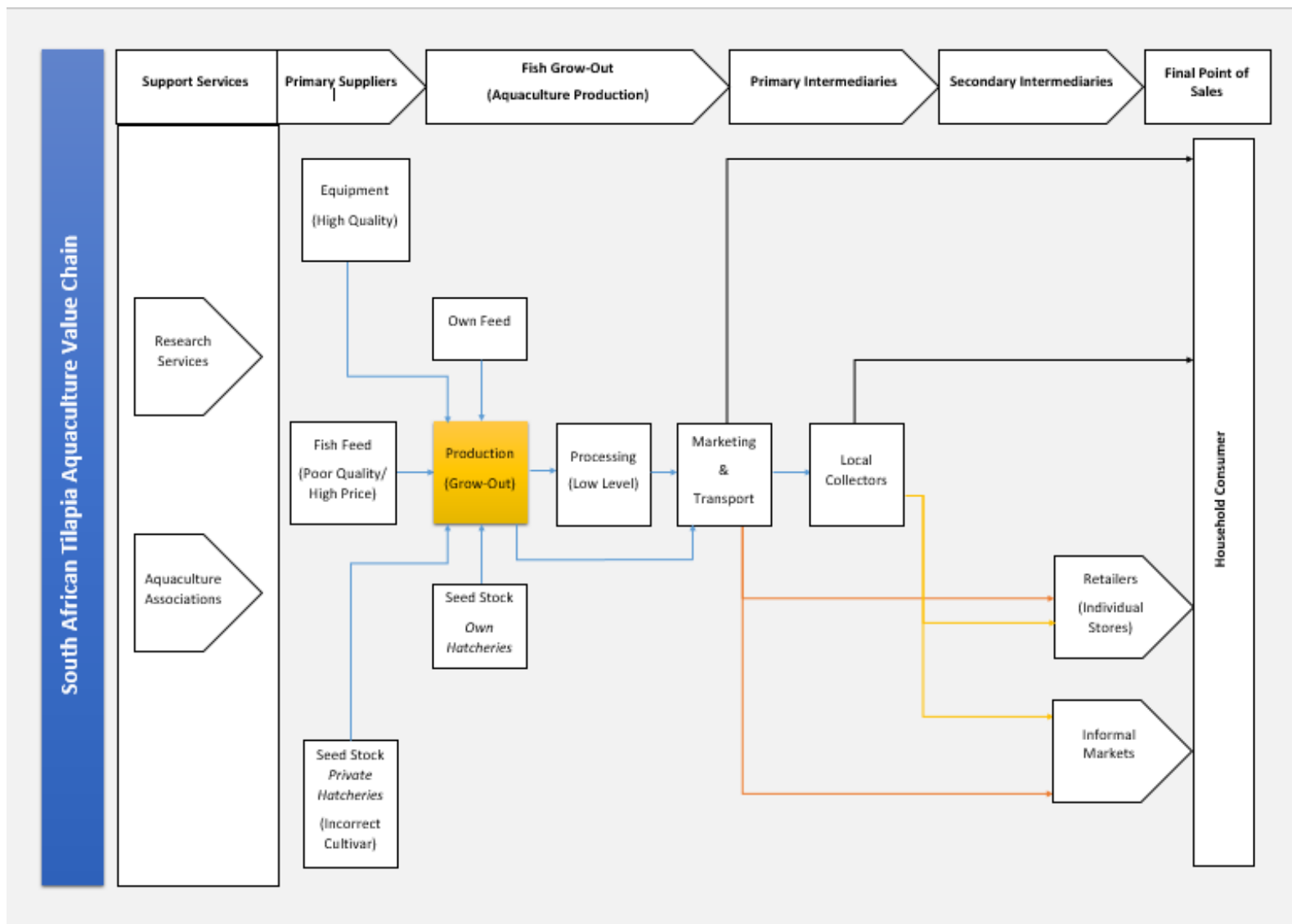


Source: TAASA, 2013

As can be seen in Figure 9-3, North West, Limpopo and Gauteng are the three largest producers by average production per producer. The Eastern Cape, Western Cape and Kwa-Zulu Natal have low average production volumes. It is hypothesised that the Eastern Cape and Western Cape have low production volumes due to climatic conditions. Kwa-Zulu Natal, on the other hand, has good climatic conditions in the north of the province but maintains low production volumes. This could be attributed to the province specialising in other species for aquaculture, with Tilapia aquaculture simply not gaining a critical mass to enter a high-growth phase in the province.

9.2. South African Tilapia Aquaculture Value Chain

From the information supplied by TAASA and through engagement with numerous stakeholders including leading academics from tertiary institutions, private hatchery owners and the Aquaculture Association of South Africa (AASA). The following value chain for the South African Tilapia industry was constructed:



What emerges immediately from this value chain is that it is far less developed than that of the typical Tilapia value chain explored earlier. This will be explored in more detail.

➤ Support Services

What is clearly significant when comparing the typical Tilapia value chain to the South African case is the lack of support services for the South African Tilapia Industry; where the typical industry had support from Finance and Grants, Research and Extension Services, Aquaculture Associations and Legislation, the South African case has typically been provided with support from only Research and Aquaculture Associations.

- Research

Tertiary institutions have been instrumental in conducting research into production protocols and methods to maximise the efficiency of aquaculture production. These institutions also provide skills in aquaculture, creating a broad base of skilled individuals who are able to enter the industry with varying degrees of knowledge and competency in aquaculture.

- Aquaculture Associations

TAASA has been considerably active in advancing the cause of the Tilapia industry in South Africa. Through extensive lobbying by TAASA and other stakeholders such as AASA, the association has made strides in influencing government policy governing freshwater aquaculture in general and Tilapia aquaculture specifically. The association was instrumental in persuading government to allow the use of Nile Tilapia in South African production and permits have been issued for production using Nile Tilapia based on TAASA's Better Management Plan.

TAASA also provides a database of suppliers for new entrants and is actively involved in the development of new feeds with tertiary institutions such as North West University. TAASA is also involved in bringing overseas experts on Tilapia cultivar to South Africa to assist in ensuring South African producers are able to develop a competitive edge in Tilapia genetics.

➤ Primary Suppliers

The primary suppliers into the South African Tilapia value chain are a mixed bag. Equipment is readily available and of a high quality. However, fish feed and seed stock has been a major stumbling block in the past.

- Equipment

Due to South Africa's relatively industrialised status, equipment for the construction of RAS systems is readily available in South Africa and the country has sufficient skills to set up such systems with a number of private consultants having developed and implemented RAS designs.

- Fish Feed

A lack of competition in the Tilapia fish feed sector in South Africa has led to only a single producer, AVI in Durban, producing commercial Tilapia feed. This feed has been found to be of general poor quality and overpriced (at an average of around R15/kg) according to a general consensus among Tilapia producers and role players that were engaged. The possibility of importing a high quality feed from Thailand was explored by producers and industry role players in the Eastern Cape, but they found that the cost would be too high. This represents a major stumbling block for local commercialisation due to feed costs making up between 50% and 70% of final Tilapia prices (Zaaiman, 2014).

However, other industry role players in Gauteng have also been exploring the possibility of importing high quality feed. As of the time of writing this report, they were on the verge of securing a contract with an international feed manufacturer. According to them, the cost of the feed would, at the worst case, be equal to that of the locally produced feed in terms of price. However, the imported feed would have a far superior FCR than the local feed, thus significantly reducing the amounts of feed needed and hence reducing overall feed costs. Notably, imported Tilapia feed carries a 20% Ad Valorem tariff rate into the Southern African Customs Union (SACU⁷) (SARS, 2014). It should be explored whether this tariff rate can be removed or reduced. Precedent for this exists, where the Salmon farming industry had the tariff rate reduced from 20% to free on imported Salmon feed to stimulate the local Salmon aquaculture industry (ITAC, 2006).

Additionally, new feed producers are beginning to enter the Tilapia feed industry. SA Feed in Hermanus is currently trialling their Tilapia feed and plans to enter the market below that of AVI while Montego are also in the process of starting trials on their own Tilapia feed formulations but possible feed prices have not been determined yet. A Western Cape company, AgriProtean, has also commercialised the growth of fly larvae into a viable Tilapia feed called MagMeal (AgriProtean, 2014). This is the first of its kind globally. Studies conducted by the company on Tilapia grown on MagMeal have shown it outperforms all locally and internationally sourced Tilapia feed (Penelope, 2014). However, sales prices for the MagMeal have yet to be released at the time of this report.

The importance of feed is second only to the importance of the seed stock. With an average feed conversion ratio of 1.5 and a feed cost of R12/kg, the feed cost of producing 1kg of Tilapia equates to R18. Assuming a conservative scenario where feed makes up 50% of production costs, this equates to a production cost of R36/kg for fresh whole Tilapia. New feeds thus need to dramatically improve on the feed conversion ratio and/or cost to lower final production costs.

⁷ See Annexure 3: Tilapia Feed Import Tariff Schedule

- Seed Stock

All major producers of Tilapia globally have had unrestricted access to various species of Tilapia, allowing producers to tailor their seed stock to the specific environmental conditions faced. In South Africa, however, Tilapia producers have had to focus purely on the use of the local indigenous variety of Mozambique Tilapia. This variety has been shown to be less commercially viable than other species. This has severely restricted the ability of the industry to realise significant commercial returns.

Recent changes in legislation, however, have resulted in an easing on restriction in the use of different species of Tilapia in aquaculture production. Specifically, the use of Nile Tilapia (a widely used species in commercial production) has now been approved, provided the necessary permits and precautions are taken to prevent the species escaping and invading local water systems. The Nile Tilapia is far superior to the local Mozambique Tilapia in rate of growth and is expected to significantly increase the commercial viability of Tilapia production in South Africa. International Tilapia seed providers, such as FishGen, have since positioned themselves in the South African market to start providing the superior Nile strain of Tilapia to local producers.

- Fish Grow-Out

Grow out of Tilapia in South Africa is somewhat restrictive when compared to major producers. Due to the South African climate, grow-out can only occur seasonally in some part of the country, unless water is heated to maintain higher temperatures. However, in the North-Eastern parts of the country, the subtropical climate allows for year-round grow-out conditions without the need for water heating.

- Processing

The processing of Tilapia by South African producers is mostly very low level processing. Fish are usually just gutted and gilled and then sold on. Very little value addition and job creation is generated downstream because of this.

- Primary Intermediaries

In the South African value chain, primary intermediaries are restricted to marketing and transport and local collectors. Lack of volume has restricted the development of Tilapia processors.

- Marketing and Transport

This is almost always carried out by the farmer. The farmer will sell their fresh product directly to local households or to high-end restaurants.

- Local Collectors

In some cases, local collectors will purchase the Tilapia product from the farmers and sell on to households or secondary intermediaries. A single local collector will often have a number of farmers that they purchase from.

➤ Secondary Intermediaries

This sector is made up of individual retailers and informal markets.

- Retailers

These retailers are often owner-managed stores located in rural areas or poorer areas such as informal settlements of townships where large local immigrant populations have a high demand for cheap fish protein. Farmers or local collectors will sell directly to these stores who then sell on to the local households.

- Informal markets

Very similar to the retailers, these markets are often located in poorer areas such as informal settlements and townships. Local collectors sell the fish in these markets to the household consumer.

9.3. Summation

Characteristics of the South African Tilapia Industry

- Limpopo and Mpumalanga have the most registered producers out of the nine provinces
- Limpopo and North West have the highest average tilapia production per producer

South African Tilapia Value Chain

- Value chain is less developed than reference countries
- For large scale commercial production, feed supply is the largest hindrance as it is too expensive and of poor quality

10. Tilapia Market Demand

The following section seeks to estimate the current demand for Tilapia in the South African market as well as potential export markets in the Southern African region. Further, potential future demand is also considered by engaging with current major buyers of fish in South Africa and looking into the substitutability of South African Cape Hake with Tilapia.

10.1. South African Tilapia Market Demand

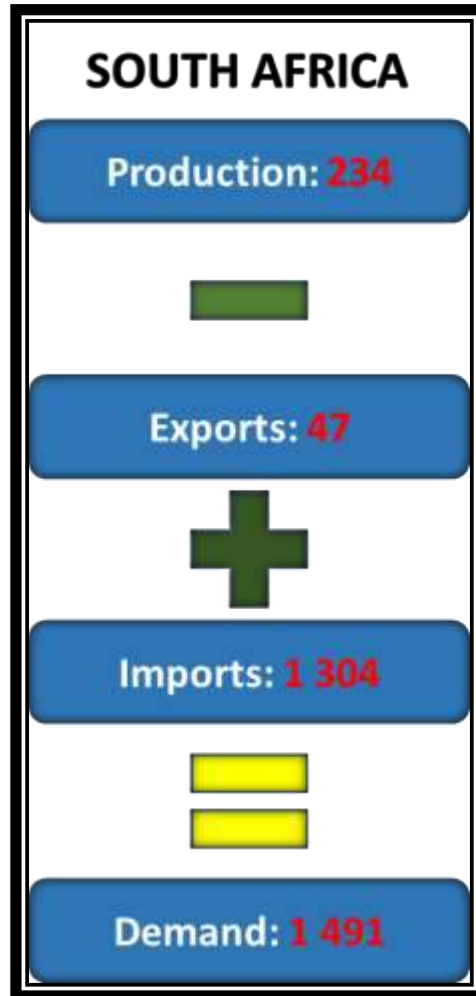
The demand for Tilapia in the South African market is difficult to determine. National statistics for consumption only go so far as determining the consumption of fish in general and not the sub-categories of species of fish, where consumption is equivalent to current demand. This is not a uniquely South African problem either; the FAO, in reporting consumption statistics, also experiences these issues. As such, the FAO developed a methodology for determining a close proxy for food fish demand called *apparent consumption* (FAO, 2014c). Essentially, *apparent consumption* is equal to the supply of food fish available in the country, which is determined by totalling imports and production and subtracting exports. This methodology is a globally accepted means of determining consumption and demand levels and as such is used in this report. Thus, any reference to demand in the current report is referring to *apparent consumption*.

10.1.1. Local Tilapia Consumption and Trade

Information on imports and exports of Tilapia in and out of South Africa was drawn from the United Nations Comtrade Database (COMTRADE, 2014) while production volumes were drawn from the FAO FishStat Database (FAO, 2014d) and corroborated with production volumes provided by engagement with TAASA.

As can be seen from Figure 10-1, local demand for Tilapia in South Africa equalled 1 491 tons in 2013. Local production satisfied 187 tons of this local demand (234 tons *less* 47 tons of exports) with imports satisfying 1 304 tons.

Figure 10-1: SA Tilapia Demand, 2013 (Tons/year)



Source: COMTRADE, 2014; TAASA, 2013

Exports in 2013 were to Botswana (36 tons), Zambia (6 tons) and Zimbabwe (4 tons), while imports originated from China (697 tons), India (531 tons), Zimbabwe (46 tons), Myanmar (29 tons) and Thailand (1 ton). This is represented in Table 10-2.

Table 10-2: South African Tilapia Exports and Imports in Tons for 2013

Trade Partner	2012		2013	
	Exports	Imports	Exports	Imports
Botswana	-	-	36	-
Zambia	-	-	6	-
Zimbabwe	1	40	4	46
China	-	473	-	697
India	-	225	-	531
Myanmar	-	-	-	29
Thailand	-	-	-	1
Mozambique	1	-	-	-
Total	2	738	47	1304

Source: COMTRADE, 2014

As can be seen in Table 10-2, activity in the trade of Tilapia in South Africa has experienced a significant increase in overall trade activity in the last two years. Notably, there was no recorded import or export of Tilapia products in 2011. Exports have increased significantly from only 2 tons in 2012 to 47 tons in 2013, while imports have increased from 738 tons in 2012 to 1 304 tons in 2013. Export destinations also increased from two to three countries while the origination of imports increased from three to five countries.

As is evidenced from the figures above, South Africa imports the vast majority of its locally consumed Tilapia. There is thus a significant shortfall in locally produced product and therefore scope for import substitution with local production, provided the right pricing structure can be achieved. This can be seen in a similar light to that of the local ornamental fish industry, as discussed earlier, where the industry began as a backyard hobby but has grown into a fully-fledged sub-sector of aquaculture through import substitution.

10.1.2. Demand from Local Fish Buyers

As part of the continual engagement process throughout this assignment, a number of well-known commercial companies involved in the purchase of fish were contacted to get a glimpse of the current perception of Tilapia amongst them and possible markets for commercial volumes of Tilapia in South Africa. The results of this engagement are provided in Table 10-3 and shows the name of the company consulted with, the amount of Tilapia they would theoretically be willing to purchase and the price they would offer. Additionally, some general comments on Tilapia were recorded.

Table 10-3: Results from Engagement with Commercial Fish Buyers

Company	Woolworths	I&J	SeaHarvest	Pick 'n Pay	Checkers	SPAR	Ocean Basket	Cape Town Fish Market	John Dory's	The Fish and Chip Co
Potential Quantity	3 Tons/ week	100 Tons/ month	No Indication	15-20 Tons /month	Does not believe Tilapia is well known enough in South African Market	None	200 Tons/ month	Only focus on saltwater fish	Only purchase Hake	No Indication
Farm gate Price	R25/kg for Whole Fresh R38/kg for Fresh Fillets	R12-R15/kg Whole Fresh	R12-R15/kg Whole Fresh	*R38/kg Whole Frozen Delivered			R30-R40/kg Fresh Filleted			R30-R39/kg Fresh Filleted
General Notes	Would prefer to purchase fresh fillets		Tilapia competes with baby hake. Demand for Tilapia increases when there is a shortfall of baby hake.	Tilapia has huge potential. Higher volumes will need to be supplied to help educate the consumer who is not used to purchasing freshwater fish.		Up to individual stores to determine whether they want to stock Tilapia or not.				Tilapia is a substitute for hake due to the bland taste.

*Indicated they wanted Frozen, not Fresh

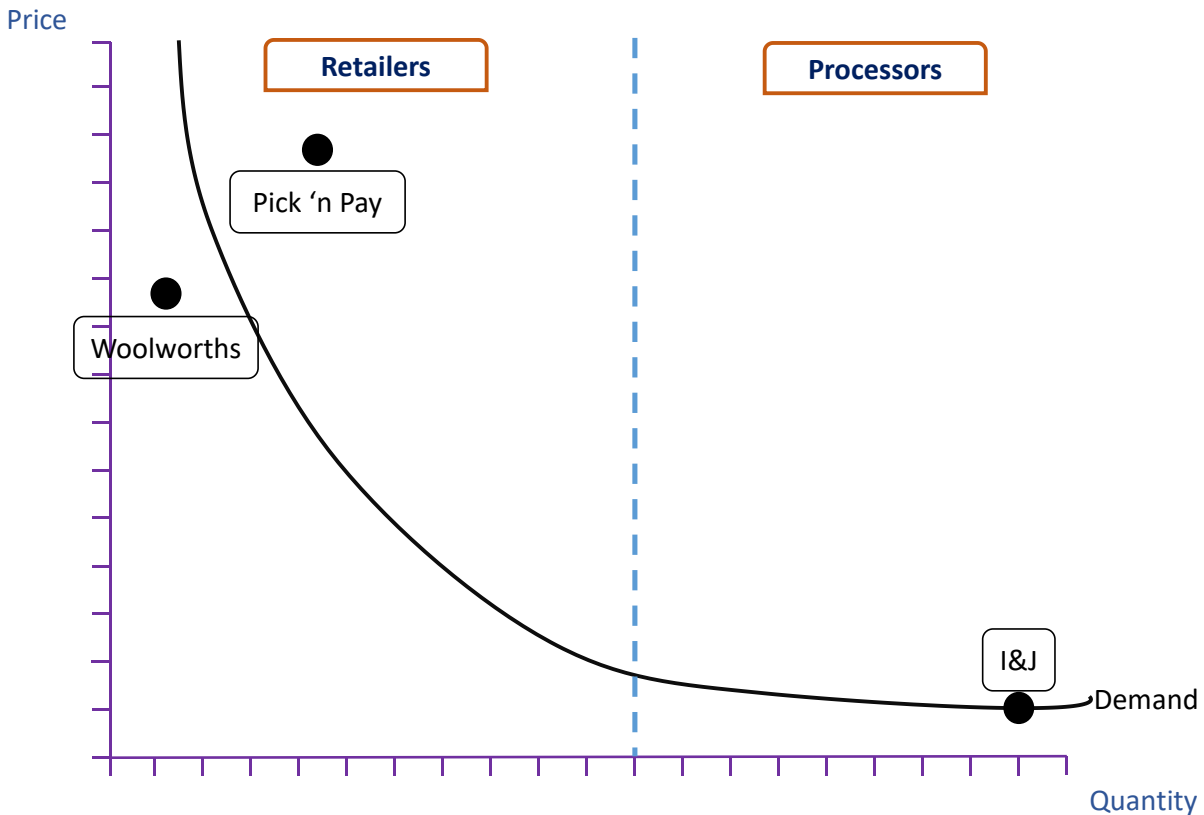
In summation of Table 10-3, it is evident that the majority of commercial buyers believe that Tilapia is moving into the mainstream of consumer conscience and acceptance. The willingness of major purchasers such as Woolworths, I&J, SeaHarvest, Pick 'n Pay, Ocean Basket and The Fish and Chip Co shows that Tilapia is not an unknown product amongst commercial stakeholders. The general sentiment is that, should a reasonable price point be found, local consumers will take up consumption of Tilapia. However, other commercial buyers such as Checkers and SPAR did not feel that Tilapia was a viable sales product to the South African consumer. The majority of major commercial buyers, however, do entertain the viability of buying and selling Tilapia in their stores. Cape Town Fish Market excluded Tilapia because it did not fit with their salt water product profile, while John Dory's had not explored the possibility of Tilapia to date.

Possibly the biggest statement to the belief that the South African consumer is open to consuming Tilapia is the move by Pick 'n Pay to start stocking imported Lake Harvest Tilapia products in its Gauteng stores. The product is now widely available across Gauteng. Pick 'n Pay have indicated that the response has been massive, with uptake of the product far outstripping their supplies. Lake Harvest has accordingly increased their prices to R38/kg for whole frozen delivered Tilapia.

Critically, Pick 'n Pay also highlighted three significant positions. Firstly, that high quality Tilapia was a very close substitute for Baby Hake/Hake. Secondly, that Chinese imported Tilapia, while being significantly cheaper, at R16.50/kg Whole Frozen, was of very poor quality and could not be used as a substitute. Thirdly, that they would be very willing to purchase locally sourced Tilapia, provided the quality was high, and would even be willing to pay a premium above the imported Lake Harvest Tilapia prices. Local Tilapia farmers have approached Pick 'n Pay before, but they could not provide the quantities that were needed to maintain a constant supply to stores.

From the above data, it can be seen that there is a significant difference between the prices and quantities offered by retail buyers, such as Pick 'n Pay, and other processor buyers, such as I&J. While Pick 'n Pay is offering to purchase at prices as high as R38/kg for Frozen Whole for between 15 and 20 tons per month, I&J offers only R12-R15/kg for 100 tons a month. The discrepancy here can be explained by the relative position of the buyers on the value chain: Buyers such as Pick 'n Pay are at the end of the value chain, being part of the retail sector and supplying direct to households. I&J, on the other hand, are in the middle of the value chain, being part of the processing sector and supplying to retailers and not to households. This would account for the differences in prices and quantities. From this, however, it is possible to develop a theoretical demand curve that can illustrate this point. This is seen in Figure 10-4.

Figure 10-4: Theoretical Demand Curve for Tilapia in South Africa



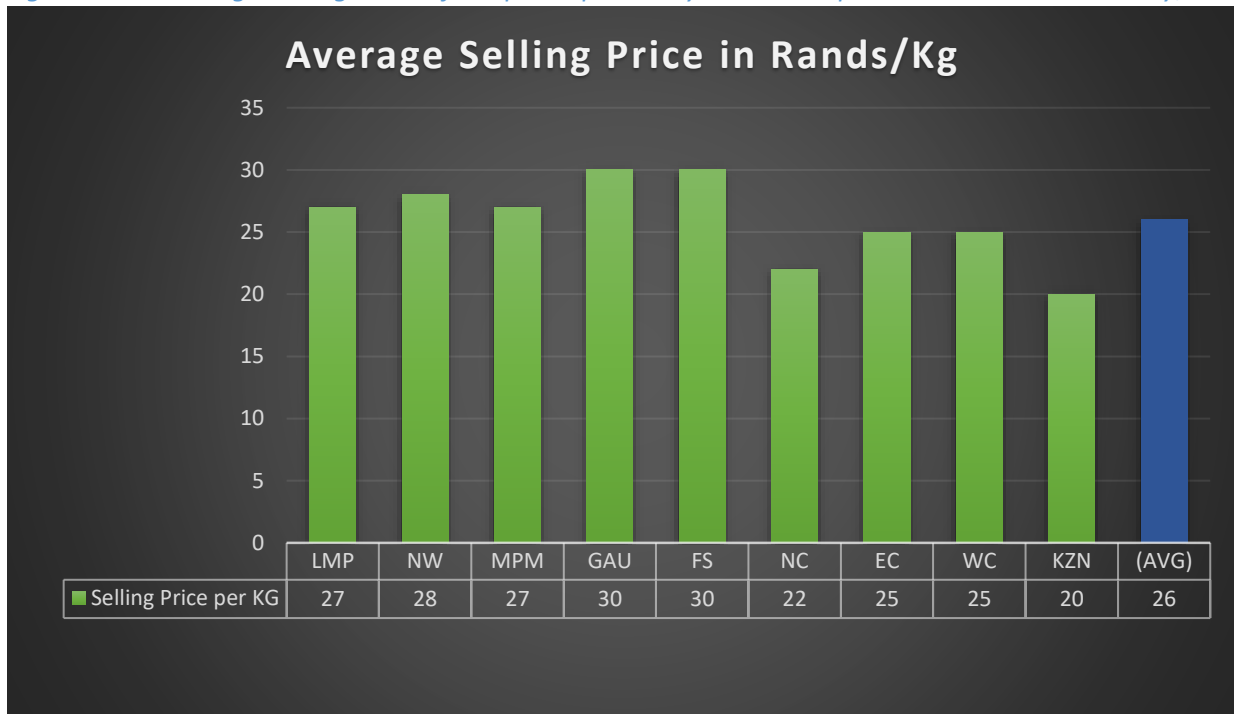
From Figure 10-4, it can be seen that retailers of Tilapia would fall on the upper-left area of the demand curve, demanding lower quantities but at higher prices, while processors fall within the lower-right area, demanding higher quantities but at lower prices.

10.1.3. South African Tilapia Prices

Having analysed the current direct market demand for Tilapia, it is thus pertinent to now consider what the current price and supply of Tilapia is from both local producers and imported Tilapia. This will provide the link between what buyers are willing to pay and what price producers are able to supply.

For local production, the average farm gate price of whole Tilapia in South Africa achieved by Tilapia producers varies between provinces. This can be seen in Figure 10-5.

Figure 10-5: Average Selling Price of Tilapia Reported by Producers per Province and Nationally, 2013

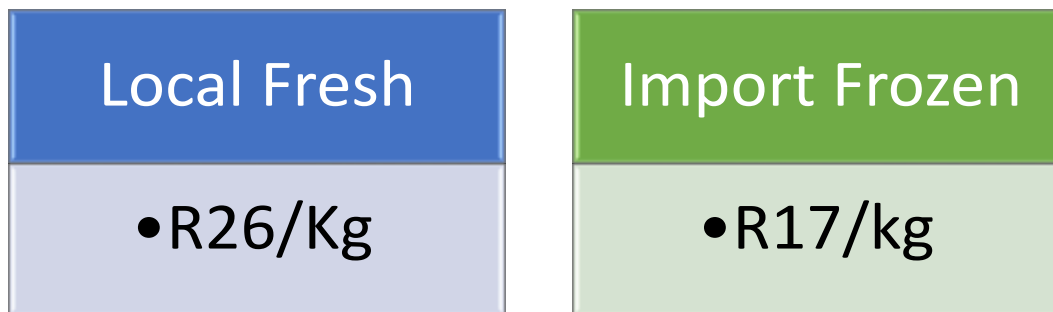


Source: TAASA, 2013

As indicated in Figure 10-5, the highest average price received was R30/kg in Gauteng and the Free State, while the lowest price received was R20/kg in Kwa-Zulu Natal. The national average price in 2013 was R26/kg. These prices are for whole Tilapia as processing to fillets is currently not practiced in South Africa due to restraints created by insufficient volumes available to make processing economically viable.

The import price for Tilapia varies considerably, depending on the exchange rate and market conditions prevalent at the time. However, as of August 2014 the average import price for frozen whole gutted Tilapia was R17/kg (FOL, 2014). According to the importer, this was the most imported product category for Tilapia by a significant margin. Buyers prefer to purchase fresh fillets, but this has proven too costly and logistically difficult to do.

Figure 10-6: Local vs. Imported Whole Gutted Tilapia



The import price for frozen whole Tilapia is thus significantly lower than local fresh prices. Thus, local consumers will be paying a premium for fresh produce as opposed to frozen. Should feed prices fall and/or feed conversion ratios improve, local producers would be better placed to compete with imports by offering a superior product at competitive prices.

Statements on what price producers would be able to produce at given improved feed cannot be made at this point due to lack of information surrounding the future of the feed supply.

10.1.4. Tilapia as a Substitute Product

Engagement with local South African buyers of fish revealed that Tilapia can be considered a close substitute for locally caught Hake and Baby Hake. This is due to similarities in the taste of the two species. Hake has been described as having a bland and slightly sweet taste, while Tilapia also has a bland taste, but without the slight sweetness. The difference in sweet taste is due to Hake being a salt water fish while Tilapia is grown in fresh water.

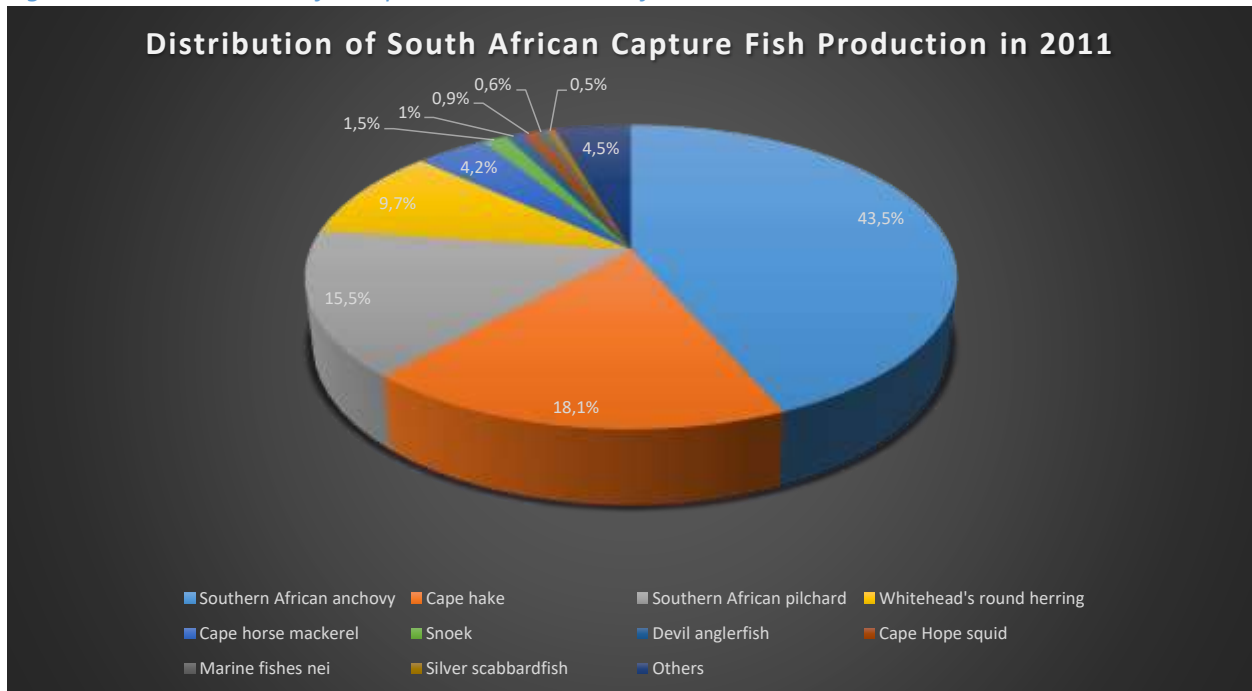
However, Tilapia are also known to sometimes have a distinctly muddy or stale taste. This results when Tilapia is grown in earthen ponds and a certain bacteria and algae create the flavours in the Tilapia (JMAF, 2014). Farmers using earthen ponds, therefore, are forced to either make use of chemicals to prevent the growth of the bacteria and algae that cause the undesirable flavours, or change water regularly to improve water qualities.

Farmers using RAS systems do not experience these issues. In order for a Tilapia product to be considered as a close substitute for Hake, the Tilapia must not have the muddy/stale taste. This is best achieved when using RAS production or cage aquaculture in deep waters. The ensuing Tilapia product will then have the desirable bland taste.

Given the substitutability of Hake and Tilapia, it is reasonable to consider then that they may compete in the same market space and, assuming perfect substitution in ideal circumstances, demand for Hake in South Africa could reasonably equate to potential demand for Tilapia.

In relative terms, South African Cape Hake was the second largest sector in terms of production weight in South Africa in 2011. This can be seen in Figure 10-7.

Figure 10-7: Distribution of Fish production in South Africa in 2011

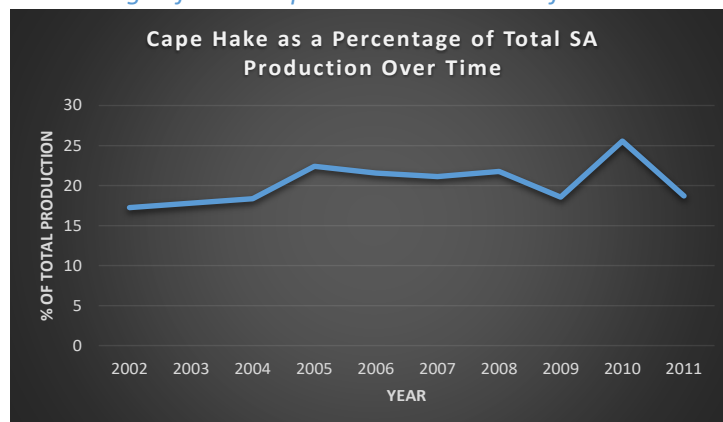


Source: FAO, 2014d

From Figure 10-7, it can be seen that Hake made up 18,1% of total South African capture fish production in 2011, amounting to over 55 000 tons. This was second only to Anchovy (43,5%). “Marine fishes nei” refers to undocumented species, while “Others” refers to an aggregation of species that fell out of the top ten and whose contribution was too small to represent on this diagram.

Over the last ten years, Hake has remained relatively stable in its make-up of total capture fish production in South Africa. This is illustrated in Figure 10-8, below.

Figure 10-8: Hake as a Percentage of Total Capture Fish Production from 2003 to 2012

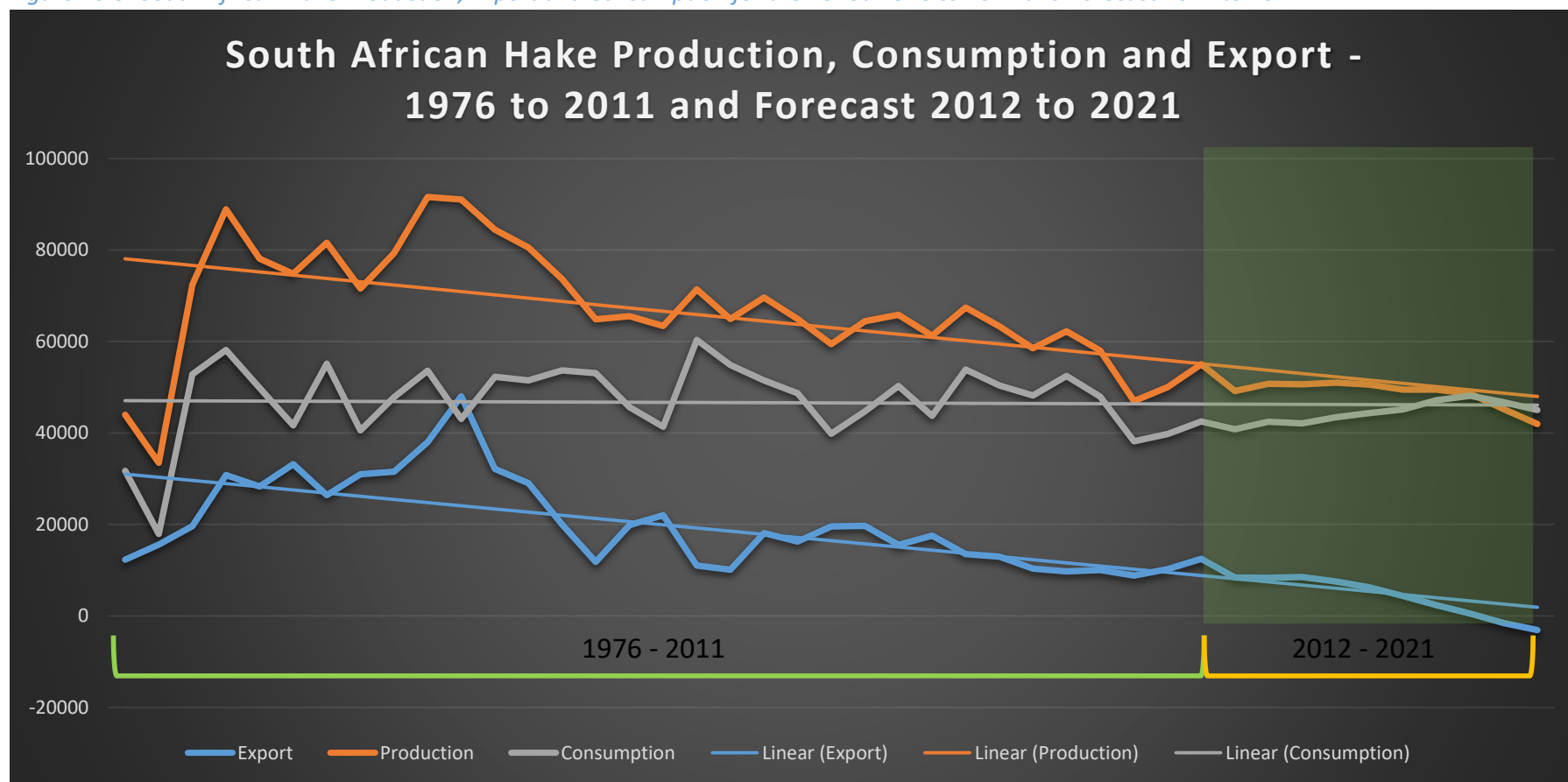


Source: FAO, 2014d

As can be seen in Figure 10-8, the contribution of Hake to the total production volume of captured production has fluctuated between 17% (2002) and 25% (2010). The large fall in 2011 can be attributed to a large increase in Anchovy catch, where the reported Anchovy catch in 2011 more than doubled from 2010.

What is clear from the above data is that Hake forms a relatively large portion of the local South African fish industry. The relatively large volumes of Hake represent a general acceptance of the fish by many South African consumers. Given the established substitutability of Hake/Baby Hake with Tilapia, it is pertinent to then consider the potential size and future trajectory of the Hake market in South Africa. South African Hake production, export and consumption for the period 1976 to 2011, and forecast for 2012 to 2021 is illustrated in Figure 10-9.

Figure 10-9: South African Hake Production, Export and Consumption for the Period 1976 to 2011 and Forecast 2012 to 2021



Source: FAO, 2014d

From Figure 10-9, it is clear that production of Hake has declined from a high of 91 000 tons in 1985 to a recorded low of 47 000 tons in 2009. Quotas were introduced in 1990 in an attempt to re-build the overexploited Hake stocks to their Maximum Sustainable Yield. This was initially successful, with indications of increasing stock levels and catch-rates and, as such, increases in the quota limits. However, in 2000 stock levels and catch-rates began to decline again and hence quotas were once again decreased (DAFF, 2012b). Statistical forecasting⁸ for 2012 to 2022, based on the time period 2002 to 2011, continues to show a general fall in production for the next 10 years. As can be seen by the Production Trend Line for the entire time period, production volumes of Hake are in general decline.

Consumption has remained fairly consistent from the period 1976 to 2012 and statistical forecasting shows this to continue. The Consumption Trend Line shows only a slightly positive incline over the entire time period. However, consumption is forecasted to meet production around the year 2019/20.

The export trend shows a general decline in export volumes over the entire time period. The declining gap between production and consumption results in less product being available for export and hence a worsening current account. The culmination of the reduced production is also a forecasted need for imports of Hake from 2019/20 to meet consumption demand.

10.1.4.1. Understanding the Market for Hake

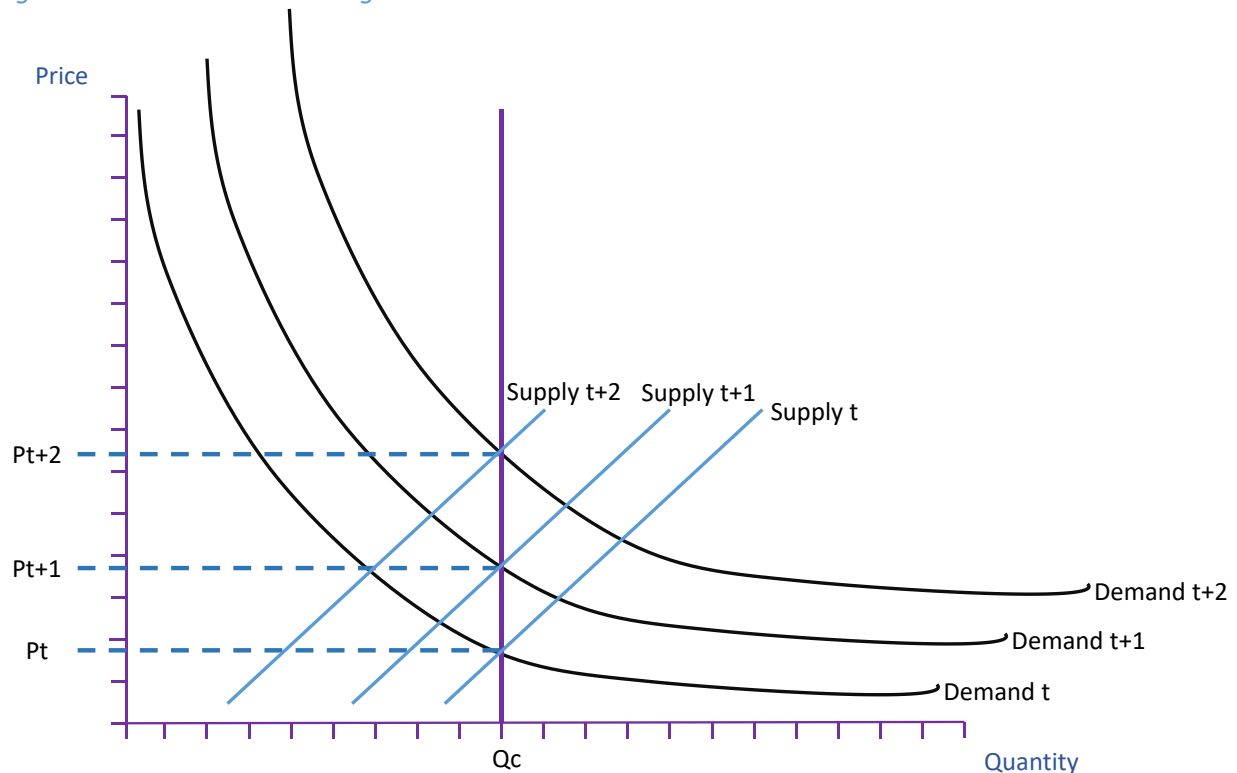
Through discussions with local Hake buyers and sellers, it has been established that prices of Hake have been increasing dramatically over the last ten years⁹. One seller of Hake revealed that the price of a 6-8 oz Hake fillet had increased from R17 per kg in 2005 to around R52-R58 per kg in 2014. Current 2014 price of Whole Frozen Hake was R30 per kg. Prices of Hake are determined by international markets, where South Africa is one of many countries that supply Hake. Some differentiation exists, where South African Hake (known as Cape Hake) is of a different species to other countries Hake, but South Africa is generally a price taker and cannot influence world prices to any significant degree.

The fact that consumption of Hake has remained relatively stable and slightly increasing, despite clear increase in price and a fall in production over time, indicates that the actual demand for Hake has been increasing while supply has been falling. This is illustrated in Figure 10-10.

⁸ The Ordinary Least Squares method was used to forecast the linear progression and assuming *Ceterus Paribus*.

⁹ All stakeholders engaged were very unwilling to provide a detailed spreadsheet of actual historical prices. This could be due to the fact that it is common practice to pay for this data or they would be unwilling to reveal strategic competencies.

Figure 10-10: Theoretical Change in Hake Market over Time



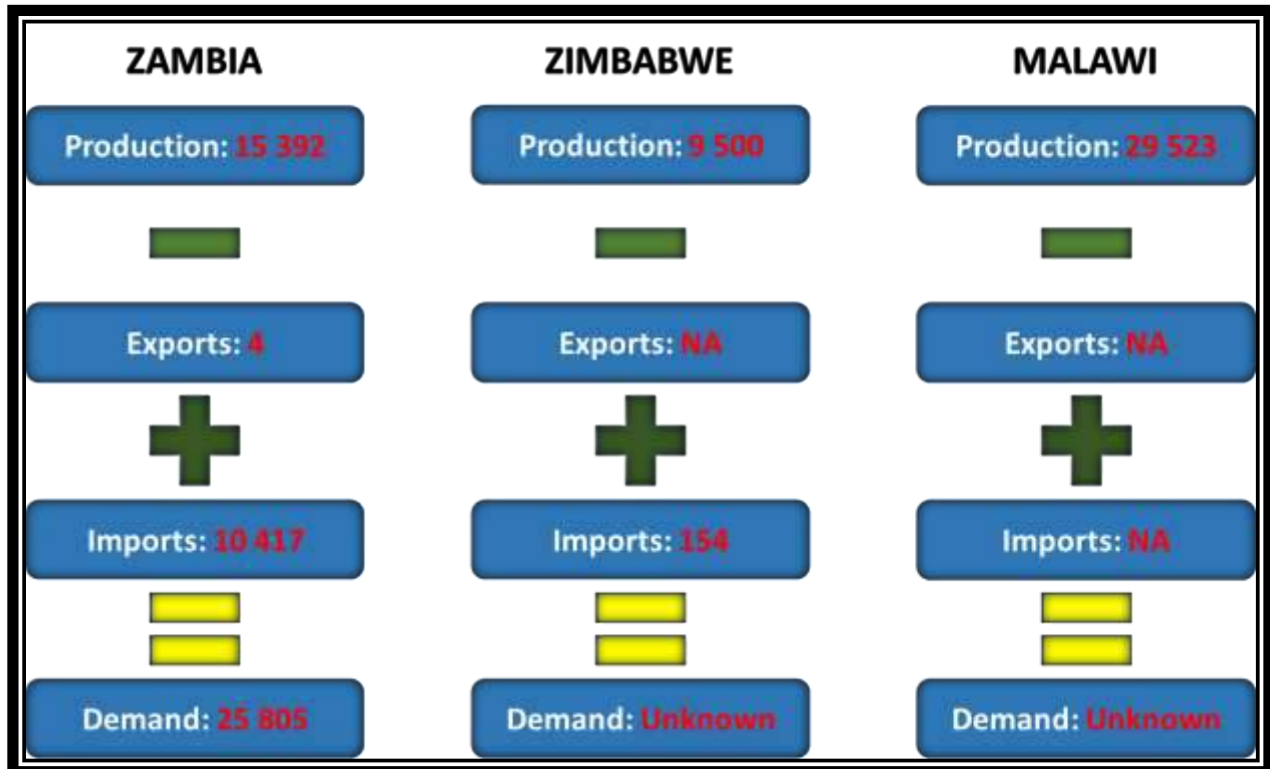
From Figure 10-10, it can be seen that the actual quantity consumed (Q_c) has remained stable as time (t) increases (t , $t+1$, $t+2$). As time increases, so prices have increased (P_t , P_{t+1} , P_{t+2}). This can only be due to increase in demand for Hake (Demand t , Demand $t+1$, Demand $t+2$) as well as decreases in the supply of Hake (Supply t , Supply $t+1$, Supply $t+2$). What Figure 10-10 shows us is that the market for Hake has been experiencing increases in demand due to exogenous variables (such as increasing population, increasing desire to consume Hake or increasing incomes). The general decline in the supply of Hake, coupled with the rising prices and yet relatively stable actual quantities consumed can only be explained by a general increase in demand for Hake in the South African market

Given the increasing demand and falling supply of Hake, coupled with rising prices, the possibility exists for Tilapia to fill this potential future market gap for Hake. Additionally, Tilapia could capture a portion of the current Hake market locally, which would free up additional Hake for export to the international market. Given that current reported prices for Whole Frozen Hake are around R30 per kg, **it would seem that Tilapia and Hake prices are approaching a point of meeting in the local fish market** (the national average farm gate price of Tilapia was R26 per kg in 2013).

10.2. Zambia, Zimbabwe and Malawi Tilapia Market Demand

Given that South Africa operates as an open economy, it is pertinent to consider the potential for exports, should a viable Tilapia industry be established locally. The main potential countries included in this regard are Zambia, Zimbabwe and Malawi, as per the terms of reference of this assignment. This is done using the same methodology for determining South African market demand. The potential Tilapia demand for these countries is provided in Figure 10-11.

Figure 10-11: Tilapia Demand for Zambia, Zimbabwe and Malawi (Tons/Year), 2013



Source: COMTRADE, 2014; FAO, 2014d

As can be seen in Figure 10-11, Zambia has a significant shortfall in local production of Tilapia. While the country's demand totalled approximately 25 805 tons of Tilapia in 2013, it had to import over 10 417 tons to satisfy this demand, as local production accounted for an estimated 15 392¹⁰ tons in 2013. Even South Africa, with its very small local industry, exported 6 tons of Tilapia to Zambia in 2013 (COMTRADE, 2014).

However, with regards to Zimbabwe and Malawi, quantitative information on Tilapia trade could not be found for 2013, with other years' data being very erratic. This may be due to a lack of institutional capacity to collect the relevant data, or poor data collection practices in general

¹⁰ 2013 figure of 15 392 tons estimated by increasing 2012 production figures by five year average increase

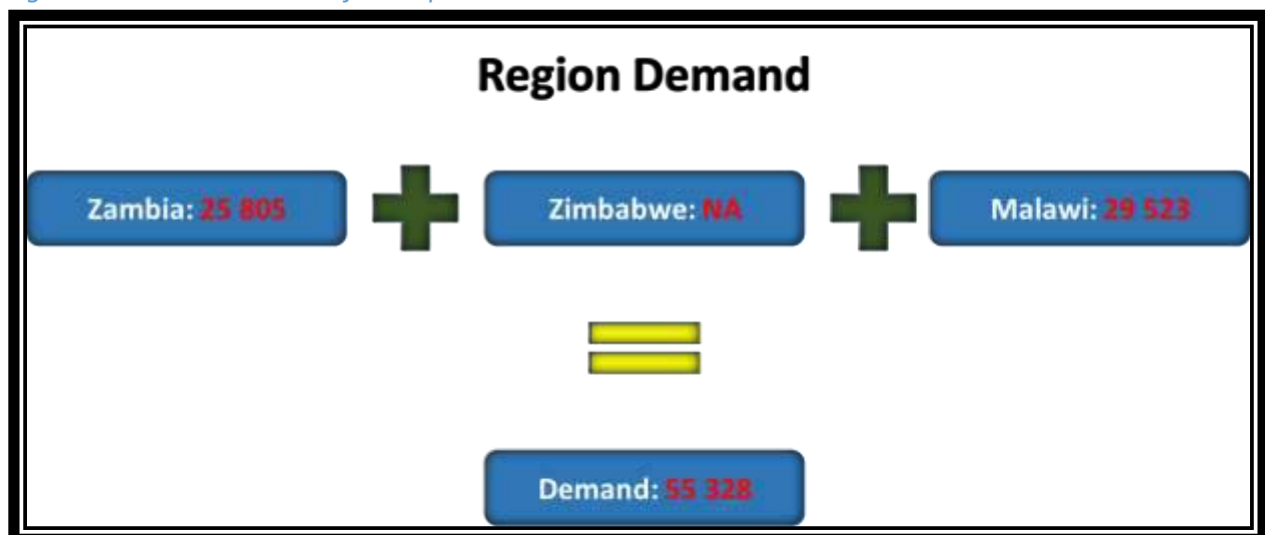
at points of entry and exit from the respective countries. Trade in Tilapia may have simply been grouped under general trade in fish and not by species. As such, analysis must fall to qualitative indicators of demand coupled with quantitative proxy indicators to determine possible demand in these countries.

For Zimbabwe, imports totalled 154 tons in 2013. This may suggest that the country experienced a general shortfall in domestic supply of Tilapia and hence that no Tilapia was exported. However, it is known from general press releases that the local Lake Harvest company exports significant amounts of Tilapia (Rogers, 2013; AFDB, 2013). It is, however, unknown how many tons of Tilapia was exported due to poor data collection. Production was also estimated at 1 000 tons of captured Tilapia and 8 500 tons of farmed Tilapia, bringing total production to 9 500 tons (FAO, 2014d). It is therefore not possible to estimate the local demand for Tilapia in Zimbabwe without more viable data.

In terms of Malawi, Tilapia aquaculture production volumes came to 3 267 tons, while wild capture of Tilapia amounted to 26 256 tons in 2012 (FAO, 2014d). According to Tallaksen (2014), both Zambia and Malawi experienced deficits in food fish supply in 2013. However, Malawi only reported overall food fish imports of 2 991 tons in 2011 (FAO, 2014d). Evidence of food fish exports, however, could not be found and as such it can reasonably be assumed that local production was mainly consumed locally. Based on the data, a conservative estimation for local Tilapia demand is 29 523 tons in 2013 for Malawi.

Conservative estimates of demand for the key export regions of Zambia, Zimbabwe and Malawi for 2013 come to 55 328 tons in 2013 (Figure 10-12).

Figure 10-12: Total Demand for Tilapia in 2013



However, while the demand for Tilapia in these markets may be considerable, it is important to consider the type of product that is being demanded. Typically, consumers in Zambia and

Malawi look for cheap, whole Tilapia and are not as concerned with Tilapia that has a muddy taste. Essentially, the consumers in these countries are looking for a cheap form of protein. It is for this very reason that China has begun looking to markets such as these in Africa to export their Tilapia to, given that more discerning markets in the USA and Europe look for high quality, sustainably produced product that China may not be able to satisfy.

There would, thus, be high levels of competition in exporting Tilapia to these countries. Due to the nature of the South African climate and legislation, production can only occur in RAS systems which naturally produce a higher quality product than pond based Tilapia production. The corollary of this is that South African produced Tilapia will be of a higher price than the lower quality Asian/Chinese Tilapia. The extent of export potential to these countries by South African producers may thus be restricted to the high-end consumer and not the average consumer.

10.3. Conclusions on Demand for Tilapia

What has emerged from the demand analysis of Tilapia is a strong indication that Tilapia demand is growing in South Africa, illustrated by the increases in imports and growth in local production. The broad knowledge of Tilapia and willingness to purchase the product expressed by the majority of commercial entities engaged is also an indication of a growing consciousness around Tilapia amongst the broader food industry.

The possibility surrounding the substitutability of Hake with Tilapia provides an important gateway for the consumption of the species by South African consumers. In an environment of rising Hake prices and dwindling demand, a market gap for Tilapia has been identified. Notably, prices between Hake and Tilapia have been found to be nearing parity between each other. Thus, the potential for Tilapia may not be purely restricted by price, but rather consumer awareness and penetration of Tilapia into the South African market. It could be envisioned that, should sufficient quantities of Tilapia be produced to allow for a processing facility to be established, Tilapia fillets could compete with Hake in the local market.

In terms of export markets, Tilapia is in high demand in Zambia and Malawi, with demand in Zimbabwe being uncertain due to poor data collection. However, demand in Zambia and Malawi alone is significant and given that these countries are reported to be experiencing deficits in fish supply, real demand for Tilapia may be even higher than the *apparent consumption* demand methodology used in the analysis. However, the nature of the product demanded by the average consumer in those countries may not tie in with the product that can viably be produced in South Africa.

It can thus be concluded that the local South African market has the potential to support large-scale local Tilapia production, while scope for export to regional markets is possible from a demand perspective, but may be limited due to the nature of the product demanded in these markets and high levels of competition from bulk suppliers such as China.

11. Implications for Commercialisation of Tilapia Production in South Africa

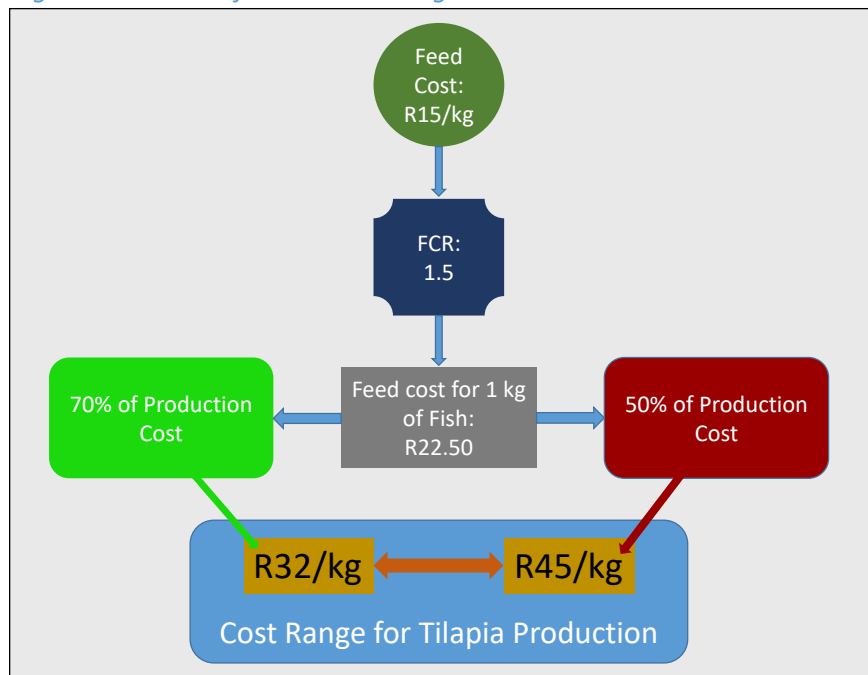
The following section provides an indication of the commercial viability of Tilapia production in South Africa, by drawing together elements already discussed throughout this research.

11.1. South Africa Commercial Scale Production Costs

One of the most difficult aspects of Tilapia production in South Africa to fully grasp and determine is the cost of producing Tilapia at a commercial scale. As the industry has never before pursued production quantities beyond a scale of 20 tons per year (TAASA, 2014), commercial scale production costs at 100 to 500 tons per year are completely unknown within South African conditions.

Given this lack of information from South African experience, it is necessary to pursue other indicative measures from international experiences. In this light, contemporary literature on Tilapia production has shown that feed is the single largest input costs in Tilapia aquaculture. An analysis of commercial scale Tilapia production around the world has shown that feed makes up between 50% and 70% of the final production cost (Zaaiman, 2014). Given this knowledge, we can thus extrapolate potential production costs for Tilapia by sourcing the current cost of feed, and applying the 50% to 70% principle to provide a potential range for current production costs under commercial conditions. The current cost of feed is R15/kg in South Africa. The applied methodology can be seen in Figure 11-1.

Figure 11-1: Cost of Production Range

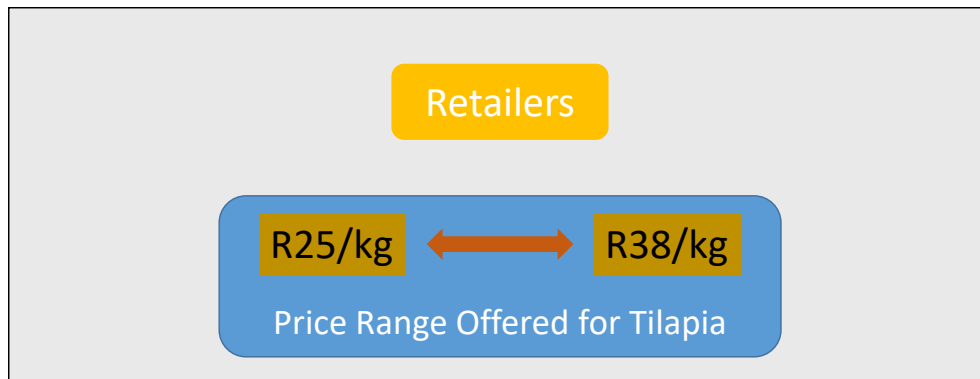


From Figure 11-1, it can be seen that the current potential production costs for Tilapia are in a range of R32/kg to R45/kg, with a feed conversion ratio of 1.5 and local feed cost of R15/kg.

11.2. South African Potential Tilapia Market Prices

Drawing from previous sections, it has been shown that the current market price for Whole Tilapia ranges from a low of R12/kg, offered by processors, to a high of R38/kg¹¹, offered by retailers. Figure 11-2 illustrates the price range offered by retailers for Tilapia.

Figure 11-2: Price Range offered for Tilapia by Local Retailers



As is evident from Figure 11-2, the local market is currently willing to pay between R25/kg and R38/kg for delivered Whole Tilapia. However, it should be noted that these prices have been increasing in recent times, especially in response to the positive acceptance by consumers of the Lake Harvest imported Tilapia products.

11.3. Market Condition Conclusions

Given that current production costs for Tilapia are estimated to be in the range of R32/kg to R45/kg and does not yet include processing, packaging and transport, it is reasonable to assume that ***the current market price offering of between R25/kg and R38/kg for Whole Tilapia is currently too low to sustain a large commercial project.***

However, the upward trend of prices must be noted as an important indicator of the growth of the industry. Growing demand for fish in general as populations' increase, while natural stock catches remain constant or decline, has created an environment of rising food fish prices. This points to the possible future viability of local Tilapia production, should production costs be held constant at current levels and prices continue to rise.

¹¹ Price offered for Whole Frozen by Pick 'n Pay

12. South African Tilapia Aquaculture Potential

The following matrix seeks to compare the potential of the South African Tilapia industry to that of benchmarks drawn from the research conducted as best practices. Each area is rated as either green (positive), yellow (area of concern) or red (major obstacle).

Table 11-1: South African Tilapia Industry Performance Matrix

Area	South Africa	Notes
Species	✓	As of the 1 st of August 2013, South African producers can now use the Nile Tilapia in production. This is a significantly positive development in the industry, placing the country in line with international producers.
Feed	X	<p>As of the time of writing this report, feed has remained a major stumbling block for the industry. With locally produced feed being of poor quality and high price, large scale commercialisation is not viable.</p> <p>However, the local feed industry is experiencing the entry of new producers and the potential for importing high quality, low cost feed has not been ruled out. This could allow for viable large scale commercialisation.</p>
Technology	—	<p>South Africa does not make use of the low capital, extensive production technologies used in China and Uganda, which represents an immediate cost disadvantage to the local industry. The use of RAS represents a longer term environmental advantage, and an intensive rather than extensive approach that can match the economic efficiencies of cage/pond if high stocking densities can be achieved</p> <p>South Africa does, however, continue to invest in research and development in production technologies, feed technologies and cultivar development.</p>
Demand	—	<p>South Africans do not have a strong culture of fish consumption in general and Tilapia in particular, as in other markets. The majority of the local Tilapia market is generated by foreign nationals living in South Africa and high-end consumers accustomed to fish consumption.</p> <p>However, demand has shown significant growth. Increased awareness amongst commercial fish buyers,</p>

Area	South Africa	Notes
		and the potential for the substitutability of Tilapia with Hake represents a significant market opportunity for absorbing local production.
Market and Production Prices	X	Given the current indicative market price of between R25 and R38 per kg being offered for Tilapia by South African retailers and the estimated local production costs between R26 and R36 per kg, it is clear the market currently cannot sustain large-scale Tilapia production until production costs fall and/or market prices increase.
Legislation	—	<p>South African Legislation surrounding freshwater aquaculture in general and Tilapia in particular is progressing in a generally positive direction, as identified by a number of stakeholders in the industry.</p> <p>South African legislation is not yet as developmental as China and Uganda and the lack of coordination between national and provincial departments is creating a significant bottleneck in terms of awarding production licenses.</p> <p>However, the continued engagement between government and stakeholders and the continued evolution of regulations indicates that this is a bottleneck that may be overcome.</p>
Climate	—	<p>The majority of South Africa does not have a viable climate for the production of Tilapia without significant interventions in heating.</p> <p>However, certain areas of South Africa do have viable climates for Tilapia production year-round and interventions through low-cost technologies, such as green housing, presents easy and cost effective means of overcoming such issues.</p>
Skills	√	South African tertiary institutions offer both formalised aquaculture courses and research-based learning opportunities, while Agri-Seta Learnerships are aiding in the development of a pool of skilled workers in Tilapia aquaculture

Area	South Africa	Notes
Potential Threats	√	While China and Uganda face potential threats of environmental and health issues surrounding their Tilapia aquaculture industries, these stem from their primary production technologies of pond and cage aquaculture. South Africa, on the other hand, relies almost exclusively of RAS aquaculture for Tilapia production. RAS has significantly reduced environmental and health hazards and positions the country as being able to offer a healthier, environmentally friendly and better quality product.

13. Conclusions

Aquaculture on a global level is a growing industry with large potential for commercial enterprise. Environmentally sound aquaculture practices are more environmentally friendly than traditional animal farming and far more efficient, while growth in the industry has outperformed traditional agriculture. Despite this global growth in aquaculture, South Africa remains an insignificant producer of aquaculture products globally and on the African continent and growth rates have been far below the continental average. The potential thus exists for South Africa to boost growth in local aquaculture production.

With the continued growth in the global human population and the levelling out of food fish catches from wild fisheries, aquaculture presents the only viable option in providing for global food fish supplies. Tilapia has proven to be a key species in supplying this demand for fish protein through aquaculture in the rest of the world and as such is seen as a key growth industry.

13.1. South African Tilapia Viability

The ultimate question that must be answered is ‘Can Tilapia farming be viable in South Africa?’

From the preceding research it is concluded that Tilapia farming is not viable in South Africa at this stage due to current conditions. However, should feed prices fall and the evident rise in price of substitute products such as Hake continue, Tilapia aquaculture will be a viable commercial concern given the presence of the following characteristics and inputs in sufficient quantity, compared to the benchmarks developed:

- The legislative environment is improving, albeit slowly, but it is generally agreed that it is moving in the correct direction to become a supportive element for the industry as opposed to hampering its development.
- South Africa possesses the technological expertise to maintain and advance production technologies and advances in feed technology are ongoing.

- Skills development is present and ongoing and a number of individuals have the ability to design and build the necessary production facilities.
- Climatic conditions are not ideal over most of the country but these can be overcome using RAS technology while some areas of the country do have suitable climatic conditions.
- The most efficient cultivar, Nile Tilapia, is now free to be used in RAS production in South Africa.
- Demand for Tilapia continues to grow and substitutability with Hake presents further market opportunities, especially with the increasing price of Hake and the falling supplies. However, awareness could facilitate further growth in demand, provided production and processing can rise to meet the increased demand (refer to Annexure 4: Growth of the USA Tilapia Market).

However, **a major stumbling block remains in the feed sector.** The current feed supply is of very poor quality and is highly priced. Similar problems have been experienced not just among the small South African producers, but it has been indicated that producers such as Lake Harvest in Zimbabwe and Ugandan producers experience similar problems with sourcing good quality, well priced feed. This stumbling block will need to be overcome if the sector is to grow to a commercial scale enterprise. The potential exists to overcome this obstacle, given South Africa's superior infrastructure and scientific expertise compared to that of regional counterparts.

14. Recommendations

The research conducted has shown that Tilapia aquaculture is possible in South Africa from a technical point of view. The emergence of over 50 registered producers is indicative of this viability and a confirmation of the research findings. However, viability does not necessarily translate into large-scale commercial sustainability. The overarching recommendation then is that ***Tilapia aquaculture, with current market prices and production costs, is not commercially viable at this time.*** That said, the industry is rapidly changing and demand for the product is growing, creating an environment of increasing real prices. If coupled with interventions in feed production to lower production costs, ***Tilapia aquaculture may be a viable commercial enterprise in the near future.***

This research culminates in four recommendations the IDC could potentially pursue;

- 1) Communication and co-operation with the industry association, TAASA;
- 2) Exploration of the possibility to establish a commercial scale Research and Demonstration facility;
- 3) Research into the potential impact of removing import tariffs of Tilapia feed; and
- 4) Investing in Tilapia feed production and research.

These interventions are summarised in Table 12-1 and described below.

14.1. Communication and Co-operation with TAASA

The landscape of Tilapia aquaculture is a fast shifting one. The industry is being championed by TAASA, who has been in continuous discussion with government departments and private consultants over a long period of time. Coupled with government's strong push to develop aquaculture in South Africa, changes are continuous. The result is that this research presents only a momentary picture of a fast evolving and changing scenario.

Given this rapid change, it is imperative that the IDC should develop contact and maintain a relationship with the industry body TAASA, to keep informed on developments and potential areas of strategic partnership that may present themselves.

Additionally, new bottlenecks may emerge as the industry grows and swift responses and interventions would ensure the continued development of the industry. The continued involvement of the IDC in this would provide essential support.

14.2. Establishment of Research/Demonstration Facility

Current production in South Africa is characterised by many small-scale facilities. The result of which is a lack of information as to the potential economies of scale that could be achieved within a commercial-scale operation.

The establishment of a research and demonstration facility would allow for current South African RAS technologies to be tested on a commercial scale and allow for potential economies of scale to be identified. Additionally, this facility could serve as a testing ground for new feed formulas or Tilapia species and as an additional practical training facility for prospective commercial Tilapia farmers. Once the market price for Tilapia has increased to a more reasonable level, in excess of around R45/kg for Whole Tilapia, *ceterus paribus*, or high quality feed can be sourced at around R12/kg, *ceterus paribus*, a commercial demonstration facility could be a viable option.

14.3. Removal of Tilapia Feed Import Tariffs

Feed represents the single most significant operational cost in Tilapia aquaculture. The access to good quality, well-priced feed is essential to the viability of a commercial-scale Tilapia aquaculture enterprise. Because current locally produced feed supply is so poor and carries a high price, producers are exploring the potential of importing Tilapia feed into South Africa.

In order to reduce the price of imported Tilapia feed, the potential for the removal of the current 20% Ad Valorem tariff and its impact on final prices is an avenue that could be pursued. Precedent exists for such a move. The Salmon aquaculture industry successfully petitioned to the International Trade Administration Commission of South Africa (ITAC) for the removal of tariffs, based on the same arguments that locally produced feed was of poor quality and over-priced.

Currently, high quality imported Tilapia feed can be landed in South Africa at \$1.44/kg (inclusive of 20% tariff and \$0.20 freight charge). At an exchange rate of R11.50 for \$1, this entails a feed cost price of R16.56/kg (production cost implications can be seen in Figure 14-1). With the removal of the 20% tariff, feed costs can be reduced to \$1.19/kg (inclusive of \$0,20 freight charge), entailing a feed cost price of R13.69/kg (production cost implications can be seen in Figure 14-2), less than the current locally produced feed price of R15/kg.

Figure 14-1: Imported Cost of Feed Implications on Local Production Costs

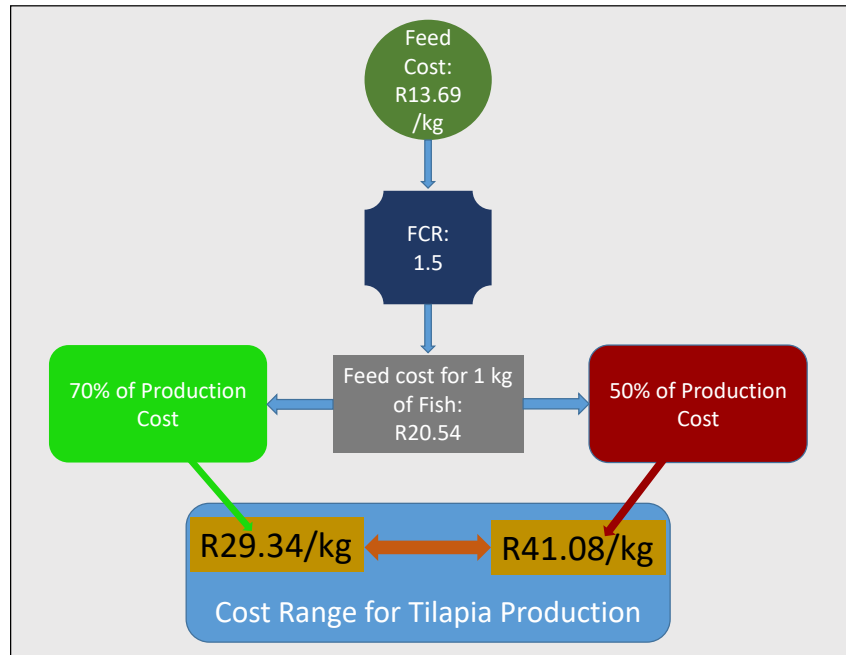
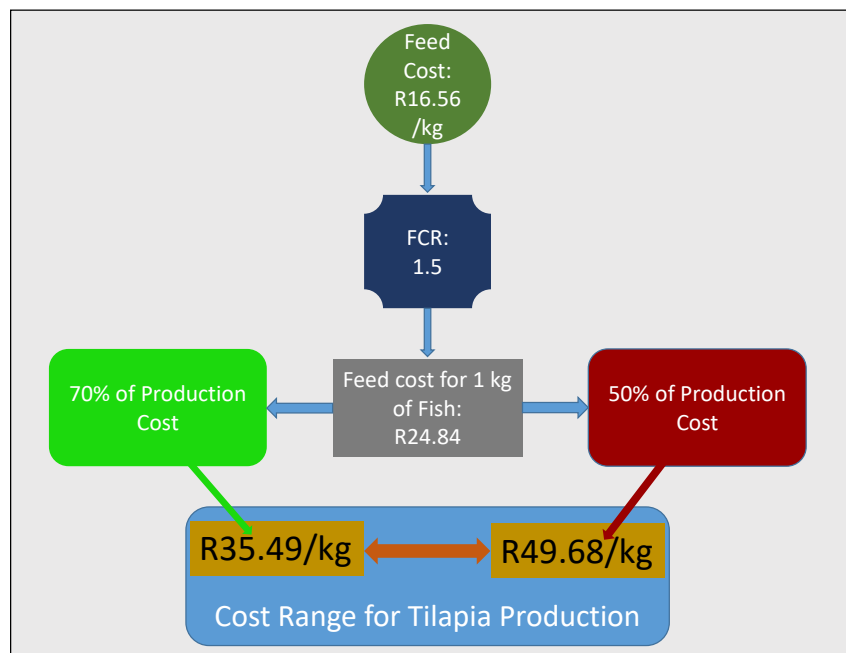


Figure 14-2: Imported Cost of Feed less Import Tariff Implications on Local Production



As can be seen in figures 14-1 and 14-2, the removal of the 20% tariff on imported feed would reduce the cost of receiving high-quality feed into South Africa below that of current locally produced low-quality feed (R15 for local vs. R14.69 for imported). This would entail a fall in the cost of producing 1kg of Tilapia from R32-R45 (at current local prices) to R29.34-R41.08 (at imported prices *less* 20% tariff). This then places the current offered Prices for Whole Tilapia (R25 to R38 per kg) within the same area, but not necessarily at a commercially viable level.

However, this intervention should be thoroughly investigated first so as to ensure that potential new local feed producers are not locked out of the market due to lower import prices.

14.4. Investing in Tilapia Feed Production and Research

Alternatively, potential for investing in local feed production should be considered. Given the mandate of the IDC to support government's objectives of growing a vibrant aquaculture sector, investing in feed production represents an indirect means of achieving this. Investment in feed production represents an investment in supporting infrastructure. The effect of supplying high-quality, well-priced feed will have the result of crowding in private investment in primary production. The result would potentially have a far greater impact on the local Tilapia industry for the investment size than if invested in a primary production facility.

Key to this intervention, however, would be the active involvement of producers, represented by TAASA, and research institutions such as Universities. A possible strategy would also be to invest in an established feed producer, to allow updated production equipment and/or recipes to be acquired.

Feed could potentially not only be produced for local Tilapia producers, but the possibility of exporting the high-quality feed to other countries in Africa may also exist. With South Africa's superior transport infrastructure and access to multiple African markets through its participation in trade agreements such as SACU and SADC, South African produced Tilapia feed could enter a niche market that imported feed from outside of Africa either could not penetrate or would prove too expensive to import for other African producers.

14.5. Summation of Recommendations

Table 12-1 below provides a summation of these four recommendations. It identifies the area of the interventions, the key stakeholders that should be engaged and the role of the IDC.

Table 12-1: Summation of Recommendations

Area	Key Stakeholder(s)	Recommended IDC Action
Communication and Co-operations	TAASA	Establish communication channels for regular information sharing
Feed Imports	ITAC/TAASA	Explore potential for removing import tariffs
Research/Demonstration	TAASA/Tertiary Institutions/Private Sector	Establish commercial scale demonstration project
Feed Production	TAASA/Tertiary Institutions/Private Sector Feed Producers	Investment in Tilapia and other fish feed production and research for local and export markets

15. References

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Annexure 1: Aquaculture Tables

Table 1: Aquaculture Production by Region in Quantity and Percentage of Total World Production

REGION		1970	1980	1990	2000	2010	2012
Africa	Tons	10 271	26 202	81 015	399 676	1 286 591	1 485 367
	Percentage	0.4	0.6	0.6	1.2	2.2	2.2
Americas	Tons	173 491	198 850	548 479	1 423 433	2 581 089	3 187 319
	Percentage	6.8	4.2	4.2	4.4	4.4	4.8
Asia	Tons	1 799 101	3 552 382	10 801 356	28 422 189	52 436 025	58 895 736
	Percentage	70.1	75.5	82.6	87.7	88.8	88.4
Europe	Tons	575 598	916 183	1 601 524	2 050 958	2 548 094	2 880 641
	Percentage	22.4	19.5	12.2	6.3	4.3	4.3
Oceania	Tons	8 421	12 224	42 005	121 482	185 617	184 191
	Percentage	0.3	0.3	0.3	0.4	0.3	0.3
World	Tons	2 566 882	4 705 841	13 074 379	32 417 738	59 037 416	66 633 253
	% Change	-	83.3	177.8	152.5	82.1	7.8

Source: FAO, 2012; FAO, 2014

Table 2: Top Ten Aquaculture Producers in Africa by Country in 2010

COUNTRY	TONS	PERCENTAGE
Egypt	919 587	71.38
Nigeria	200 535	15.57
Uganda	95 000	7.37
Kenya	12 154	0.94
Zambia	10 290	0.80
Ghana	10 200	0.79
Madagascar	6 886	0.53
Tunisia	5 424	0.42
Malawi	3 163	0.25
South Africa	3 133	0.24
Other	21 950	1.70
Total	1 288 320	100

Source: FAO, 2012

Table 3: South African Aquaculture Production

SECTOR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Abalone	181.03	372.88	429.42	462.02	509.2	670.8	833.36	783.25	1037.11	913.58	1 015.44	1 036.01
Finfish	1.04	0.3	2.38	14	1.81	1.68	0	0	2.71	22.75	0	7.99
Muscles	500	600	429.11	623	640	472	542	466	736.74	682.4	700.14	570.16
Oysters	247.01	187.53	272.1	255.24	147.66	174.91	279.87	157.86	226.62	223.53	276.57	269.34
Prawns	126.84	120.19	157.7	124.88	0	0	0	0	11.4	17.92	0	0
Seaweed	0	0	0	0	0	0	664	0	1 833.49	1 900.18	2 015.01	2 884.61
Tilapia	NO DATA						0	0	0	10	10	100
Trout							807	658	943	948.62	950	1 428
Salmon							0.1	0	0	0	0	0
Catfish							180	180	180	180	180	160
Malawi Cichlids							0.01	0.01	0.012	0.012	0.015	0.016
Koi Carp							493	518.8	514.2	515.6	520	572
Ornamentials							546	609	601	585.5	600	660
Marron							0.2	0.4	0.4	0.4	0.8	0.8
Carp							0.65	0.45	0.65	0.75	0.8	0.8
Total							1 055.92	1 280.90	1 290.71	1 479.14	1 298.67	1 319.39
Total (Marine)	1 055.92	1 280.90	1 290.71	1 479.14	1 298.67	1 319.39	2 319.23	1 407.11	3 848.07	3 760.36	4 007.16	4 768.11
Total (Fresh)	-	-	-	-	-	-	2 026.96	1 966.66	2 239.26	2 240.88	2 261.62	2 921.62
Total (FoodFish)	1 055.92	1 280.90	1 290.71	1 479.14	1 298.67	1 319.39	2 643.18	2 245.96	3 138.63	2 999.95	3 133.75	3 573.10
	Salt-Water Aquaculture			Fresh-Water Aquaculture								

Source: DAFF, 2012a

*Food Fish include: Abalone, Finfish, Muscles, Oysters, Prawns, Tilapia, Trout, Salmon, Catfish, Marron, and Carp

Annexure 2: Extract from NEMBA Regulations Published 1 August 2013

NO.	SPECIES	COMMON NAME	CATEGORY / AREA	SCOPE OF EXEMPTION FROM THE PROVISIONS OF SECTION 71(3) / PROHIBITION IN TERMS OF SECTION 71A(1)
11.	<i>Micropterus salmoides</i> (Lacépède, 1802)	Large-mouth bass	a. 2 in National Parks, Provincial Reserves, Mountain Catchment Areas and Forestry Reserves declared in terms of the Protected Areas Act. b. 3 in all rivers, wetlands, natural lakes and estuaries in which it occurs. c. 2 for conveying, moving or otherwise translocating a live specimen. d. Large-mouth bass is not listed for dams within discrete catchment systems in which it occurs (excluding (a) above).	a. The transfer or release of a specimen of large-mouth bass from one discrete catchment system in which it occurs, to another discrete catchment system in which it does not occur, or, from within a part of a discrete catchment system where it does occur to another part where it does not occur as a result of a natural or artificial barrier, is prohibited. b. The release of large-mouth bass in any rivers, wetlands, natural lakes or estuaries is prohibited. c. Large-mouth bass listed as category 2 are exempted for a period of two years from the date upon which this notice takes effect, from requiring a Permit for any restricted activity in terms of the Act or Alien and Invasive Species Regulations, 2014, provided a person is in possession of a valid Provincial Permit issued in terms of Provincial legislation where required for large-mouth bass. d. Catch and release of large-mouth bass is exempted in discrete catchment systems in which it occurs.
12.	<i>Oreochromis niloticus</i> (Linnaeus, 1758)	Nile tilapia	a. 1b in National Parks, Provincial Reserves, Mountain Catchment Areas and Forestry Reserves specified in terms of the Protected Areas Act. b. 2 for aquaculture facilities in the rest of the country. c. 3 in all other discrete catchment systems in which it occurs.	a. The transfer or release of a specimen of Nile tilapia from one discrete catchment system in which it occurs, to a river, wetland, natural lake or estuary, or a dam that is not an aquaculture facility, in another discrete catchment system in which it does not occur, or, from within a part of a discrete catchment system where it does occur to a river, wetland, natural lake or estuary, or a dam that is not an aquaculture facility, in another part where it does not occur as a result of a natural or artificial barrier, is prohibited. b. Release of Nile tilapia in National Parks, Provincial Reserves, Mountain Catchment Areas and Forestry Reserves declared in terms of the Protected Areas Act is prohibited. c. Catch and release of Nile tilapia is exempted in discrete catchment systems in which it occurs.
13.	<i>Perca fluviatilis</i> (Linnaeus, 1758)	Perch	a. 1b in National Parks, Provincial Reserves, Mountain Catchment Areas and Forestry Reserves declared in terms of the Protected Areas Act. b. 3 for all other discrete catchment systems in which it occurs.	a. The transfer or release of a specimen of perch from one discrete catchment system in which it occurs, to another discrete catchment system in which it does not occur, or, from within a part of a discrete catchment system where it does occur to another part where it does not occur as a result of a natural or artificial barrier, is prohibited. b. Catch and release of perch is exempted in discrete catchment systems in which it occurs.
14.	<i>Pterygoplichthys disjunctivus</i> (Weber, 1991)	Vermiculated sailfin catfish	a. 1b in National Parks, Provincial Reserves, Mountain Catchment Areas and Forestry Reserves declared in terms of the Protected Areas Act. b. 3 for all other discrete catchment systems in which it occurs.	a. The transfer or release of a specimen of vermiculated sailfin catfish from one discrete catchment system in which it occurs, to another discrete catchment system in which it does not occur, or, from within a part of a discrete catchment system where it does occur to another part where it does not occur as a result of a natural or artificial barrier, is prohibited. b. Catch and release of vermiculated sailfin catfish is exempted in discrete catchment systems in which it occurs.

4. Category 2 Listed Invasive Species

- (1) Category 2 Listed Invasive Species are those species listed by notice in terms of section 70(1)(a) of the Act as species which require a permit to carry out a restricted activity within an area specified in the Notice or an area specified in the permit, as the case may be.
- (2) Unless otherwise indicated in the Notice, no person may carry out a restricted activity in respect of a Category 2 Listed Invasive Species without a permit.
- (3) A landowner on whose land a Category 2 Listed Invasive Species occurs or person in possession of a permit, must ensure that the specimens of the species do not spread outside of the land or the area specified in the Notice or permit.
- (4) If an Invasive Species Management Programme has been developed in terms of section 75(4) of the Act, a person must control the listed invasive species in accordance with such programme.
- (5) Unless otherwise specified in the Notice, any species listed as a Category 2 Listed Invasive Species that occurs outside the specified area contemplated in sub-regulation (1), must, for purposes of these regulations, be considered to be a Category 1b Listed Invasive Species and must be managed according to Regulation 3.
- (6) Notwithstanding the specific exemptions relating to existing plantations in respect of Listed Invasive Plant Species published in *Government Gazette* No. 37886, Notice 599 of 1 August 2014 (as amended), any person or organ of state must ensure that the specimens of such Listed Invasive Plant Species do not spread outside of the land over which they have control.

Annexure 3: Tilapia Feed Import Tariff Schedule

Heading / Subheading		CD	Article Description	Statistical Unit	Rate of Duty			
					General	EU	EFTA	SADC
2308.00	1		Vegetable materials and vegetable waste, vegetable residues and by-products, whether or not in the form of pellets, of a kind used in animal feeding, not elsewhere specified or included	kg	free	free	free	free
23.09			Preparations of a kind used in animal feeding:					
2309.10		--	Dog or cat food, put up for retail sale:					
2309.10.10	7	---	Imported from Switzerland	kg	20%	free	2,6%	free
2309.10.90	5	---	Other	kg	20%	free	20%	free
2309.90		--	Other:					
2309.90.10	3	---	Sweetened forage	kg	free	free	free	free
2309.90.15	4	---	Preparations put up as crustacean food, preparations put up as salmon food	kg	free	free	free	free
2309.90.20	0	---	Feed supplements (excluding milk substitutes) containing added antibiotics	kg	free	free	free	free
2309.90.30	8	---	Feed supplements containing added melengestrol acetate	kg	free	free	free	free
2309.90.35	9	---	Feed supplements, containing, by mass, 40 per cent or more of oltoline chloride	kg	free	free	free	free
2309.90.40	5	---	Protein concentrates obtained from alfalfa juice (lucerne juice)	kg	free	free	free	free
2309.90.50	2	---	Calcium salts of palm fatty acid	kg	free	free	free	free
2309.90.60	4	---	Feed supplements containing furazolidone	kg	free	free	free	free
2309.90.65	0	---	Feed supplements, containing, by mass, 40 per cent or more lysine, whether or not containing added antibiotics or added melengestrol acetate	kg	free	free	free	free
2309.90.70	7	---	Single vitamins and their derivatives, stabilised with antioxidants or anti-caking agents	kg	free	free	free	free
2309.90.75	8	---	Preparations containing rocloperamine	kg	free	free	free	free
2309.90.77	4	---	Preparations containing by mass, 85 percent or more of methionine	kg	free	free	free	free
2309.90.90	4	---	Flash solubles	kg	20%	free	free	free
2309.90.9		---	Other:					
2309.90.91	3	---	Imported from Switzerland	kg	20%	free	2,6%	free
2309.90.92	3	---	Other	kg	20%	free	20%	free

Annexure 4: Growth of the USA Tilapia Market

At this point it is pertinent to consider how Tilapia consumption growth has occurred in other markets and use this as possible learning points for the South African case. Particularly, this report focuses on the growth of demand for Tilapia in the USA, as this is fairly well documented and the country is, like South Africa, a relatively open economy and thus changes in world prices and demand trends affect local consumption patterns.

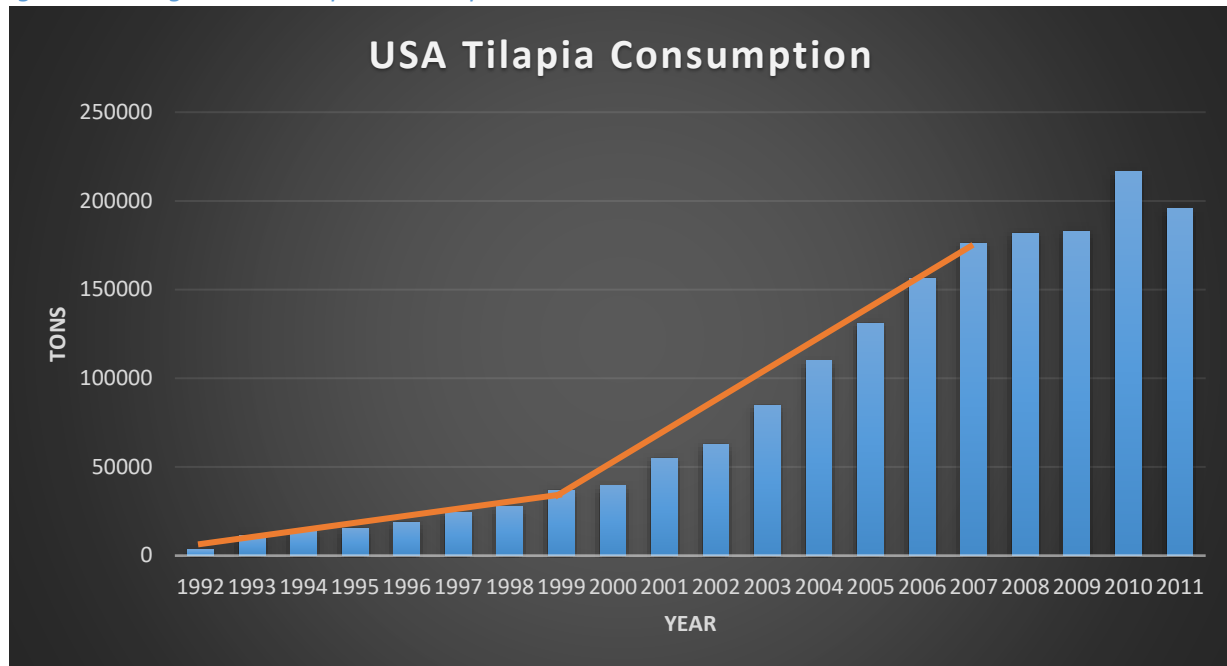
Prior to 1980, Tilapia was an almost unknown food fish in the USA. Tilapia was grown locally, but at a very small scale and sold in local Asian markets and to immigrants familiar with the fish (Fitzsimmons, 1999). It was only in 1992 that Tilapia began to be measured as a separate commodity, as the consumption of the fish slowly expanded among foreign internationals and locals who had been exposed to the fish through travels or from Asian markets and restaurants. However, in 1998 leading local and foreign producers grouped together to form the Tilapia Marketing Institute (TMI), with the goal of increasing awareness and demand for Tilapia products.

TMI had nine producer members and one member from the packaging industry. The TMI strategy was to position Tilapia by identifying its most favourable attributes and matching these to the needs of a target market. It accomplished this by working closely with food journalists to prepare informative stories reporting on Tilapia and its place in the seafood market. A series of strategic messages were developed to create a strong image of Tilapia with consumers. Several themes were then presented to the food press to reinforce and diversify the basic message about Tilapia.

TMI's generic campaign was designed to benefit all Tilapia producers and product forms. No differentiation was made between USA produced and imported Tilapia products. However, all producers were under pressure to ensure that only the highest quality products were offered to the market. With a generic campaign, all producers suffer if anyone should distribute poor quality fish (Fitzsimmons and Pantoja, 2003).

The positive impact of this initiative is clearly evident in the growth of Tilapia consumption in the USA, as illustrated in Figure 1.

Figure 1: Change in USA Tilapia Consumption over Time



Source: FAO, 2014d

As can be seen in Figure 1, growth in USA Tilapia consumption from 1992, when Tilapia began to be measured as a stand-alone consumption species, grew relatively slowly until 1999 after the formation of TMI in 1998¹². From 1999, Tilapia consumption growth rates increased dramatically relative to the prior period. Tilapia moved from a relatively unknown fish amongst American consumers in 1992 to the fourth most consumed fish in 2012 behind Shrimp, Canned Tuna and Salmon (About Seafood, 2014).

It is thus clear that the influence of the TMI was sufficient to impact on the consumption of Tilapia in the USA market and aided in the rapid growth in consumption of the species among common American consumers. The TMI was disbanded in 2007, having achieved its stated objectives of increasing awareness of Tilapia among American consumers. The possibility of establishing a similar entity in South Africa should be explored.

¹² It is reasonable to assume that it would have taken time for TMI to develop strategies and working competencies during 1998 for roll-out in late 1998/early 1999, thus only impacting on consumers in 1999.