Faculty of Biosciences, Fisheries and Economics
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Egypt's success and Africa's failure - how to explain different development trajectories in (tilapia) aquaculture

A case study of the (tilapia) aquaculture industry development in Africa

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A Master's thesis by:
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May, 2018
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Declaration:

I hereby declare that this thesis is my own production and that no part of it has been submitted anywhere else for any purpose. I furthermore declare that all cited works of others have been accordingly acknowledged and referenced.

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May 5, 2018

I hereby confirm that this thesis was supervised in accordance with the Master's thesis supervision guidelines of the UiT – The Arctic University of Norway, Faculty of Biosciences, Fisheries and Economics.

Professor Bjørn Hersoug

Supervisor

Dedication:

My beloved parents, Mrs Aisha Adam and Mr Abdulkarim Adam; and my dear brothers and sisters, I humbly dedicate to you this thesis, for your infinite love, support, and prayers.

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Abstract:

As various concerned scientists and organisations such as the UN, the World Bank, WFP, and FAO point out, global food security progressively turns out to be one of the major challenges that our human family faces nowadays. Among other factors, this is a function of rapid population growth, decreasing global food production due climate change. As they have always been an important traditional source of food fish, most of the conventional fisheries have either reached maximum output or are dwindling according to FAO (2016b). Thus, many, including FAO believe that the booming industry of fish farming plays an important role in meeting global fish needs (Cunningham 2005). Africa is among the regions FAO believe are most promising in terms of increasing global aquaculture production (FAO 2017c). Paradoxically, the continent is still the least productive area in the world, except one country – Egypt. While Egypt flies among the highest productive aquaculture nations, the rest of the continent fails to take-off despite the efforts of many international development countries who have for years invested to help the industry take-off. This case study investigated this mystery with the hope to find out the factors underpinning Egypt's success and Africa's failure. To do so, I studied the course of tilapia aquaculture (which constitutes 95% of continent's production) in Africa in a period of 25 years – from 1990 and 2015. Besides exploring FAO's databases for aquaculture production statics, I reviewed 19 literature pieces relevant to the state and the course of aquaculture in Africa. The analysis showed that limited alternative food sources; strong yet growing market demand; political will; effective administrative; and extension services were the key factors for Egypt's success as aquaculture producer. On the other hand, a plentiful supply of conventional fisheries; lack of political will; weak institutional foundations; and backfiring international donor initiated development aid appears to be the complex blocking the development of aquaculture industry in Africa. However, due to reliance on only second-hand data and simplifying judgements on such a large pool of countries, these conclusions should be taken with a pinch of salt. In its place, a closer, more explicit research is recommended in this concern.

Keywords: Aquaculture, Development, Africa, Egypt, Tilapia, International Development.

Table of Contents

List of Tables

List of Figures

List of Acronyms and Abbreviations

AHD – Aswan High Dam
BMZ – Germany's Federal Ministry for Economic Cooperation and Development
CIRAD – The French Agricultural Research Centre for International Development
CLAR – Central Laboratory for Aquaculture Research
DFID – The Department for International Development of UK
EFPEA – Egyptian Fish Producers and Exporters Association
FAO – Food and Agricultural Organization
GAFRD – General Authority for Fish Resource Development
GDP – Gross Domestic Product
GOVS – General Organisation for Veterinary Services
GTZ – The German Corporation for International Cooperation
IMF – The International Monetary Fund
MoWRI – Ministry of Water Resources and Irrigation
NGO – Non-Governmental Organization
NORAD – The Norwegian Agency for Development Cooperation
Ppt – Parts Per Trillion
SIDA – The Swedish International Development Cooperation Agency
UAC – Union of Aquatic Cooperatives
UN – United Nations
USA – United States of America
USAID – The United States Agency of International Development
US$ – United State Dollar

1 Chapter one: Introduction and study background

1.1 Introduction

Consistent with the United Nations' approximations, due to reasons such as improved healthcare and increased education levels, the current global population of 7.6 billion is projected to rise to 9.1 billion by 2050 – most of which (7.8 billion) is going to take place in developing countries (United Nations 2005). Moreover, in sub-Saharan Africa, predicts the population to soar from 856 million in 2010 to 2.7 billion people by 2050. The pressing question here is, therefore, how are we going to feed such a substantial number of people in the face of scarce, yet dwindling natural resources? To make matters worse, global challenges such as global warming, urbanisation, desertification, overfishing and poverty further exacerbate the situation. Together with the conventional agriculture, the seafood industry with its two branches, aquaculture and capture fisheries, is one of the key sources of global food security. In 2014, aquaculture and wild fisheries collectively produced slightly above 160 million tonnes. Yet, the industry still needs to keep pushing forward to satisfy an ever-increasing demand for seafood. Considering Africa, continent's share was insignificant. Out of the 90 million tonnes of global capture fisheries production, the entire region produced only 8 million tonnes. What is really concerning is that FAO (2016) believes most of the wild fisheries around the globe have either reached the maximum production limits or are declining. As a response, many argue that sustainable development of the aquaculture sector is the solution in order to keep up with future fish demands (FAO 2017a; Renner 2014).

Defined by FAO as "the farming of aquatic organisms, including fish, crustaceans, molluscs and aquatic plants", the origins of aquaculture are quite controversial. While some argue that it began in Africa, occurring in Egypt 2500 B.C., most historians say that it commenced in China some 3500 to 4000 B.C. (Stickney and Treece 2012). According to the latter theory, the art of rearing aquatic organisms is then spread across the globe as the Chinese migrants brought their carp farming tradition to Japan, India and Indonesia in the 1800s. Stickney and Treece claim, furthermore, that Romans and Hawaiians also contributed to popularising aquaculture by introducing carp farming to Greece, Italy and the United States. The success of artificial fertilisation of trout egg, was another milestone – but in the opposite direction. Trout was a favoured fish amongst the western monarchies and elites which lead to its industrialisation across Europe, and later eastwards to Asia and Africa as

well as southwards to the Americas (Stickney and Treece 2012). After this breakthrough, and due to rising popularity for leisure fishing in addition to reports of wild-stock overexploitation by the end of 18th century, both private and public sectors in Europe and USA started to investigate aquaculture potentials for commercial and restocking purposes (Ibid).

Moreover, modern tilapia farming is said to have been pioneered in Africa. In their book "History of Aquaculture" Stickney and Treece (2012), argue that the first tilapia culturing trial took place in 1924 in Kenya, then Congo in 1937 and Zambia in 1942. Thereafter, the technology which basically was "ponds" was introduced to China in 1930s and the USA in 1960s (Ibid). The enthusiasm continued to grow ever since, attracting more and more investors and scholars leading to the development of the activity into the science-based multidisciplinary industry that we have now. As technology develops and knowledge about aquaculture accumulates, people have come to realise the industry's potential of securing the human family a cheap but high quality source of protein. Costa-Pierce (2003), for instance, explains that besides nourishment, fish farming is also of great importance in terms of rural development, which is now evident from the number of people employed in all segments of the value chain across the world.

Presently, consistent with FAO's statistics, in 2015, 201 aquaculture nations worldwide altogether produced 106 million tonnes, 76.6 million tonnes of which was of animal origin while 29.4 million tonnes was of farmed aquatic plants (FAO 2017a). FAO's new publication further notes that consisting mainly of finfish, crustaceans, molluscs and some other animals, all production of animal origin (76.6 million tons) was supplied for human consumption. The report further shows records of 591 species currently being cultivated throughout the globe. Despite the increasing production volumes, however, the rate of growth of 5.9% at which the industry grew between 2001 and 2015 in global terms, is somewhat lower than what was recorded in the preceding decades.

With regard to Africa, similar to its performance in capture fisheries, the continent is again amongst the least productive regions in terms of aquaculture. In spite of the fact that many believe that Africa has an enormous potential for aquaculture, development of the sector has been a continuous failure amongst most of the African countries (Hishamunda 2007). In 2008, while 90% of world's aquaculture yield came from the developing world, Africa's share constituted only less than 2%, whereas Asia contributed nearly 90%. Nevertheless, some claim that this trend is taking a turn. Social factors such as a growing

population and resource scarcity, as well as economic drivers such as new markets, growing economies and urbanisation – together with increasing knowledge and development programs are stimulating the sector's growth. According to recent FAO statements, the average growth rate of the African aquaculture industry recording 10.4% was indeed nearly twice the global average of the aquaculture sector growth in 2015 (FAO 2017a). However, almost 82% of Africa's production came from Egypt (Beveridge et al. 2010). In fact, only 11 African nations produced above half a million tonnes annually between 1980s and late 1990s. Egypt remained the top contributor, accounting for more than half of the total aquaculture production of the continent (Brummett and Williams 2000; FAO 2016a). It is an unsolved mystery that despite the claimed favourable conditions of water resources; suitable land and climate; and decades long international development endeavours – the activity failed to take off in the continent, except for Egypt. Why is it so, is what I intend to find out here.

1.2 Study background

1.2.1 The geographical context of Egypt

Situated at the north-eastern angle of Africa, and bordering with Libya to the west, the Mediterranean to the north, Gaza Strip and Israel to the east, and Sudan to the south Egypt is the 30th largest country in the world on an area of 995,450 square kilometres (World Atlas 2017). Though the country is stereotyped, especially in the eyes of westerners as "the land of desert" – Egyptians themselves prefer better the biblical nuance of "the gift of the Nile" (Ibrahim and Ibrahim 2003: 8). Actually, many of the Egyptians do not even comprehend the connection with the desert (Ibrahim and Ibrahim 2003; Zahran and Willis 2009). The literature shows, nonetheless, that most of Egypt's land (95%) is either hyperarid or arid desert which is divided by the Nile into the Eastern and Western Deserts. According to the records, the desert has never received a drop of rain since 8000 to 4000 B.C. (Ibrahim and Ibrahim 2003; Zahran and Willis 2009). Consequently, water scarcity is a major issue, especially in the provinces far from the Nile. For instance, seasonal flows of orographic rainfalls of the Red Sea mountains running down the valleys, is the only source of water in the Eastern Desert. In terms of temperatures, there is large variation, from slightly below 10 °C to over 40 °C. In summer, the average temperature is around 30 °C and drops to an average of 10 °C in wither (Zahran and Willis 2009).

1.2.2 The demographic context of Egypt

Accommodating 98,5 million inhabitants at the density of 98 persons per square kilometre, Egypt is the 14th most populous state worldwide and 3rd in Africa (Worldometers 2018). Consistent with Paisley and Henshaw (2013), the country's vast population is living on only 1% of the republic's territories along the fertile banks of the Nile River. Furthermore, among the ten Nile River basin countries, and as its last destination country, Egypt is the country most reliant on the Nile, fetching approximately 95% of its water needs from the river (Paisley and Henshaw 2013). This is a clear sign of the nation's close ties with the Nile.

1.2.3 The evolution of aquaculture in Egypt

Although some state that aquaculture in Egypt dates back to the pharaonic era as mentioned above, it is not earlier than a few decades ago fish farming turned into a nationally significant industry. As El-Gayar (2003) demonstrates, despite the long tradition, it is not until the early 1990s aquaculture output exceeded 10% of Egypt's total fish production. El-Gayar attributes the breakthrough to the constant increase in fish demand, propelled by the population growth, boosted incomes, declining wild stocks, and widening export deficit. He says that this setting drew the attention of both the Egyptian government as well as development agencies, for example the United States Agency for International Development (USAID). Moreover, the situation meant a unique business opportunity attracting private investors too. The business sector became aware of the market opportunity, particularly, as a result of the price peak following the plummeting of sardine fisheries in the Nile Delta zone, says El-Gayar. Collectively, these interactions resulted in advancing the industry and as by 2000, the aquaculture production accounted for 45% of the total fish supply in Egypt (El-Gayar 2003). In 2014, Egypt's aquaculture production reached a new all-time record of 1.12 million tonnes (FAO 2016a).

1.3 Objectives of the study

In line with the Development Goals of the United Nations Organisation, several development agencies have tried hard to support Africa to develop its aquaculture. According to Beveridge et al. (2010), among others, the German Corporation for International Cooperation (GTZ), Germany's Federal Ministry for Economic Cooperation and Development (BMZ), USAID, the French Agricultural Research Centre for International Development (CIRAD), the Department for International Development of UK (DFID), the Swedish International Development Cooperation Agency (SIDA), and the Norwegian Agency for Development Cooperation (NORAD) have invested heavily in developing aquaculture in sub-Saharan Africa since the early 1980s, so far, without significant results. While the explanation behind the fiasco appears to be multifaceted, some of these organisations seems to blame it on African fish farmers' failure to adopt the new ways of production. Diffusion of aquaculture technologies in Africa was limited basically due to Africans' limited interest in the technologies (Cleaver 1993). Cleaver further attributes the disinclination to inadequate awareness of aquaculture science and technology amongst the African farmers deterring farmers' aptitude towards innovative farm inputs. Another issue is the mismatch between the cost of new technologies and the risks involved compared to the relatively low fish prices (Ibid). In other cases where there is an inclination towards the new modern ways of production, the market lacked supplies of the necessary technologies (Ibid). Attempting to overcome dilemma, the governments and the development organisations tried to increase innovation in the sector by imposing policies emphasising input distribution and subsidisation policies – but the approach again failed to address the problem (Cleaver 1993). Furthermore, Thomas (1994) argues that many of the development programmes try to intervene through importing western-developed technologies along with experts to patch up the information gaps. Nevertheless, the outcomes prove the inefficiency of this approach (Ibid). Others blame the miscarriage of the development efforts on unconducive local policies, such as ineffective aquaculture development schemes; lack of or too expensive bank loans; insufficient research and extension programmes; and absence of or faulty market information (Hishamunda 2007).

Egypt, however, managed to craft a different story. In 1978 several public farms were founded in Manzala, Zawia and Barsiqu with the aim of providing carp and tilapia fingerlings to the private sector (Suloma and Ogata 2006). This step was foundational sparking a progressive expansion of the sector upbringing Egypt into a major tilapia producer not only in Africa, but also globally (Ibid). Additionally, integrating fish farming, especially carps, with

rice-farming was another contributor of Egypt's aquaculture success, according to Suloma and Ogata (2006). They claim that, the technique was so well-liked as it was introduced in the 1970s that in 1995, 32% of the overall aquaculture output came from rice fields. Unlike in most of the African countries, Egyptians were more responsive to the modernisation of the fish farming activity as it is clear from Suloma and Ogata's (2006) example of the rapid success of the carp-rice integrated farming technique. Compared with the rest of the African countries, Egypt's authorities seem to be better at promoting innovative solutions. One clear example of this is Egypt's successful introduction of the semi-intensive tilapia farming system along with industrial fish feed in the 1970s, a stride that radically changed the Egyptian aquaculture industry (Suloma and Ogata 2006). Comparatively, aquaculture in sub-Saharan African countries was commonly extensive with no or very little use of formulated feed which, if found, was on-farm produced and of a very poor quality (Thomas 1994).

This thesis is a case study in which I attempt to study why the aquaculture industry flourishes in Egypt while it commonly fails to take-off in the rest of the African countries. In order to do so, I investigate the progression of the subsector of the most commonly cultured fish species in Africa, namely tilapia aquaculture which constitutes the most part of the continent's farmed fish production (FAO 2017d). More specifically, studying the course of the industry through a period of 25 years, this thesis tries to answer the following research questions:

I. What is the current status of the tilapia aquaculture in Africa and in Egypt?
II. What are the main drivers and constraints of tilapia aquaculture development in Africa and in Egypt?
III. Which institutional factors can explain the difference in aquaculture development in Egypt versus the rest of Africa?

1.4 Organisation of the Study

Chapter One bestows the general overview on fisheries and aquaculture status; aquaculture history; study background; objectives of the study and research questions; in addition to thesis's roadmap. Thereafter, chapter two features the study's theoretical framework. This section, moreover, discusses development strategies relevant to the perspective of this study. Then comes chapter three detailing the research methodology of the present thesis by systematically describing how the study is designed and carried out. It shows how the secondary research data are collected, analysed, together with how the results are organised and presented. The chapter also offers a brief account of the reviewed literature and how it fits the research questions. Additionally, issues concerning data reliability and validity are summarized in this chapter. The following chapter four, displays the findings of the study that are drawn upon in depth analysis of the relevant literature and databases. It exhibits the current state of tilapia aquaculture in Africa and in Egypt; the drivers and constraints of tilapia farming in Africa and in Egypt; as well as institutional factors explaining the different sector development trajectories in Africa and in Egypt. Finally, chapter five discusses the findings and concludes the thesis. Here, I reflect on the results, looking for patterns and evidences answering why aquaculture thrives in Egypt while it frequently miscarriages in most of the African countries. The chapter closes with a few conclusive remarks on the research problem as well as suggesting how Africa may realise its full aquaculture potential and avenues for future research.

2 Chapter two: theoretical framework

2.1 Introduction

As many scholars emphasise, rather than relying only on immediate data, conceptual frameworks are of importance when trying to scientifically explain a phenomenon. The enquiry why fish farming prospers in Egypt while it largely flops in the rest of Africa, is one such a phenomenon. In fact, for its complexity, perhaps more than one analytical background is necessary so as to appropriately grasp this problematic. In this chapter, I explore three of the common theories relevant to the issue of development. These three theories jointly form the analytical basis of the study at hand. First, I explain two development models, namely *the modernisation approach to development* and *the alternative development theory*. Next, I review the *institutional theory* illustrating the importance of institutions in development as well as the implications of bureaucracy in development processes. However, it should be noted that literature on these subjects is considerably abundant to be fully examined within the scope of this study. Consequently, this chapter is limited on presenting some bits and messages of the theories which are essential to articulate a solid analytical foundation for the present research.

2.2 Modernisation theory and development

Despite that *modernisation* as a term, which is also interchangeably referred to as *industrialisation,* might seem obvious at first glance, scholars have varying thoughts on how the word is to be defined. Its political-ideological origins, however, appears to be less dubious. The literature frequently suggests that the modernisation concept was fashioned in the United States as a new *capitalistic* paradigm and a substitute for *communism* during the era of the Cold War (Klinger 2017; Marsh 2014). According to Klinger (2017), a multidisciplinary group of scientists influenced by the repercussions of second World War saw that "modern" strategic guidelines were needed to guide United States' international policy – an attempt that disapproved the malfunctioning approach of forcible "nation-building" interventions. The new approach was titled "modernisation" and provided a framework and justification for a new strategy, promoting development-based policies. Though they criticised violent interventions, this group, however, argued that underdeveloped countries which they call "traditional societies" are in need of adopting new ways of thinking,

not only ideologically but also culturally (Ibid). The basic assumption behind the idea was that introducing a new philosophy with aggressive involvement was counterproductive, and in its place, peaceful interface between developed and the developing nations would lead to the development of those less developed countries.

The term has, nevertheless, different meanings to different groups. While some academics constrain modernisation merely as changes in technical tools and manoeuvres used in converting natural resources into manufactured items, others extend the notion to mean political transformation accompanied with organisational changes enabling internalisation of the technical changes (Klinger 2017). For both parties, modernisation ultimately aims at a nation-wide economic improvement. Klinger further asserts that even though modernisation simply strives for economic development, there are some key prerequisites so as to materialise the objectives of the framework. For instance, he argues that modernisation alone would not improve a society's welfare unless accompanied by democracy. He defends that, only democratically constructed authorities are able to device and conduct meaningful development schemes capable of incorporating innovative principles into their societies' progressive options. In line with this argument, Pye (1963) further emphasises the fundamental role of effective information sharing and communication in modernisation. What is more, Pye condensed the process of modernisation into two major points: changing the attitude of the nation and reducing the political-cultural gap between nations' leaders and their citizens. Moreover, as pointed out by Rostow (1959), in addition to representative governing regimes and effective communication – significant economic growth which is the key essence of modernisation, is still unattainable unless accompanied by adoption of more efficient production technologies. For example, considering the agricultural sector, modernisation would mean encouraging farmers to implement new highly productive crops and production techniques.

Generally speaking, modernisation as a mainstream development theory actually states that developing countries, or so-called "the third world", should follow in the footsteps of the well-developed western world through implementing their political ideas as well as industrial technologies that would (hopefully) cause these countries also to build industrial economies instead of subsistence economies (Klinger 2017; Rostow 1959). Accordingly, the approach underscores that traditional reliance on agriculture, lack of industrial innovation, employment of outdated production regimes, and low levels of education, are usually some of the shortcomings keeping developing countries behind. This is what Rostow calls "primitive

societies" relying on subsistence farming and basic trade. According to Rostow, in order to induce economic transformation in such a society, four clear stages must be undertaken. First, there must be specialised expertise so as to craft efficient production strategies to bring surplus agricultural production. Second, advancement of trade channels as well as building effective support systems e.g. production related and transportation infrastructure - which Rostow denotes as "preparation for take-off". The aim of these two stages is promoting business-principles such as increased physical production, money saving and investment projects. At the third stage, Rostow underlines that economic diversification should embark and the society must be encouraged to develop new sectors, especially, manufacturing industries – a step known as "take-off". When the materialistic production economy takes off, the task is then to maintain the growth and the society should gradually become self-sufficient and imports are limited – a period Rostow indicates as "maturation phase". Finally, the society reaches a point at which, even though the service sectors will start to dominate, the diversified goods-production oriented economy makes it possible for the people to consume high quantities of goods. And this stage is referred to as "mass consumption period" (Rostow 1959).

In comparison to various parts of the world, Africa embraced the ideas of the modernisation theory. Though Rostow's hypothesis transformed Europe and the United States of America into thriving economies, the paradigm was unsuccessful in other regions of the world, including Africa. Matunhu (2011) proclaims that, the modernisation scheme has been repeatedly presented to Africa. Earlier by the colonials, and in association with series of developmental aid programmes during the recent decades. It is believed that the modernisation framework brought to Africa technologies such as green houses, genetically modified crops that would presumably enhance crop yield, industrial fertilisers, pesticides, machineries and scientific knowledge in place of traditional farming methods (Matunhu 2011). Matunhu claims, however, that despite the continent's large deposits of natural resources, the framework failed to bring Africa the economic prosperity that many dreamed would lift the millions of impoverished Africans out of poverty. The philosophy was simply not appreciated (Ibid). While Matunhu seems to blame it on not implementing modernisation, other scholars claim that destructive political and civil conflicts, harsh epidemic diseases and natural disasters as some of the major dynamics prohibiting most of the African countries from turning into modern states. In line with Matunhu's argument, others such as Pieterse (1998) highlight that it is part of the human beings' natural behaviour to resist change –

especially a change that is being imposed forcibly. Matunhu further explains his point saying that modernisation model's exclusive focus on profit-generating practices to achieve economic is its major weakness. Moreover, from Matunhu's point of view, there is a widely shared scepticism amongst African nations towards foreign development initiatives and to what extent these initiatives could really make a difference. Some of the concerns raised by the African nations are that the targeted countries are themselves not involved in the development of these packages which are typically designed and shipped from western countries with a perception that they would work equally well. In Africa, in addition, there is a concern that international development interventions place no value on local factors such as local beliefs and value systems; local cultures; traditions and local knowledge – factors that play an essential role in the lives of the African and are in fact some of the issues underpinning the failure of the model (Matunhu 2011). The *one size fits all* propensity is not only incompatible, but it draws mistrust in the recipient societies that are left with a feeling that there are perhaps some imperialistic policies implied in these modern mainstream development strategies (Matunhu 2011; Tagarirofa 2017). According to Cardoso (1972) and Tagarirofa (2017), the introduction of modernisation concept into countries of the global South was in fact perceived as more of a threat than as an opportunity. In India for example, in spite of some positive contribution in boosting economic growth, the concept was later heavily criticised for its environmental and social pitfalls that overshadowed the welfare gains (Tagarirofa 2017). The main idea behind Tagarirofa's (2017) understanding is that, the benefits of implementing modernisation framework tactics of economic progress were reaped by few elite Indians while , on the other hand, the ecological and societal drawbacks were to be shared by the society as a whole. In the same manner, Castles (2001) outlines that the modernisation model based, poorly designed development interventions were predestined to equal blunder in Latin America too.

To sum up, regardless of these critical points of views, it would be wrong to completely denounce modernisation as unquestionably unfit as development strategy for the developing world. After all, there are some living examples of success. The United States supported liberalisation of Japan, South Korea and Taiwan from the clenches of poverty into key economies, advocates for the significance of international support in inspiring economic development (Castles 2001). Consistent with those who argue that this mainstream-theory of modernisation approach to development is on its way out, structural reform of the framework is needed, if the model is yet to be applied anywhere in the South. Local, self-governance

councils of the targeted communities as well as official authorities must partake in the design as well as the execution of any development programme as Cardoso (1972) advocates. Moreover, in line with Castles' (2001) suggestions, comprehensive socio-economic analysis of the targeted society, prior to and throughout the development projects is necessary so as to understand the aspirations and priorities of the country and community in question and not least to reflect these desires in these projects. Afterwards, it must be made sure that the development initiatives are arranged in accordance with the scientific findings of the socioeconomic analysis and the indigenous values in order to ensure greater societal acceptance of the development efforts (Castles 2001).

Some other thinkers such as Munck (1998), take the criticism of the modernisation concept a step forward arguing that the industrialist paradigm should be replaced altogether with one that puts human-capacity building and welfare at its heart – a paradigm that they call *alternative development.*

2.3 Alternative development theory

After having facilitated the global North into industrialisation and tremendous economic growth, by 1970s, the course of modernisation inflicted three inflexible inconsistencies: purely market-oriented economy or a nurturing society welfare; unquestioned economic growth advantages versus self-preservation; and continual financial growth as opposed to environmental sustainability (Sheth 1987). These contradictions contributed to the growing pessimism amongst the developing nations towards the globally renowned industrialisation movement that is illustrated in the preceding section. Fundamental criticism gradually spread amongst intellectuals across Latin America, Asia and Africa resulting in multiple proposals. In Latin America, the notion of "dependency theory" surfaced, arguing that through modernisation Western countries try to trap the so-called "Third World" countries into the global economic order that merely benefits the well-off, while the former descends further into dismay (Munck 1999; Sheth 1987). In Africa, the "centre-periphery" argument resonated propagating a notion that the international economy is structured in a way that enables the world's economic hubs "the centre" to apprehend critical economic resources of their subordinated underdeveloped countries "the periphery" (Raagmaa 2003; Sheth 1987). Similarly, a series of concepts were developed in Asia trying to address the poverty issue of

the region (Sheth 1987). These rebellious opinions from the "Third World" challenging what they perceived as an undesired style of development, collectively resulted in what is recognised as *alternative development theory* as Sheth (1987) highlights.

In order to coherently grasp the impression of *alternative development,* the concept is usually contrasted with *modernisation* (Munck 1999). Though both strategies claim to strive for growth, the modernisation approach is chiefly concerned with enlarging national GDPs, while the alternative model to development is perceived to be oriented around the development of a community at local level (Pieterse 1998). Though Pieterse and his peers try to simplify the idea of alternative development, intellectuals nonetheless failed to settle on a single clear definition of the term. For example, for Munck (1998) alternative development philosophy reflects a socialist viewpoint that indorses social transformative development plans instead of the mainstream national development solutions. The main idea behind Munck's statement is to abandon blind integration with the global economic system and instead implement policies that allow less dependency on international linkages. Munck further claims that the alternative model aims also to fostering bottom-up or "participatory development" which advocates for comprehensive development that causes self-reliant local oriented economies. This critical notion is arguably the main reasoning behind the tendency to label the new paradigm as "anti-modernist" and "anti-capitalist" (Munck 1999; Pieterse 1998). In short, the alternative development model replaces the capitalistic practices of modernisation previously held as the objectives of any development plan with new exercises, namely increased community participation in development decision making and the overall wellbeing of a society.

However, others disclaim the existence of such a thing as alternative development maintaining that the distinction between *alternative* and the orthodox *post-war development* paradigms is more of a rhetorical proposition than a justified difference (Pieterse 1998). This is perhaps due to the fact that some of the alternative development model advocates do not absolutely refute some of the fundamentals of the modernisation model (Sheth 1987). As Sheth puts it, the only principal difference between the two schemes is in how they approach the issue of development. According to Sheth, while the modernisation framework emphasises market efficiency, excessive production of goods and the improvement of communication and transportation systems – the alternative development model emphasises human empowerment. Moreover, Korten (1990), identifies alternative development with "sustainable development" which implies both environmental sustainability and sustainable

human development. In other words, seen from this perspective, good development approaches would inherently protect ecosystems, limit unwise improvident exploitation of natural resources along with equally strong systems to promote human development. In spite of supporting ideas such as democracy, self-governance[1], and the importance of human development – the alternative development model attracted further criticism. Its critiques blame it for the failure to provide a constructive criticism of the post-war's modernisation framework, and merely questioning how unworkable and undesired the foregoing theory was (Sheth 1987). From Sheth's point of view, the new philosophy lacks an operational blueprint.

So, what is alternative development now? According to (Korten 1990: 1), the most generalisable definition of alternative development is "An alternative people-centred development vision, articulated and promoted primarily by voluntary organisations (VOs) emphasises human well-being, stewardship of environmental resources, local self-reliance in basic needs, development of domestic markets, broadly based political and economic participation, local control of environmental resources, and strong participatory local government". This description conveys multiple development factors, but the people-centeredness and the involvement of nongovernmental organisation*s* are recurrently associated with this approach as Pieterse (1998) asserts. There is little doubt that human development in terms of individual's intellectual and professional competences is directly proportional to the quality of life one is destined to lead. At a larger scale, it is also the case that the socioeconomic wellbeing of a society at large is in turn contingent to the collective intellectual and professional level of its members. This "human capacity building" viewpoint is confirmed with what Amartya Sen (1999) argues in his much celebrated publication *Development as Freedom.* In light of Sen's thinking, development should empower the people in a way that would consequently expand the range of choices (or freedom) available for them to lead meaningful and blossoming lives. In this sense, and consistent with Fukuda-Parr (2011), human-centred development can be seen as a snowball effect where improved wellbeing of people will eventually produce a better standing and more resilient society. Franzel (1999) further emphasises the role of human empowerment when he discusses factors affecting the potential of adopting new technologies and practices. Among the three

[1] Governance is a slippery term with many meanings (at least six). Here, I refer to governance as *good governance* which includes the distribution and practice of political and economic powers in a society in a way that ensures transparent management of nation's affairs consistent with laws and regulations that maintain justice and human rights – adopted from (Rhodes, 1996).

socioeconomic influences Franzel pictures, two of them, namely the *technical feasibility and acceptability of an innovation* are fundamentally attributed to the intellectual and cosmopolitan levels of the people. The third factor he says affects the acceptance of a new technology is the *economic profitability* of implementing it. Technical feasibility concerns with whether an individual is capable of managing and operating the new technology or the new way of conducting the business. In other words, do fish farmers, for instance, have the necessary knowledge about the proposed new way or technology of growing fish or the required managerial skills to establish and run a fish farm. Acceptability is about whether the farmers, in this case, are willing to practice the new routine and/ or new equipment. From Franzel's point of view, there are an array of conditions that determine the acceptability. These include, perception of risk involved with the new way of life or doing business; the suitability to the role of the target group (for example females or males in a society); the cultural suitability and acceptance; and to what degree it is fitting within the pre-existing operations. As it emerged out of frustration with the mainstream "Western" modernisation approach, alternative development mantra tried to associate itself with nongovernmental voluntary organisations (Korten 1990; Pieterse 1998). Today, this approach seems to be widely appreciated within the development community. This is clear from the position of and the role development organisations, including NGOs, play in promoting enhanced human wellbeing worldwide (Pieterse 1998). According to Pieterse, in recognition to the significance of NGOs and their closeness to beneficiaries on the ground, monetary assistance to developing countries by the international donors that was traditionally channelled through the International Monetary Fund (IMF), the World Bank and the national governments, is nowadays increasingly delivered through local and international NGOs. This shift marks the dissatisfaction of the donors of the shortcomings of the previous approach and a hope to reduce the gap between donor and end beneficiaries and thus increase the efficiency of the aid (Ibid).

To summarise, opposite to the modernisation model, alternative development is a *bottom-up* development process in which "bottom" denotes the *community* whereas "up" denotes the top i.e. a government as well as national and international NGOs. However, it must be noted that alternative development is in no way limited to what NGOs do, but they are key players. The word "alternative" used here does not necessarily stands for alternative to the usual discourse of development, but also alternative to government and market-oriented approaches. The key point in this development discourse is the development of the people and

enhancing society's welfare through participatory, endogenous communities and self-reliance strengthening practices. It is also worth mentioning that alternative development has been absorbed into the conventional development discourse. Hence the two paradigms are increasingly less distinguishable as Pieterse (1998) indicates. In this sense, it is argued that the alternative development approach has failed to acquire a distinctive theoretical position.

Yet, even if an industry, fisheries sector for instance, or a society at large is on the "right" track and is intellectually well-standing with plentiful number of skilled labour, it is still incapable of further growth survival unless it has functional institutions – as suggested by Hersoug et. al (2004).

2.4 Institutional theory and development

As discussed in the second section of this chapter, billions of dollars and limitless hours of advice and consultations have been paid to the developing world, including Africa, whether through aid conduits or direct investments. Notwithstanding, most of these countries still lag behind unable to substantiate viable economic growth and social improvement. The literature trying to answer the *why* is obviously rich. Generally, some of the scholars attempt to correlate it with backfiring external interventions, generally conveyed under what is known as *modernisation* or "industrialisation" path. Inherent to its paradigm, this strategy neglected the significance of the human capital. Others try to relate the fiasco to issues related to the recipient countries such as investment limitations; weak technological innovation and research; and low levels of education. However, as discussed by Menard and Shirley (2005), multiple studies on African countries, link continent's modest economic wealth to "institutional variables". Menard and Shirley outline that there are two discrete arrangements of institutions that are indispensable to any sensible seriocomic improvement. The first group consists of institutions that are oriented towards promoting trust and communication amongst the concerned partners whereas the second group comprises institutions that are intended to run the state and other influential actors to uphold order in a society e.g. private property and individual's rights. Consistently, it is commonly held that when things don't seem to go right, for instance the problem of the research at hand i.e. maldevelopment of aquaculture in Africa, institutions governing the system in question are what we need to invoke (Hersoug et al. 2004). The main idea underpinning this argument is that the institutions are sometimes where

the problem lies, either they are dysfunctional and in need of reform or that they are non-existent and new ones must be established. In this sense, institutions are double-faced. They are sometimes the solution, and in other times they are the problem.

But, before diving any deeper into the functionalities of institutions, *what are institutions?* This is a question that many have dealt with and as Hersoug et al. (2004) point out, the concept of institutions may mean different things to different groups of people, including amongst the different scholastic disciplines. According to Scott (1995), this old concept of institutions which has been discussed since early 19th century, evolved into a theory during the intellectual revolution of mid 1960s which brought about theories of *open systems* into the conception of organisations. Within the realm of institutional economics where the concept is believed to be initially conceived, some institutionalists such as Thorstein Veblen envisioned institutions as *established habits of thought commonly shared by a group of people* (Scott 1995). For John Commons the term meant "rules of conduct" which suggest restrictions according to which individuals and corporations are ought to conduct themselves (Ibid: 3). The concept has received even more attention in the field of sociology, by both political scientists and economists. Consistent with what Scott (1995: 8) outlines, some scientists describe an institution as "a habit of mind and of action, largely unconscious because they are largely common to all the group". He further cites that institutions in a society are incrementally fashioned by human beings which themselves are the product of the same institutions. Discussing institutions in terms of economic practices, North (1991) conforms this reasoning by explaining that people establish institutions to create order and minimise uncertainty in trade and then are governed by the instructions of these establishments. The main idea in North's understanding is that along with standard economic constraints, institutions strive to outline a set of choices available for the traders and henceforth determine economic aspects e.g. feasibility, cost of production and profitability – all of which determine one's choices of partaking in an economic activity. Offering a rather broader definition compared with the postulations cited above, North sees institutions as manmade informal constraints such as sanctions, customs, taboos and codes of conduct as well as formal systems e.g. legal regulations, constitutions and laws that shape political, social and economic interactions between people.

Within the realm of fisheries, which encompasses both wild and farmed resources, even more robust outlook of the "institutions" concept is need so as to address the sectors' complex socioeconomic and natural systems. In their book *Fisheries Development: The*

Institutional Challenge, Hersoug et al. (2004) respond to this problem by broadening the concept of institutions into a more relaxed connotation that comprehends the socioeconomic aspects of the complex systems of fisheries. They state that the classical definitions such as those of North and Veblen at best only partially overlap or in fact denote completely different things. As they describe it, institutions in fisheries are so diverse that they range from as small as families to a government. In between there are fishery and fishery related companies; markets; communities; social networks; nongovernmental organisations; research organisations; public administrative organisations; and law-making entities – all of which are considered institutions. Despite the diversity of entities this concept embodies, institutions unanimously share one primary feature, namely the underpinning moral bond between an institution and its members (Hersoug et al. 2004). Once a person signs up for an institution, be it through joining an existing one or forming a new one, it becomes nearly impossible for the individual to act outside of what the institution permits. In this way, institutions exert supreme control on how a person's life evolves and indeed eventually affect the overall developmental discourse of the society in question.

Clearly, people have dissimilar viewpoints on what institutions are, but there are two undisputable facts about institutions – namely, their endurance and importance for structure and operation of fisheries as for almost every other sector. As discussed earlier in the present section, well-functioning institutions are crucial in order to attain fruitful developmental outcomes. According to Hersoug et al. (2004), insistent miscarriage of the developmental aid programmes between 1960s and 1970s raised investigations which also associated the failure to lack of institutional capacity in the receiver countries. Consequently, it became a standard by the World Bank to demand the receiver countries to certify their institutional capability to safely planning and running development programmes in order to qualify for financial support. In the fisheries sector too, building administrative competence became an essential part of fisheries development assistance packages (Hersoug et al. 2004). The importance of institutions for fisheries stems from the fact that, in a regulatory sense, the sustainability of fishery systems is simply inconceivable in the absence of institutions. Similar to what is the case in other socioeconomic complexes, Hersoug et al. (2004) explain that institutions are there to inform the role of different fishery users and instruct how each actor should behave towards other constituents of the system. In other words, it is institutions' function to enable fishers and other members of the value chain to exercise their activities, be it fishing, fish processing, marketing, fish consumption, coaching newcomers, and the survival of their

families (Ibid). Simply put, institutions are there for safeguarding the fishing communities. Furthermore, fishery institutions offer operational functions such as fisheries organisation; intercommunication; stakeholder[2] representation; negotiations; fisheries leadership and management; as well fisheries research and development (Ibid). Ironically though, there seem to be no explicit universal understanding on what *institution building* really is (Hersoug et al. 2004). Hersoug and his colleagues state that along with terminologies such as *capacity building, civil service reform, organisational development* that are frequently employed in the domain of fisheries development, *institutional building* is another vague term. As they see it, however, *institutional building* would be rightly concerned with a range of activities that deal with multiple segments of a fishery system. For example, while activities e.g. *training and education* would more appropriately be associated with *people* and *organisational development, institutional building* would be seen as *structural reforms* aiming to bring positive change to a fishery system. Not surprisingly, neither straightforward goals of the developmental interventions, nor clear-cut target groups are usually known for such developmental interventions (Ibid). To make things worse, project evaluation mechanisms to check the outcomes of these actions are also lacking (Ibid).

Fortunately, many begin to realise the necessity to focus on the institutional aspects when dealing with the issue of development. This evident when we look at the large and more than a decade long development project carried out the Directorate General for Development Cooperation of the Netherlands Ministry for Foreign Affairs in Western Africa (Röling 2016). According to Röling, the project was solely focussed on disseminating the ideas of how institutions are generated, transformed, or reinvented to promote innovations in the agricultural sector (Röling 2016). Such a large international funded development venture dedicated to developing institutions rather than what was earlier known of such projects to directly invest in creating businesses, indicates two points. The acknowledgment of the donor community of the importance of institutions and a shift from the "old" mainstream *industrialisation* approach to development (Ibid). As Djurfeldt et al. (2005) draw attention to, despite being the backbone of food security in the majority of African countries, region's food sector, especially smallholder farmers have experienced pervasive neglect. This point is

[2] Within the context of fisheries, stakeholders could generally be defined as any group or individual related to a fishery and who can directly or indirectly affect or be affected in realisation of fishery's objectives – adopted from (Mikalsen and Jentoft, 2001).

confirmed by what Röling found out. Historically, robust institutions were a central feature behind the successful agricultural revolution that followed the World War II, as Röling argues. The West's solid institutional foundation as well as high education enabled the region effective introduction and rapid diffusion of new production techniques. The *treadmill* and *hybrid maize* as well as implementing fruitful research and extension services were some these technologies (Ibid). These innovations not only helped Europe and the USA to feed their citizens, but they revolutionised agriculture into the modern business that it is today (Ibid). However, there is a paradox contingent on this perceptive. On one hand there is a common believe that research, extension, policy reforms and direct capital investments in the form of enhanced technologies would lead to increased yields and subsequently higher returns. On the other hand, these services and machineries require considerable amounts of finances to initiate research and buy production inputs. Since such resources are in the first lacking in the developing countries, or are concentrated in the hands of the few, development and prosperity in a society is either imbalanced or is hard to spark (Röling 2016). In such desperate circumstances, people are simply too busy of day-to-day survival and the noble hopes of institutional development are thus abandoned (Ibid).

Imperatively, mere existence of institutions in itself is not a recipe for success – some institutional qualities must be ensured. One of these qualities is *institutional design*. According to Jentoft (2000), meaning how power is shared within an institution, how decisions are made and not least how its members communicate, a healthy design is a prerequisite for an institution to deliver on its goals. *Legitimacy* is second precondition for institutions' endurance. Though Jentoft discusses *legitimacy* within the context of fisheries management, the essence of his argumentation is equally applicable to the broader theme of institutions. He maintains that, for instance, when fishers experience a regulatory regime not to be in their favour, that would certainly invoke collective frustration that will either cause them to leave the institution (exit response) or protest against the system (voice response). In the former, fishery participants would express their dissatisfaction through deliberately disobeying rules produced by the unfair-stamped system. However, the latter strategy is also likely. Since disobedience is punishable, organised demonstrations through media and other forums are likely. Both tactics lead to risks. Whilst violating the system is punishable by laws, opting to voice the discontent would possibly trigger public condemnations and criticism. Therefore, Jentoft underlines the importance of institutions that embrace democratic values such as free speech that allows alternative views to surface – which is crucial to the survival

of the societal systems. The third quality, *communication*, implies that institutions must foster effective two-way communication at all levels (Jentoft 2000).

To conclude, this chapter briefly exhibits the evolution of the contemporary discourse of the issue of development, with emphasise on the "Third World". It gives an account of the longstanding *industrialisation (or modernisation)* approach to development as opposed to the emerging model of *alternative development*. While the former seeks increasing the Gross Domestic Productions (GDPs) of the nations, the latter advocates rather soft qualities such as autonomy, education, and the welfare of societies. Thereafter, the chapter deals with institutions. Institutions are sets of guidelines and social codes that control the dealings of the members of a society and ultimately securing the society's existence. The chapter stresses the importance of democracy and effective communication within the institutions. These three philosophies; *modernisation, alternative development,* and *institutional theories,* are the three pillars jointly constituting the analytical backdrop of this study.

The bottom line is that, while they have mainly been generated by Western agencies, development initiatives to Africa and other developing regions, were recurrently based on the industrialisation scheme. This is criticised by many for its circumvention of the beneficiaries in developing and executing these initiatives, and for focussing only on economic growth. These opponents suggest alternative development instead, calling for developing the human capital. The latter is itself criticised for not providing explicitly enough a true alternative way of thinking. However, many scholars, particularly within the realm of fisheries, underline that democratic institutions must be in place so as to transform a society or bring development irrespective to whichever development model, be it modernisation or alternative development, is employed. Thus, all stakeholders in a developmental endeavour, including the target groups, must be actively included in all stages of the developmental projects. In this way, development partners and project beneficiaries would better appreciate those institutions which they themselves created. This way will establish even stronger moral ties of all parties to the causes of development which would ultimately result in enhanced compliance and greater of development success.

3 Chapter three: Study Strategy, Methods and Materials

3.1 Introduction

Through examining the development of the African tilapia aquaculture industry, the objective of this thesis is understanding what might be the factors instigating the two, clearly divergent paths of the development of the industry in the region. In other words, I try to find out what is behind the successful story represented by Egypt and the failure shared by nearly all the other nations of the continent. In this chapter, I briefly present the research methods I employed as well as a concise justification of my choice of the study strategy. Furthermore, the chapter details the scientific process of conducting the study, including data collection; data reliability and validity concerns; data analysis techniques; and the limitations of the study.

Endeavouring to explore, understand and interpret a phenomenon – a researcher would perhaps embark the expedition with no more than her/ his urging queries and imaginations. Thanks to well-developed and widely agreed upon research strategies, scientists are able to examine their ideas and study objects with satisfactorily reproducible[3] or replicable[4] results, according to the norms of their respective disciplines. It is worth stating that, different research approaches require equally unalike sets of skills and research practices. Therefore, although it generally depends on the aims of the study, which methodology one employs will inevitably impact the study structure as well as the outcomes. However, as any other project, research is also subject to resources constraints which implies that researcher's choice of methods and approach is also restricted by the financial resources and time available to the project. This thesis is a case study that is, though chiefly based on qualitative data analysis, also engages a bit of quantitative analysis in order to describe the statistical aspects of the fish farming industry in Africa.

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[3] Reproducibility refers to to what extent the results of experiments executed by different searchers, at different locations, with different instruments are agreeable. Put simply, it measures the degree of ability to obtain the findings of others (Casadevall and Fang, 2010).

[4] Replicability refers to being able to replicate a procedure or capability of repeatedly getting identical results under identical conditions (Casadevall and Fang, 2010).

3.2 Case study strategy

While classifying them hierarchically is controversial, five ways to do scientific research are recognised. They include, *experiments*, *surveys*, *histories*, *archival analysis* and *case studies* (Yin 1994). Case study, is the method applied in the investigation at hand. The phrase, *case study,* has multiple definitions. To Yin (1994: 23), for instance, case study is "empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used". To Schramm, a case study is a process wherein one "… tries to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what result". Both definitions work for this study. In his book *Case Study Research: Design and Methods*, Yin isolates three conditions for choosing a research strategy: 1) the type of research question, 2) investigator's control over the behavioural events, and 3) whither the study is dealing with a historical or contemporary phenomenon. Even though this paper does not intend to pursue all these research strategies, it is worth mentioning some basics of the uses of the different approaches. According to Yin (1994), regarding research questions, whereas *surveys* and *archival analysis* are both appropriate when addressing "who, what, where, how many and how much" queries, *experiments*, *histories* and *case study* analysis are preferred when answering "how and why" questions. Case study methodology, however, stands out in three ways. One, is in their suitability when studying phenomena where behavioural factors cannot be manipulated (Ibid). Then, most importantly, like the experimental approach, case studies help obtain results that are not applicable to the population being studied, but are rather theoretically generalisable (Yin 1994). These two points make the case study approach a suitable choice for exploring the contrary development trajectories of the African aquaculture. What is more, my research problem also requires exploring both qualitative and quantitative data. This is the second argument to pick the case study approach as it perfectly allows to combine the two types of analyses compared with the other four strategies.

Nonetheless, whether it is a *single* or *multiple* [5]case study, or categorised as *exploratory*, *descriptive* or *explanatory* case study – case studies are not free of critique (Yin 1994). There are basically three drawbacks for the approach as Zainal (2007) illustrates.

[5] Single case study is a design that focuses on one problem at the time whereas a multiple case study design deals with more than one research problem simultaneously (Yin 1994)

Zainal points out that, case studies are blamed for being less rigorous. That is to say that there is a tendency amongst the researchers using this approach to subjectively influence their findings and conclusions either by allowing ambiguous substantiations or biased interpretations. Secondly, the strategy is criticised for its generalisation tendency, especially when the scientific foundation is insufficient (Campbell 1975; Zainal 2007). Lastly, the case study outcomes are thought to be problematic to present in writing and that they usually generate huge amounts of documents (Yin 1994; Zainal 2007).

3.3 Qualitative research

The primary analyses methodology of the present thesis, namely qualitative investigation, has emerged and developed into a separate style of social science in the 1960s as a measure to overcome the limitations of the conventional methodology of quantitative scheme (Hammersley 2013). Ever since, it has received wide appreciation within the realm of social science applied to investigate themes such as anthropology, social psychology and political science (Ibid). The vast literature on qualitative research holds diverse opinions on how to define the phrase. For example, Bryman (2008) sees qualitative research as a research practice that is usually concerned with *words* instead of *numbers* in processes of data collection and analysis. A more comprehensive connotation is suggested by Sandelowski (2004) when he understands the idiom as an umbrella expression covering a range of procedures of conducting scientific analyses. Studying how people experience, understand, interpret, and produce a social ecosystem, demonstrates Sandelowski's opinion. Moreover, according to Walliman (2006), qualitative study is particularly relevant when *human* is the research object – for instance when studying the topography of a group of people or individuals. In short, qualitative research is not about numerical data, instead it is a research wherein we deal with nonnumerical manuscripts. It helps us describe feelings, beliefs, ideas, behaviours, and attitudes of mankind. Thus, qualitative studies reflect the researcher's observations and interpretations of what he/she encounters rather than quantifying the setting. Moreover, qualitative research is subdivided into five tracts (Walliman 2006). First, *ethnography and participant observation* in which a scientist immerses in a society for a period of time to observe, question, learn and experience the society first hand. The objective is to gain an in-depth knowledge of social processes and implications. The second track is *qualitative interviewing* which deals with questioning individuals and engaging in

conversations with the goal of gathering data necessary for unravelling social phenomena and attitudes. The third is *focus groups* by which a scholar gets a group of people to discuss a set of questions in order to extract qualitative information. Fourth, *discourse and conversation analysis* which is a language-based style aiming to understand how varieties of reality are produced. The last style of a qualitative approach, which is employed in this thesis, is the *analysis of text and documents* wherein a researcher engages with collecting, analysing and interpreting written documents.

3.4 Quantitative research

Contrary to qualitative research, quantitative research is concerned with methodical analysis of phenomena by means of statistical or numerical data (Watson, 2015). In other words, quantitative research entails quantification measurements with underpinning assumption that the phenomena or object of the study can be measured and enumerated. Moreover, it attempts to collect and analyse numeric data so as to delineate trends and relations. It enables the researcher to reject or accept predefined research hypothesis as well as verifying the study's outcomes. Hence, according to Watson, the design of quantitative research is centred around two kinds of variables: *dependent* and *independent*. A variable can be anything that is measurable e.g. distance, body mass, weight, quantity and production rates, etc. The rule is that an independent variable is the one that may or may not affect the measurement of the dependent variable. For example, if we are examining the effect of aquaculture extension services on the number of individuals involved with fish farming in a certain country, the frequency of the extension outreach will be the independent variable whereas the number of fish farmers is the dependent one. Similar to its qualitative equivalent, quantitative research too has different designs: *experimental* and *survey* designs. However, in contrast to the qualitative research, in an experimental design the investigator is able to manipulate the independent factor to see how it affects the dependent variable (Getliffe 1998). In other words, experimental quantitative research allows us to learn the causality in a phenomenon. Survey design, on the other hand, is a nonexperimental study where the researcher collects the data through a survey technique, for example, by questionnaires, interviews or observation (Ibid). In contradiction to experiments, rather than testing causal effects, surveys are suited for collecting large quantities of data. For this reason, surveys enhances a researcher's ability to more accurately describe populations, samples or phenomena (Watson 2015). The common ground between the sorts of quantitative study is

that, in both, the raw data must be digitalised to make them compatible to the computational packages we use to conduct the digital analyses e.g. Excel spreadsheet, R, SPSS (Statistical Package for the Social Sciences). When the data is pooled, *preparing data*[6] is needed prior to statistical analysis (Lazar et al. 2010). Data preparation involves *cleaning* (dealing with the errors), *coding* (data segmenting) and *organising* (fine-tuning the data for the intended analysis) (Ibid). For instance, when we use Excel, analytical measures such as data entering, storing and analysing are followed to produce indicative numbers or visual results such as graphs. Afterwards, we interpret these results in terms of quantities, *spread* (range or standard deviation), *central tendency* (mode, median or average) or in percentages terms and draw conclusions (Watson 2015). In this research, the quantitative method was used to assimilate farmed tilapia production statistics in Egypt and in the rest of Africa.

3.5 Data collection and research materials

All the data used in this case study are secondary data, a term referring to data published by other people. In order to analyse aspects such as development policies, developmental aid and intervention programmes, I collected and analysed journal articles, government documents, reports and databases of regional and international organisations. As the list of materials provided under annexes shows, 19 relevant data sources are exploited in this study. Thirteen of these are published by FAO, four papers published by independent authors, and one document each by the WorldFish Centre and the United States Development agency. The qualitatively analysed documents include five aquaculture industry profiles of Egypt, Uganda, Nigeria, Ghana and Kenya all of which are produced by FAO; four regional aquaculture reviews on Africa; three aquaculture business analysis reviews from Africa; three analytical journal articles of the Egyptian aquaculture industry; two Aquaculture Yearbooks of FAO; and one paper on the biological characteristics of tilapia farming. Regarding the quantitative analysis, on the other hand, the statistical package Excel was employed to explore the FAO database *Global Aquaculture Production Database* for records of the annual African tilapia aquaculture production figures from 1990 to 2015.

[6] Data preparation means pre-processing it in order to detect and fix or filter out potential errors and inconsistencies as well as identifying underlying themes. Another reason for this step is to transform the data into a layout suitable to the statistical software being used (Lazar et al., 2010, p. 71)

3.6 Data reliability

Reliability of the data in a scientific research is an important concept that is related to the overall quality of the scientific work. Conventionally, reliability is associated with quantitative studies. It states that the health and the consistency of the measurement instrument used in the study is the key factor determining the quality of the data obtained and consequently, the overall quality of the study (University of the West of England 2017). In other words, reliability demands that measuring the same variable repeatedly with the same instrument should give similar results, even when the experiments are done by different individuals. Thus, it requires the homogeneity of the measurement gadgets and that the findings are not prone to research errors. However, reliability does not apply in the same sense in a qualitative research. That is because the researcher either lacks control over the research circumstances or that the data obtained is subject to external influences e.g. the researcher's or the study object's effect (Kumar 2005). Therefore, reliability of the research at hand is, at large, subject to the reliability of the literature and the initial sources which they are based on.

3.7 Data validity

Similar to reliability, validity too must be ensured throughout the study process, if the validity of the research as a whole is to be claimed. As Glen (2017) demonstrates, there are two sources of validity – internal and external validity. Internal validity indicates the degree of certainty to which the study results are actually caused by the treatment rather than unknown or extraneous factors. Thus, for satisfactorily valid outcomes, the investigation in its entirety must be consistent i.e. study design, theoretical foundation and methodology are well linked and that the data is properly representative for addressing the research questions. Second, external validity is about to what extent the findings of the research are theoretically generalisable and applicable to the real-life (Ibid). Paradoxically, however, internal and external validity cannot be enhanced simultaneously. In line with the guidelines of the University of the West of England (2017), trying to improve internal validity will possibly lessen the external validity. This is because external influence to improve internal validity entails that the study is conducted in a way that is gradually less reflective of the real-life (Glen 2017). This in turn limits the chances of obtaining sensibly generalisable conclusions

(Kumar 2005). For this research, fisheries data are insufficient or non-existent in many countries in Africa (FAO 2017c). Fortunately for this study, relatively reliable information was attainable. This is so because most of the data analysed are documents produced by FAO and partly by the WorldFish, two of which are the most reliable sources for fisheries data (FAO 2004).

3.8 Data analysis

Regarding the qualitative part of the analysis, I applied the practises of qualitative data analysis described by Kawulich (2004). This methodology involves narrative reading; reducing data and coding; understanding; confirmation; and presentation. Accordingly, I first thoroughly read the documents, and reduced the texts by sorting the data segments relevant to my research questions. Then, I clustered these data pieces into their respective categories which are the three research questions of my study. Thereafter, based on the data patterns in each category, and through the line-by-line coding technique defined by Lofland et al. (2006), I further organised the information into discrete data driven codes which are the headings under each of the corresponding research question. When it comes to quantitative analysis, by means of the statistical tool Excel, I examined different aspects of the African aquaculture production data between 1990 to 2015 in order obtain tilapia production trends in Africa and in Egypt during this period. The results of both qualitative and quantitative investigation of the case study are merged and displayed in the form of a descriptive text and statistical graphs.

3.9 Study limitations

In the realm of scientific research, perfection is hardly an attainable goal. Consistent with Glen (2017) and Patton (1990), there are simply no means for ultimate control over an investigative research results. Accordingly, the thesis at hand claims no such perfection. In my opinion, the most important hindrance of this study is connected to the complete reliance on secondary data. This is problematic for two main reasons. Firstly, there is an obvious lack of control over the quality of the data since it is out of my reach to crosscheck how the original authors of the literature did their research and what was the quality of the initial data. Secondly, as admitted by FAO, there is a huge underrepresentation of the African continent when it comes to scientific research. For fisheries and aquaculture, the deficiency is even worse (Ibid). Official production statistics are also severely limited, not to mention information on the opinions of the user groups. To me, such limitations were not only inconvenient to the study at hand, but they also disturb the credibility of the FAO manuscripts as the organisation has to estimate the unreported data in order to produce its reports. FAO attributes the misfortunate to competence and resources limitations given the fact that most of the countries in Africa either lack systems for recordkeeping or misreport fisheries information. In fact, the original idea with this study was to collect first-hand data through *structured-interviews* to obtain in-depth insights into the opinions, attitudes and behaviours of not only government officials and the development community – but also of the fish farmers who carry out the day-to-day business. Unfortunately, this was unattainable because of financial and time constraints.

4 Chapter four: Study results

4.1 Introduction

Aquaculture plays an important role as a source of livelihoods and a potential sector for economic development and food security in Africa. Henceforth, it is increasingly recognised across Africa that encouraging fish farming could considerably benefit the national economies. Yet, most of the countries are far from achieving that goal. While the African aquaculture constitutes almost entirely of tilapia (FAO 2009), five countries – Egypt, Uganda, Nigeria, Ghana and Kenya, produce close to 95% of its total farmed tilapia production (FAO 2017d). FAO reports that, Egypt alone produces approximately 84% of the total farmed tilapia in Africa. The remaining four nations are ranked: Uganda, Nigeria, Ghana and Kenya, and they collectively contribute around 10% of continent's total tilapia production. This chapter presents the findings of the current study answering its three research questions. The chapter is structured in a chronological order of the research questions i.e. each question's findings are presented separately. Each question represents a category whereas the questions' subordinate headlines represent the codes which subsequently contain their respective information segments.

4.2 What is the current status of tilapia aquaculture in Africa and in Egypt?

4.2.1 The current status of the tilapia aquaculture in Africa

4.2.1.1 Cultured species, farming environments and farming systems

4.2.1.1.1 Cultured species

While the African aquaculture constitutes nearly exclusively of tilapia, the dominant tilapia species are *Oreochromis niloticus* commonly known as the *Nile tilapia*, *Oreochromis aureus* commonly called the *Blue tilapia,* and *Oreochromis mossambicus* known as *Mozambique tilapia*. To a limited extend *Sabaki tilapia, Longfin tilapia, Mango tilapia, Blackchin tilapia, Redbelly tilapia, Redbreast tilapia, Tilapias nei, Three spotted tilapia, and Tilapia shiranus* are also currently farmed. The following pictures show the three most farmed tilapia species.

Figure 1:Nile tilapia (Oreochromis niloticus). Photo Credit: Wikipedia.

Figure 2: Mozambique tilapia (Oreochromis niloticus). Photo Credit: Wikipedia.

Figure 3: Blue tilapia (Oreochromis niloticus). Photo Credit: Wikipedia.

4.2.1.1.2 Farming environments

In biological terms, tilapia is a highly tolerant fish capable of surviving in excessive concentrations of ammonia, salinity, high temperatures and low dissolved oxygen. In terms of salinity, most tilapia species tolerate salinity up to 15 ppt, but it performs optimally at salinity below 10 ppt. Considering water temperature, tilapia thrives optimally between 27°C and 20°C. Temperatures lower than 20°C, have negative effects as the fish stops feeding at 17 °C and it dies when water temperature is around 10.5°C or lower. The perfect water temperature for optimal overall performance ranges between 29°C and 31°C. Tilapia farming environments in Africa include freshwater bodies near or in rivers, lakes, reservoirs, dams, and wells.

4.2.1.1.3 Farming systems

The tilapia farming industry in Africa comprises largely of small-scale farms with average farm area of 531 square meters. While the majority of farmers cultivate in earthen ponds, cages and tanks are also used in some areas. However, most part of the production comes from extensive farming i.e. without the use of fish feed. Instead, ponds are usually fertilised with manure to create a natural food web in the pond on which the fish will feed. To a limited extend, semi-intensive production regimes i.e. with little use of aquafeed is practiced, especially associated with tanks. However, most of the feed is produced on the farm of legumes and corn and of a poor quality. As it is practiced in cage farms using industrial aquafeed, intensive farming system is quite rare.

Firstly, as shown in the picture below, the ponds are basically shallow earthen pools in different sizes and ranging from 1.2 – 3.0 meters in depth. The water sources are either wells, nearby rivers, lakes, reservoirs, or dams. Technology involved is very limited, often in the form of protective nets and some agricultural tools. The advantage with the extensive culture system is its feasibility, especially to those who have access to land and water. Economic inefficiency, on the other hand, is the main disadvantage compared with intensive system.

Figure 4: A small-scale tilapia farmers in Kenya harvesting their pond while customers lined waiting for the crop. Photo credit: Amisy Fish.

Secondly, the cages. Cages are made of plastic floating collars and nets and are used for large scale production in deep lakes and rivers. This technique is advantageous to the other two for that the water and land is almost free, thus per kilogram capital cost is lower. On the other hand, it requires expensive production inputs.

Figure 5: A large cage-tilapia farm in Lake Kariba, Zambia. Photo credit: FishingSoc.

Thirdly, the tanks. They are either made of plastic or are earthen tanks constructed of concrete. The bright side of this system is better water management and comprehensive control over diseases. On the other hand, it requires high initial and running costs especially in large scale constructions, thus becoming relatively expensive.

Figure 6: A concrete tank for tilapia farming in Zimbabwe. Photo credit: Zimbabwe Farming.

4.2.1.2 Time series of annual tilapia production in Africa from 1990 to 2015

The following table shows farmed tilapia production statistics (in tonnes) in the four most significant producers in Africa (behind Egypt), namely Uganda, Ghana, Nigeria and Kenya besides the aggregated annual production of farmed tilapia in the African countries other than Egypt from 1990 to 2015. Thereafter, the subsequent graph represents the tilapia aquaculture production in the four countries as well as Africa's entire production of farmed tilapia during the same period.

Table 1: Annual tilapia aquaculture production (in tonnes) in the four of Africa's most productive countries, following Egypt, from 1990 to 2015. Data source: multiple FAO data sources.

Year	Africa's Production	Uganda	Nigeria	Ghana	Kenya
1990	8,178	32	3,795	280	405
1991	7,225	36	1,962	300	451
1992	14,208	42	7,525	300	467
1993	15,041	47	7,500	300	474
1994	12,953	108	5,500	330	502
1995	10,767	116	6,020	350	536
1996	10,179	40	3,040	350	500
1997	11,623	288	3,040	300	124
1998	13,745	200	4,471	315	87
1999	15,311	350	1,589	2,175	118
2000	19,538	600	2,705	3,712	222
2001	22,606	1,550	2,626	4,400	412
2002	26,256	1,957	4,496	4,400	421
2003	22,236	2,200	3,948	285	600
2004	22,687	1,660	4,176	760	614
2005	27,397	4,239	6,114	954	622
2006	93,542	11,388	9,216	2,000	609
2007	50,217	16,891	9,272	3,500	2,965
2008	46,937	17,130	3,233	5,100	3,113
2009	63,826	21,573	10,218	6,676	3,424
2010	87,350	31,670	11,989	9,424	9,115
2011	108,332	28,181	13,675	18,200	16,602
2012	148,838	52,303	16,872	26,400	16,115
2013	168,151	47,841	21,681	30,900	17,626
2014	189,328	53,093	27,987	36,900	18,072
2015	236,653	57,329	28,284	43,300	13,991
Average	**55,889**	**8,497**	**7,765**	**13,494**	**4,161**

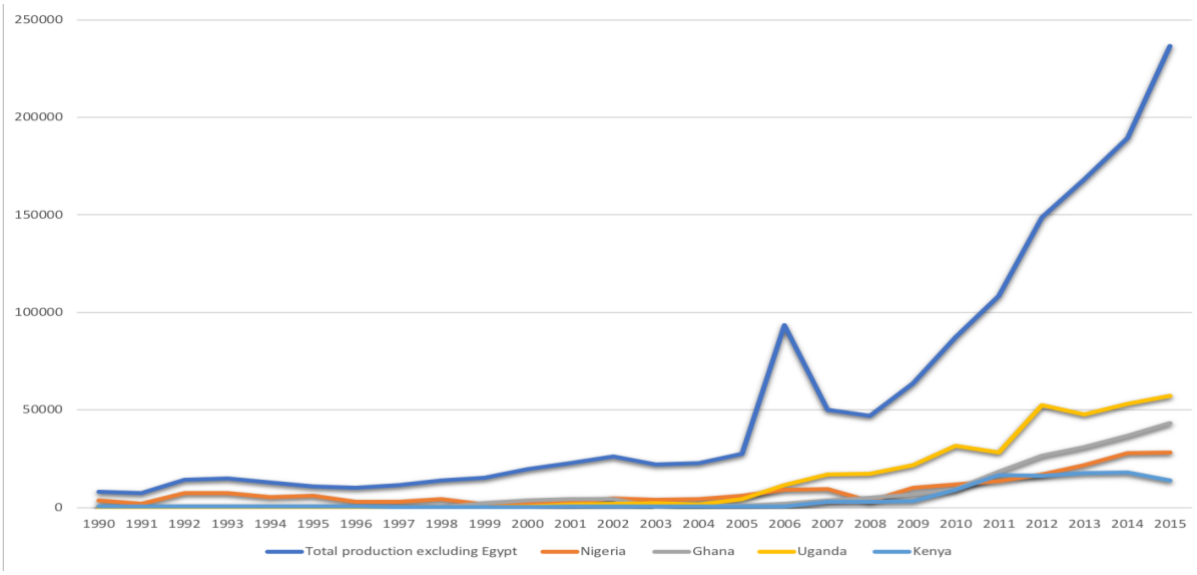


Figure 7: Time series of the farmed tilapia production (in tonnes) in Africa's four most productive countries, following Egypt, from 1990 to 2015.

4.2.1.3 The socioeconomic impact of the tilapia aquaculture industry in Africa

4.2.1.3.1 Contribution to food security

In general terms, fish consumption constitutes 19% of the average animal protein consumption in Africa. Competing with catfish, tilapia remains the preferred fish for both farmers and consumers in most of the African countries. In 2015, out of 10,166,139 tonnes of fish produced by all African nations excluding Egypt, 272,334 tonnes were farmed tilapia. In other words, tilapia aquaculture contributed 2.7% of the total fish production.

In Uganda, whereas 83% of the Ugandans derive their daily animal protein intake from fish, 80% of the rural populations directly depend on fish as their main protein source. What is more, tilapia is appreciated as an important nutrient for pregnant and nursing mothers as well as for children. In 2015, while farmed tilapia constituted roughly 50% of the overall aquaculture fish production, it accounted for 11% of the total fish produced in the Uganda.

In Nigeria, 40% of the animal-based protein consumed across the country comes from fish. While fish is generally cheaper compared with meats, tilapia is among the cheapest fish varieties. The low prices of tilapia and its high nutritional value make tilapia a valuable and suitable staple food. Hence, it is an important component of Nigerian's diet, particularly for poor Nigerians who otherwise survive on cereals and legumes. Furthermore, tilapia plays an

important role concerning the efforts being made in Nigeria to improve the food security of the disadvantaged groups. Pregnant and nursing women as well as children, are encouraged to include tilapia in place of legumes to improve their nutrition. In 2015, roughly 9% of Nigeria's aquaculture fish production constituted of farmed tilapia which was 3% of Nigeria's overall fish production.

In Ghana, between 60% to 73% of animal protein consumption is fish. On average 90% of the households eat tilapia either regularly or occasionally. However, the consumption varies amongst the regions and for the fact that the poor fish farming families consume more fish than their well standing counterparts. As a highly preferred fish, tilapia is central to Ghana's food security, particularly in the rural communities where tilapia farming is more common. In 2015, tilapia aquaculture contributed 97% of the overall farmed fish production and 11% of the country's total fish production.

In Kenya, fish consumption accounts for 7.5% of the entire animal protein intake. Since fish is normally regarded as a premium food, it is not consumed on a regular basis by the majority. While tilapia is the most consumed fish across the country, the government conducts campaigns to increase its consumption as part of a national goal to increase fish intake in the country. In 2015, tilapia accounted for 75% of the total farmed fish production and 7.7% of the country's entire fish production.

4.2.1.3.2 Contribution to incomes and employment

Tilapia farming in Africa is largely characterised by low-technology and labour-intensive production regimes. Thus, large numbers of workers are employed throughout the industry in activities such as pond construction, pond maintenance, feed production, pond fertilisation, farm protection, harvest, fish processing and marketing. While the labour is divided into family workforce and hired employment, in 2014, the average cost of labour was estimated at 24% of the production cost.

In Uganda, the most part of tilapia farming comprises of labour-intensive small-scale farms. While 82% of the Ugandan fish farmers were engaged in tilapia aquaculture, the number of the active tilapia farmers in 2017 was reported at12,000 farmers. While most of the farm owners are men taking the major decisions, women dominate as the workforce and as

managers of their husbands' farms. In 2015, tilapia aquaculture contributed to the Ugandan economy US$142,631 constituting roughly 1.25% of the national GDP and 6% of the total agricultural GDP. In total, directly and indirectly, the tilapia industry provides livelihoods for 3.5 million individuals i.e. approximately 4% of the entire population. These are either farmers or other types of occupations down the value chain and its secondary businesses.

In Nigeria, the tilapia business offer jobs throughout the value chain in activities such as ponds, tanks or cages construction; feed production; seed production; nursing and outgrowing farmers; processing and value addition; as well as marketing and sales. Tilapia processing and marketing are popular businesses for women across the country which is shown by the 70% of fish processors being women. Men on the other hand, traditionally engage with production related activities. In 2015, tilapia aquaculture added US$56,568 to the national Nigerian economy which accounted for around 0.11% of the GDP.

In Ghana, while farms are mostly owned by men, manly workforce is traditionally concentrated in production activities e.g. pond preparation; procurement of production inputs; feeding and fertilisation of ponds; and harvesting. Part of the labour in pond constructions is represented by women. In total, women own ca. 10% of the farms and hold both managerial and technical positions. In other cases, women share with their husbands some accompanying enterprises such as feed and fertilizer retail stores, hatcheries and restaurants. Otherwise, almost the entire workforce engaged in post-harvest activities comprises of women working with the processing and marketing of tilapia. All in all, about 97,000 people are estimated to be working in jobs related to the tilapia farming business. In 2015, the tilapia industry added US$46,285 to the Ghanaian economy comprising approximately 0.77% of the country's total GDP.

In Kenya, the aquaculture sector which fundamentally consists of tilapia farming is considered a major source of employment. About 4,500 people are engaged in tilapia aquaculture value chain from production to sales. The majority of this number is represented by men who traditionally own the land and thus the farms. While the masculine workforce takes care of harvesting and bookkeeping activities, women take charge of day-to-day management. Nonetheless, women participation in the industry is reduced compared with men. By 2015, the tilapia industry contributed US$ 39,822 which represented 0.38% of Uganda's GDP. Regarding livelihoods, the subsector is supporting 88,000 persons who are either involved with production or at other segments down the value chain.

4.2.2 The current status of the tilapia aquaculture in Egypt

4.2.2.1 Cultured species, farming environments and farming systems

4.2.2.1.1 Cultured species

While there are sixteen species currently cultured in Egypt, *Oreochromis niloticus* commonly referred to as Nile tilapia is the most farmed fish in the country. It constitutes 76% of Egypt's entire aquaculture fish production. The other species are produced in negligible quantities.

4.2.2.1.2 Farming environments

As most of the tilapia species, Nile tilapia is a highly tolerant fish capable of surviving in high concentrations of ammonia, salinity, high temperatures and low dissolved oxygen. In terms of salinity, it tolerates salinity up to 15 ppt, but it performs better at salinity below 10 ppt. Considering water temperature, growth and reproductive performance of Nile tilapia is highest at 27°C while reproduction stops at 20°C downwards. Low temperatures have negative effects as the fish stops feeding at 17°C whereas it dies when water temperature is around 10.5°C or lower. The perfect water temperature for optimal overall performance ranges between 29°C and 31°C. The Egyptian tilapia farming happens typically in large earthen ponds in brackish-waters environments surrounding the Delta lagoons in the northernmost part of the country.

4.2.2.1.3 Farming systems

Semi-intensive culture in earthen ponds with relatively high use of high quality formulated feed is the most important farming system, followed by intensive farming in the same ponds or cages with very high use of aquafeed. Concrete tanks and recirculating systems are practiced in some occasions. Below are pictures of an earthen pond and a cage farm, the two most frequently adopted types of farms farm in Egypt.

Figure 8: A large earthen-pond tilapia farm in Egypt. Photo credit: Flicker.com.

Figure 9: A floating-cage tilapia farm on the Nile in Egypt. Photo credit: Flicker.com.

4.2.2.2 Time series of tilapia production in Egypt from 1990 to 2015

The next table shows the Egyptian tilapia production statistics (in tonnes) between 1990 and 2015. Thereafter, the line graph illustrates the time series of tilapia aquaculture production (in tonnes) in Egypt during the same period.

Table 2: Egypt's annual tilapia aquaculture production (in tonnes) from 1990 to 2015. Data source: multiple FAO data sources.

Year	Egypt's annual tilapia production
1990	24,916
1991	22,156
1992	21,505
1993	19,857
1994	25,214
1995	21,969
1996	27,854
1997	30,416
1998	52,755
1999	103,988
2000	157,425
2001	152,515
2002	167,735
2003	199,557
2004	199,038
2005	217,019
2006	258,925
2007	265,862
2008	386,186
2009	390,280
2010	557,049
2011	610,617
2012	768,752
2013	635,843
2014	759,601
2015	875,513
Average	**267,405**

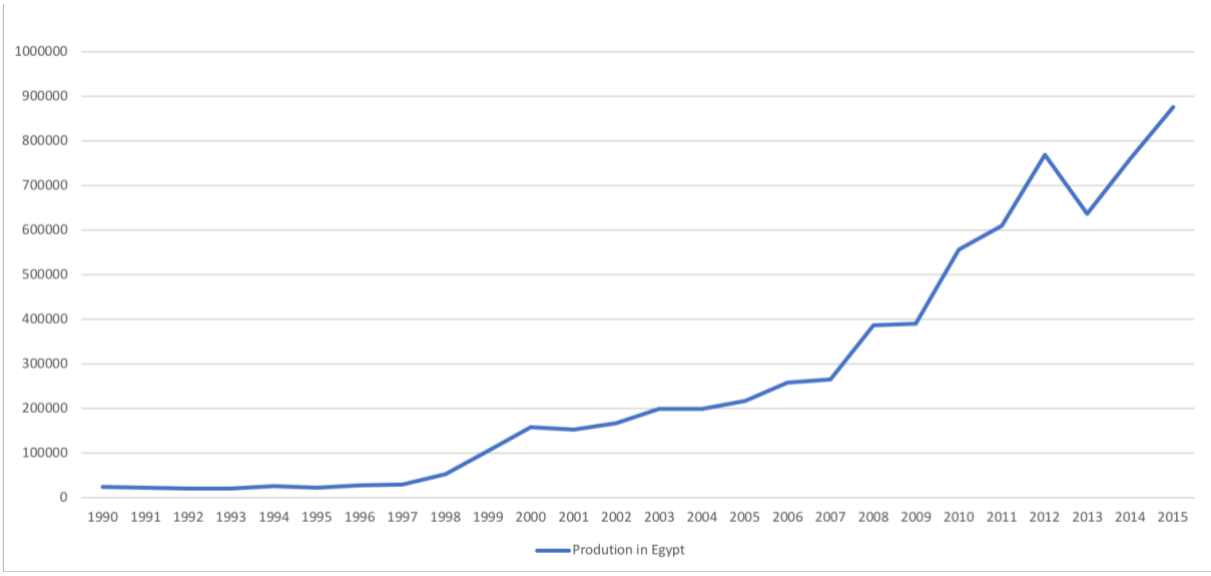


Figure 10: Time series of the Egyptian tilapia aquaculture production (in tonnes) between 1990 and 2015.

4.2.2.3 The socioeconomic impact of the tilapia aquaculture industry in Egypt

4.2.2.3.1 Contribution to food security

Tilapia aquaculture is a key element with regard to Egypt's food security. Thanks to the subsector's enormous output, fish is the most affordable source of animal protein in Egypt. As the tilapia industry grew, per capita fish consumption in Egypt raised from 9.5 kilograms in mid 1990s to 22.4 kilograms in 2015. As by 2015, fish consumption constituted 50% of the total animal protein intake in Egypt. In the same year, farmed tilapia production contributed 76% of Egypt's total fish production.

4.2.2.3.2 Income and employment

Tilapia farming in Egypt is appraised to be maintaining 50,681 farmers, and in general terms, 84,265 fulltime employees distributed throughout the value chain. Half of the tilapia aquaculture production comes from family owned enterprises whereas the other half is produced by private investments contracting hired workers. A limited portion is produced by state owned businesses. Additionally, roughly 1,840 fulltime employees work in the feed division of the industry. The tilapia aquaculture industry accounts for around 1% of Egypt's GDP.

4.3 What are the main drivers and constraints of tilapia aquaculture development in Africa and in Egypt?

4.3.1 The main drivers of tilapia aquaculture development in Africa

The main factors motivating tilapia aquaculture in Africa stem from three origins: social, market and policy.

4.3.1.1 Social drivers

The imperative social factor motivating people to embrace the profession of fish farming, including tilapia aquaculture, is the need for income sources alternative to the less profitable business of conventional agriculture. Secondly, fish farming is also practiced for self-sustenance, especially among the rural communities where other sources of animal protein are precious. Thirdly, establishment of farmers' unions contributes positively to the growth of the subsector as they function as hubs for story sharing and skills exchange amongst fish farmers.

4.3.1.2 Market drivers

From a market-standpoint, domestic demand is the main factor boosting the African tilapia aquaculture. In many countries, there is higher demand for fish than what is supplied. This increasingly attracts more farmers and companies who invest in production and in the secondary enterprises such as aquafeed.

4.3.1.3 Policy drivers

Policies contributing to the development of the tilapia farming subsector in Africa include international and national agriculture development strategies. These strategies contribute to the tilapia aquaculture through farmer training programmes and reciprocal visits of fish farmers between the countries in the region. The tilapia farming subsector gets further promotion through national youth employment programmes which encourage youth to enter the agricultural sector including tilapia farming enterprises. Finally, public extension services too positively influence the tilapia aquaculture, but their role is minuscule.

4.3.2 The main constraints of tilapia aquaculture development in Africa

The constraints of tilapia aquaculture industry development in Africa also can be categorised into three groups: production related constraints, market related constraints, and policy related constraints.

4.3.2.1 Production related constraints

First of all, regarding production-obstacles, the major obstruction restraining growth in the production side of tilapia farming in Africa is related to how most of the societies in the region perceive the activity of fish farming itself. The aquaculture sector, including tilapia farming, is largely seen as a subsistence activity commonly practiced in extensive small-scale production units. Consistently, the sector is predominantly family businesses with limited technical skills and technological inputs. Manufactured feed is either unavailable, highly costly or does not meet adequate criteria which further blocks commercial expansion of the industry. Historically, the sector suffered limited support from the governments. There is a lack of infrastructure, research and information sharing networks, not to mention the subsequent lack of skilled professionals to plan for the development of aquaculture. Moreover, tilapia farmers lack access to sufficient quantity and quality tilapia juveniles. Some farmers try, therefore, to produce their own fingerlings or else purchase from unskilled producers who collect the eggs from wild stocks which is of poor quality. Industrially produced high-quality tilapia fingerlings are uncommon and, where available, are highly priced. Thirdly, there are complications related to the limited knowledge of farmers. Tilapia farmers are generally unfamiliar with the biological aspects of fish farming such as fish growth, health management, water quality management and fish feeding and feed management strategies which results in inefficient production. Finally, in some parts of the continent there are environmental limitations such as low water temperatures which is unfavourable to tilapia farming.

4.3.2.2 Market related constraints

The key market-aspect impeding the expansion of tilapia farming in Africa is competition from wild caught fish. In many countries, there is significant supply of wild tilapia as well as various fish species from both inland and marine fisheries which are offered

at prices lower than those of farmed tilapia. The situation is further exacerbated by negative consumer perception of the farmed fish and hence lower demand. Secondly, the tilapia value chain is incomplete, lacking some key players such as fingerling and feed producers. Moreover, farmed tilapia producers lack sufficient information on markets and marketing strategies for farmed fish. This makes it difficult for the farmers to manoeuvre their products into better paying markets e.g. export markets.

4.3.2.3 Policy related constraints

Among the constraints holding back aquaculture development in Africa, poor policies are a key is element. The sector has not been given much consideration in national development schemes and effective administrative regulations are missing. The preseasons to this are either little political will to support the sector or budgetary and technical incapacity of the nations, and sometimes both. This results in poor or non-existent of research and development programmes as well as public extension services. However, the international development community historically tried to support the activity in the region, but since the 1990s the support is being diverted to new and more pressing challenges such as AIDS and terrorism. For two main reasons, the aid brought little value to farmers. First, most of the African countries lack proper professional, regulatory and institutional frameworks for aquaculture and hence are unable to achieve the objectives of the development programmes. Second, there is an intrinsic problem with the imported donor programmes that they are often readymade top-down designed projects which are incompatible with the national strategies. On one hand, the international donors generally focus on commercialising the aquaculture sector and are unwilling to finance small-scale farmers. What is more, the different international donors communicate equally different and sometimes contradicting development agendas and approaches. On the other hand, while direct domestic and foreign investments in aquaculture limited, recipient states are technically incapable of properly executing the international projects.

4.3.3 The main drivers of tilapia aquaculture development in Egypt

The analysis of the Egyptian tilapia farming subsector shows that the activity is driven by a combination of three types of factors: social, market and policy factors.

4.3.3.1 Social drivers

From a historical point of view, the major social power underpinning the success of Egyptian tilapia farming industry is a long tradition with the activity. As they are said to be its pioneers, Egyptians reared tilapia as a conventional source of sustenance. However, the tradition gradually developed into its modern-day highly industrialised business. The effect of the traditional perspective is that it produced a skilled workforce as well as maintain high national fish consumption. Added to other factors, the skilled farmers were also more open and capable of adopting new technologies such as the semi-intensive farming system that was introduced by the government. Secondly, the growing population concentrated around the production sites of the Nile river banks asserted increasingly greater demand for fish which drives the need for farming to satisfy the mounting demand. Finally, the farmers' associations also contribute positively as they function as arenas for information and dexterities sharing amongst the fish farmers.

4.3.3.2 Market drivers

From market viewpoint, Egypt's well-developed fish value chain and the strongly growing demand for fish, are the principal market factors compelling tilapia aquaculture to continue to grow. Furthermore, the flourishing business increasingly attracts rich investors who particularly invest in the costly segments e.g. hatcheries and feed mills. This proves essential to sustaining the aquaculture industry.

4.3.3.3 Policy drivers

From a policy perspective, the most important dynamic behind the success of the Egyptian tilapia farming industry is the strong political will to develop the aquaculture industry. The consecutive governments of Egypt recognised the importance of the aquaculture

sector in providing jobs, raising incomes, poverty alleviation, and most importantly for the food security. Thus, the Egyptian state regularly intervened in promoting the activity via public aquaculture research and development; state-owned pilot and commercial farms; state-owned hatcheries and feed mills; in addition to the extension services helped strengthen the tilapia farming subsector and spread improved production techniques and technologies. For instance, the introduction of the semi-intensive culture scheme besides the development of all-male fingerlings were key to boosting the farmed tilapia production. The introduction of agriculture-aquaculture integrated culture system also positively contributes to a limited level. International support to Egypt, both financial and research help, significantly contributes to the growth of tilapia farming subsector.

4.3.4 The main constraints of tilapia aquaculture expansion in Egypt

Factors restraining further growth of the Egyptian tilapia aquaculture industry can be classified in three groups: production related constraints, market related constraints, and policy related constraints.

4.3.4.1 Production related constraints

The most critical limiting factor is water shortage. Being nearly the only source providing 95% of country's freshwater need, Nile water use is prioritised for plant agriculture besides civil uses rather than for fish farming. In some case, only irrigation drainage water is allowed for fish farming. Consistently, arable land is also prioritised for field crop production. Aquaculture, especially new licences, is only allowed where the land is infertile. Secondly, there are financial limitations. Starting costs are high, and due to expensive formal finances, farmers turn to borrow from informal creditors who then tend to impose early harvest upon loan-calls which causes considerable economic losses for the farmers. In other cases, farmers undertake financing agreements with wholesalers, who in turn dictate prices unfavourable to the producers. The third hindrance is poor farm management expertise which is adversely affect the production efficiency. What is more, tilapia farmers lack proper knowledge on water quality management, fish health management, fish breeding, as well as optimal feeding and feed management regimes. Finally, there are tilapia seed shortages and farmers experience difficulties to access good quality fingerlings.

4.3.4.2 Market related constraints

The main challenge the Egyptian tilapia farmers face in terms of market is their lack of bargaining power. This is primarily because of market monopolies of the wholesalers. Due to the fact that the majority of farmers do not own their farm-land besides absence of adequate insurance schemes, the financial system is either unwilling to finance aquaculture businesses or charges high interest rates on loans. Therefore, farmers rely on informal creditors such as wholesalers to secure interest-free cash. However, these off-the-record mortgages turn very costly for two main reasons. First, farmers are forced to harvest and sell their crops at times when prices are low. Second, farmers are often obliged to sell at discouraging predetermined prices. Moreover, aquaculture products are in some cases of poor quality negatively affecting the prices.

4.3.4.3 Policy related constraints

From a policy viewpoint, the prohibition of use of freshwater in aquaculture is a key blockage to the tilapia industry expansion in Egypt. Then, the policy of land use and property rights which hinder the farmers to own the land, is the second policy disadvantage. Therefore, most of the aquaculture farms are built on leased land, often by short-term leases. Subsequently, the insurance and financial institutions are unwilling to deal with the aquaculture sector. Moreover, due to lack of proper operational regulatory framework, quality control of the sector is poor. This implicates deficiency in aquafeed quality control inspections besides absence of coherent animal health control systems for aquaculture. There are also complaints that extension service coverage is poor, and that the subsector lacks a capacity building strategy. Finally, the farmers' associations are ineffective leaving farmers with little or no defensive voice.

4.4 Which institutional factors can explain the difference in aquaculture development in Egypt versus the rest of Africa?

This section presents the findings of the analysis on the institutional frameworks of the aquaculture sectors in Egypt and in the rest of Africa. It provides lists of the various governmental and nongovernmental institutions governing the aquaculture sectors as well as succinct descriptions of the roles of these institutions.

4.4.1 The institutional framework of aquaculture development in Egypt

4.4.1.1 Government institutions

4.4.1.1.1 Ministry of Agriculture and Land Reclamation (MoALR)

The Ministry is responsible for developing the national agriculture policies, including aquaculture, and land reclamation in accordance with Egypt's development strategies. It is primary goal is developing the agricultural sector and the economies of the rural communities. Furthermore, the Ministry is concerned with carrying out research and studies to develop agriculture, animal and fish production. The Ministry's activities for aquaculture development are conducted via three main subsidiaries: *General Authority for Fish Resource Development; the General Organisation for Veterinary Services; and the Agricultural Research Centre (including the Central Laboratory for Aquaculture Research).*

4.4.1.1.1.1 General Authority for Fish Resource Development (GAFRD)

GAFRD is the agency responsible for planning and managing of all activities of fish production. GAFRD is thus delegated to conduct the following functions:

1. Development and execution of laws and regulations related to fisheries activities on aquatic areas determined by the President.

2. Develop and conduct capacity building plans including establishment and delivery of pilot programmes for extension services as well as providing the needed technical support.

3. Cooperate with relevant national and foreign third parties and conducting research to stimulate production.

4. Regulate fishing and aquaculture activities on water bodies specified by the President including issuing licences.

5. Plan fisheries and related activities and implement in collaboration with Governorly authorities.

6. Development and dissemination of improved skills and increasing awareness of recent innovations and harmful practices in addition to promoting modernisation.

7. Economic and technical cooperation with relevant international institutions concerned with fisheries conservation.

8. Establishing and running public companies as well as joint ventures within the sector in line with the Arab and Foreign Capital Investment Scheme Law.

9. Suggesting marketing and pricing policies of local and imported fish products in conjunction with the Ministry of Supply and Internal Trade.

10. Within its competence, provide technical advice on public enterprises undertaken by other entities that involve water usage or pollutions.

11. Provide knowledge and advice on development of and execution of technical studies and economic feasibility studies for fishery related projects.

Consistent with the contemporary institutional setup in Egypt, GAFRD is the principal authority overseeing the aquaculture sector.

4.4.1.1.2 General Organisation for Veterinary Services (GOVS)

GOVS is the professional agency nominated by the Egyptian government to manage food safety and quality control of fish products tailored to fit the European market. Through its Inspection and Veterinary Quarantine units, the agency is responsible for supervising, revising, and enforcing laws and regulations concerned with animal, marine and fish products.

4.4.1.1.3 Central Laboratory for Aquaculture Research (CLAR)

Its main mandate is to design and carry out research for sustainable development of aquaculture and fisheries in accordance with the national agriculture development strategies. The utmost objective of CLAR is to satisfy the Egyptian nation with its fish protein requirements. The agency runs 162 farming ponds for both experimental and production farming purposes besides other training facilities. In total, the agency employs 130 researchers assigned to the organisation's ten research branches as follows:

1. Fish genetics and breeding
2. Fish hatchery and reproductive physiology 3. Fish production and aquaculture systems
3. Limnology
4. Nutrition and feed technology
5. Fish health and zoonosis
6. Fish biology and ecology
7. Economics of aquaculture
8. Extension
9. Fish processing and quality

4.4.1.1.4 Ministry of State for Environmental Affairs

The Ministry is responsible for formulating state policies related to the environment and environment protection. Ministry's subordinate agency, *the Egyptian Environmental Affairs Agency (EEAA)* is the unit directly involved with the implementation of the Ministry's legislations. Fish farms must get approval from this Ministry in order to get aquaculture licences.

4.4.1.1.5 Ministry of Water Resources and Irrigation (MoWRI)

The Ministry is mandated to developing irrigation systems so as to secure nation's water needs in terms of both quantity and quality whilst optimising water usage. The *National Water Research Centre* is the subsidiary responsible for providing technical support to Ministry's work. The *Authority of Shore Protection* is another subsidiary responsible for issuing fisheries licences. Fish farms must get approval from this Ministry through its inspection departments in order to get an aquaculture licence.

4.4.1.1.6 Other Ministries

In addition to the above listed entities, aquaculture activities such as allocating farm sites, might be subject to the approval (depending on circumstances) of: Ministry of Archaeology, Ministry of Tourism, the Authority of Shore protection, and the Border Guard which belongs to the Ministry of Defence.

4.4.1.2 Professional Associations

4.4.1.2.1 Union of Aquatic Cooperatives (UAC)

According to the Egyptian law, there must be at least 20 individuals in order to establish a professional union. Furthermore, the law is so strict that cooperatives are only allowed to perform certain roles specified by the state, and judicial persons and bodies e.g. companies are not entitled to partake in cooperatives. However, incentives such as tax exemptions, discounts on goods and services supplied by state owned businesses, lower energy prices, and preferential conditions on tenders are provided to members who join cooperatives. Out of 99 aquaculture and fisheries associations under UAC, there are currently the following ten aquaculture cooperatives collectively accommodating 1,796 members:

1. Aquaculture Cooperative in Damietta
2. Aquaculture Cooperative in Suez
3. Aquaculture Cooperative in Sharkia

4. Aquaculture Cooperative in Kafr El-Sheikh

5. Aquaculture Cooperative in El-Amerya

6. Aquaculture Cooperative in Edko

7. Aquaculture Cooperative in Fayoum

8. Aquaculture Cooperative in Villages of West Port Said in Manasra Village

9. Aquaculture and Fish Cages Cooperative in Kafr El-Sheikh

10. Aquaculture in Fish Cages Cooperative in Dakahlia

4.4.1.2.2 Egyptian Fish Producers and Exporters Association (EFPEA)

This organisation is open to both individuals and corporates. While the association primarily comprises of aquaculture and feed producers, other actors e.g. wholesalers, retailers, as well as production inputs providers are amongst its members. The main aims of the association are to represent the sector to the government in addition to improving brand and identity of Egyptian aquaculture products. Nevertheless, EFPEA has not yet developed a clear institutional structure. Therefore, the agency is existing only as a Board without a manager and its role on the ground is absent.

In my opinion, his large bureaucratic framework of aquaculture governance is perhaps a clear sign indicating the strong national consideration towards the development of aquaculture. However, the strict regulation of the professional unions is negative to the representative role of these associations which is evident from the weak structures and performance of these professional associations.

4.4.2 Institutional aquaculture development framework in Africa

4.4.2.1 Government institutions

Governmentally, aquaculture is recognised in one way or another in most of the countries in Africa. Though in some instances aquaculture occasionally shifts institutions under which it falls, it normally falls under the ministries of agriculture or a ministry that deals with animal production and poverty alleviation strategies. In most of the countries in the region, direct managerial control resides in the hands of directors or deputy directors of the ministries. The administrative tasks are then normally divided into research, monitoring and extension. Institutions to carry out the micromanagement tasks are extremely rare. Moreover, with the exception of Uganda, Madagascar, Mozambique, Republic of Congo, South Africa and Kenya, legislations and regulatory frameworks specific for aquaculture development are either non- existent or unproductive in the African countries. For a closer look into the aquaculture development institutions in Africa under which tilapia farming functions, this study looks into a sample of the 12 most productive countries from 1990 to 2015. As charted below, in:

1. Nigeria: aquaculture lies under the Ministry of Agriculture and Rural Development. The main responsible agency is the Department of Fisheries. The Ministry has in total 59 stations. Additionally, it includes 6 training institutes and 2 research institutes.

2. Madagascar: aquaculture lies under the Ministry of Agriculture and Aquaculture. The main responsible agency is the Directorate of Fisheries and Aquatic Resources. The Ministry has in total 29 stations. Additionally, it includes 3 training institutes and 7 research institutes.

3. South Africa: aquaculture lies under the Ministry of Environmental Affairs and Tourism and Agriculture. The main responsible agency is the Division of Marine and Coastal Management. The Ministry has only 1 station. Additionally, it includes 3 training institutes and 1 research institute.

4. Tanzania: aquaculture lies under the Ministry of Natural Resources and Tourism. The main responsible agency is the Fisheries Division. Total number of stations is unknown depending on the data. Additionally, it includes 4 training institutes and 1 research institute.

5. Uganda: aquaculture lies under the Ministry of Agriculture, Animal Industry and Fisheries. The main responsible agency is the Department of Fisheries (Aquaculture Unit). The Ministry has only 1 station. Additionally, it includes 3 training institutes and 1 research institute.

6. Zambia: aquaculture lies under the Ministry of Agriculture and Cooperatives. The main responsible agency is the Department of Fisheries (Aquaculture Division). The Ministry has in total 19 stations. Additionally, it includes 3 training institutes and it has no research institutes.

7. Democratic Republic of Congo: aquaculture lies under the Ministry of Agriculture. The main responsible agency is the National Aquaculture Service Division. There is no information on training or research institutions.

8. Kenya: aquaculture lies under the Ministry of Livestock and Fisheries Development. The main responsible agency is the Department of Fisheries. Total number of stations is 2. Additionally, it includes 2 training institutes and 1 research institute.

9. Ghana: aquaculture lies under the Ministry of Food and Agriculture. The main responsible agency is the Directorate of Fisheries. Total number of stations is 19. Additionally, it includes 4 training institutes and 1 research institute.

10. Côte d'Ivoire: aquaculture lies under the Ministry of Animal Production and Aquatic Resources. The main responsible agency is the Directorate of Aquaculture. Total number of stations is 2. Additionally, it includes 2 training institutes and 2 research institutes.

11. Malawi: aquaculture lies under the Ministry of Mines, Natural Resources and Environment. The main responsible agency is the Department of Fisheries. Total number of stations is 13. Additionally, it includes 3 training institutes and 2 research institutes.

12. Mozambique: aquaculture lies under the Ministry of Fisheries. The main responsible agency is the Aquaculture Department. Total number of stations is 2. Additionally, the Ministry has only 1 research institute and there is no training institutes.

Analysing the public representation of the sector in these 12 countries, it is clear to me that aquaculture administration is vaguely positioned under the ministries dealing with agricultural affairs. There are no robust independent national institutions explicitly taking care

of the aquaculture sector. This, and the absence of national legislations and regulatory frameworks specific for aquaculture development except in few countries, indicate that strategic plans to support the fish farming industry are either non-existent or inactive. To make things worse, while micromanagement entities are absent in most of the continent, the direct administrative power is concentrated at the desks of the directors and deputy directors of the respective ministries. Bearing in mind that the African aquaculture is mainly small-scale scattered all-over, this weak institutional framework means that the communication between the aquaculture authorities and the farmers on the ground is particularly ambiguous.

4.4.2.2 Professional associations

Aquaculture producers in most of the countries on the continent have established associations, both in the form of commercial unions and non-commercial supportive associations. In scope and capacity, they range from informal or community farmers' associations to national and regional associations. On one hand, the commercially oriented aquaculture associations mainly focus on promoting collaborative marketing of their products and research development needs. On the other hand, the non-commercial farmers' associations, most of which are founded with donor support, are primarily geared towards helping their members to access credit, which is problematic for non-commercial farmers throughout the region. Generally, associations are few in numbers and weak in terms of influence, especially the non-commercial. What is more, with the exception of Madagascar, it seems that the position of non-commercial fish farmers' associations is not fully acknowledged by central aquaculture institutions. Below is a list of the professional organisations in the sample of the 12 most tilapia aquaculture productive countries in Africa. As follows, in:

1. Nigeria: there are one national association, one commercial association and one local farmers' associations, whereas there is no regional association

2. Madagascar: there are one commercial association and one non-commercial association, whereas there is no national or regional association.

3. South Africa: there are one national association, one regional associations, one commercial association and one non-commercial associations.

4. Tanzania: there are two, industrial and small-scale farmers' associations; and one farmers' association; whereas there is no regional association.

5. Uganda: there are two, industrial and small-scale farmers' associations; and one local farmers' association; whereas there is no regional association.

6. Zambia: there is one, industrial association; and one local farmers' association; whereas there is no regional association.

7. Democratic Republic of Congo: there is only one association which is a local farmers' association.

8. Kenya: there is only one association which is a local farmers' association.

9. Ghana: there are one regional and one local farmers' associations.

10. Côte d'Ivoire: there is only one association which is a local farmers' association.

11. Malawi: there are one industrial and one local farmers' associations.

12. Mozambique: there are one regional and one industrial associations.

Similar to the representation of the sector in the public administration, aquaculture professionals' unions are also humble in both their numbers as well as their influence. While these associations are basically initiated by the farmers' own efforts and/or with the help of the international development organisations, the governments either do not recognise them or do not support their efforts.

5 Chapter five: Discussion and conclusion

5.1 Analysis and discussion

In this research, in an attempt to expose why the African aquaculture industry thrives only in Egypt while it flops elsewhere in Africa, I tried to compare the development trajectories of the tilapia farming industry in the two units in a period of 25 years, 1990 to 2015. After exploring the historical context and the current state of the development of the tilapia industry in the continent, I studied the drives and constraints of tilapia aquaculture business in the region. Thenceforth, I examined the institutional factors that may be underpinning the two different tilapia aquaculture development paths in the continent.

The analysis shows that the tilapia's environmental robustness and tolerance to most of Africa's environments made it one of the most common indigenous fish species across the continent. Encompassing tens of species all of which are commonly referred to as *tilapia* fish, is also the most consumed species in most of the African countries. The history shows that rearing tilapia originated in Egypt 2500 B.C. as the ancient Egyptians used to trap the fish in earthen ponds when it was abundant to use it in the times out of its production peaks. The study reveals that up to the present day farmed tilapia in most parts of the region is produced the same way the ancient Egyptians did, namely earthen ponds. However, the results show that, thanks to their adoption of industrial fish-feed production technologies, the Egyptians have the last decades developed the conventional practice into a highly productive industry. The history also tells that the modern tilapia aquaculture was invented by the European Colonisers in Kenya in the mid-1990s. Ironically, most of the African farmers, except in Egypt, still engage in the extensive farming regimes with very little or no inputs. As the prehistoric Egyptians did, they simply excavate ponds, cultivate the juveniles, add some animal manure to the ponds and wait for the fish to grow. The semi-intensive method which is the dominant culture system in Egypt, is uncommon elsewhere in Africa. The challenge to the expansion of this scheme of production is the lack of manufactured feed in the region. Where it is found, farmers usually produce their own formulated feed which is inefficient due to its poor quality. Other farming methods such as ages and tanks that are to some extent practiced in Egypt, are also infrequent elsewhere in the continent.

Consequently, the level of production is incomparable. As the following graph displays, while Africa's aggregated farmed tilapia production excluding Egypt increased only

from 8,178 tonnes in 1990 to 236,653 tonnes in 2015 which was 2.7% of region's overall fish output, Egypt's output soared from 24,916 tonnes to 875,513 during the same period. In 2015, the Egyptian tilapia aquaculture output accounted for 59% of the entire fish produced in the country. In general terms, Egypt contributes 85% of continent's tilapia production whereas Uganda, Nigeria, Ghana and Kenya were collectively responsible for 10% of the farmed tilapia production in Africa as of 2015.

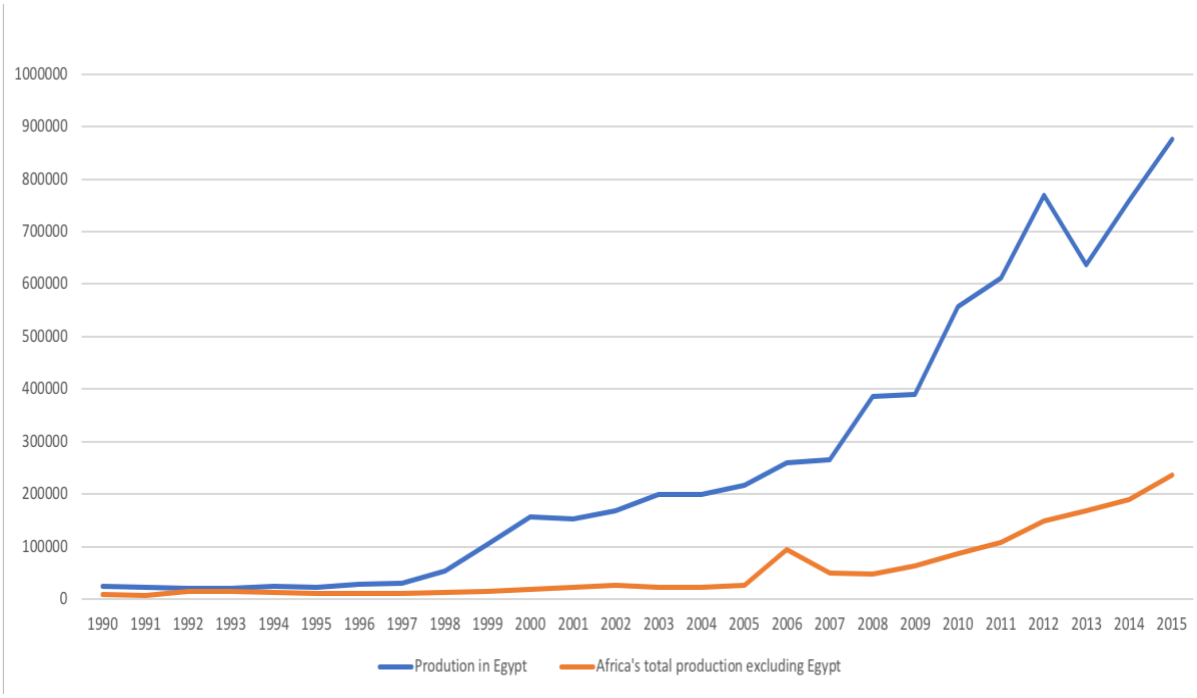


Figure 11: Time series of farmed tilapia production in Egypt compared with production from the rest of the African countries from 1990 to 2015 (in tonnes).

Fish plays a major role in food security across the continent. In fact, while roughly 19% of the dietary animal protein in the African countries constitutes of fish, 50% of Egyptians' animal protein intake was of fish in 2015. Though, on average, farmed tilapia accounts for less than 1% of the average animal protein intake in Africa. In Egypt, on the other hand, constituting 76% of country's total fish production, farmed tilapia is a central component of the animal protein intake in Egypt.

When it comes to the subsector's economic contribution, numbers appear more similar. On one hand, the tilapia farming value chain provides 86,105 fulltime jobs to the Egyptians, collectively generating 1% of country's GDP as of 2015. On the other hand, while tilapia aquaculture production and its contribution are negligible in countries other than Uganda, Nigeria, Ghana and Kenya, the subsector's contribution to employment and GDPs in

these four countries is quite notable. Comparing the figures obtained from the analysis of the tilapia aquaculture contributions to the national GDPs in these countries, the following percentages are extracted. In Uganda, the tilapia farming value chain employs 3.5 million Ugandans creating 1.25% of the country's GDP in 2015. In Nigeria, while employment statistics are lacking, the activity was responsible to 0.11% of Nigeria's GDP in 2015. Next, tilapia farming provides incomes to 97,000 individuals in Ghana adding 0.8% of country's GDP as of 2015. In the same year, 88,000 Kenyans were employed in the tilapia aquaculture value chain producing 0.4% of nation's GDP. [7]

Why Egypt, ranking number two in the world behind China (FAO 2016c), produces so much farmed tilapia while the remaining African countries combined produce only about 10% that of Egypt? To begin with, the study at hand suggests that there is one visible clarification. While both consume a lot of it, Africa gets most of its tilapia from wild stocks whereas Egypt, given its limited wild resources, has to produce its tilapia unconventionally. But, that is not the end of the story. In fact, there is no such a simple answer in the domain of fisheries. As (Jentoft and Chuenpagdee 2009) put it, fisheries problems, including aquaculture, are inherently "wicked problems". It implies that, neither a definitive clarification nor an absolute remedy to these problems are attainable. This is undeniably the case concerning the development of tilapia aquaculture in Africa.

The analysis of this research reveals that the social dynamics compelling the development of tilapia aquaculture as an industry in Africa, are virtually identical – people need more fish to eat. The constraints, on the other hand are various. One of the key limitations is that fish farming is not appreciated as an important activity amongst Africans. For officials and farmers alike, it is just a partial activity of the traditional agriculture, a sector employing as many as 60% of the African workforce (UN 2014). Thus, aquaculture at large does not receive enough attention from both parties. This is partly due to lack of strong market incentive. While strong market demand for fish is present across the board, Egypt differs from rest of the African countries in its shortage of capture fisheries resources. Thus, market plays a primary role behind the Egyptian aquaculture. Egypt's production of wild fish

[7] The percentages of contributions of tilapia aquaculture value chains to the GDPs in the respective countries, were obtained by dividing the values (in US$ obtained from FAO Statistics) of the total tilapia produced in these countries by their GDPs in 2015 (in US$ obtained from https://tradingeconomics.com).

barely covers 25% of country's fish needs (Soliman and Yacout 2016), leaving an extremely appealing market niche for the aquaculture to satisfy. Reversely, in most of the other countries, miniscule in quantity, farmed tilapia is overshadowed by caught wild fish. Wild tilapia not only dominates quantitatively, but also in terms of consumer preferences. Unfortunately, wild fisheries production curves start to level out, and even point downwards in some instances. Therefore, even though it remains undetermined to what degree it contributes to global hunger reduction, FAO recognises that aquaculture plays and will have to play a major role in satisfying the fish demands of the global population (Cunningham 2005). This situation dictates the inclusion of aquaculture in the national plans of the countries in Africa. In fact, my study indicates that state involvement is notably the most direct trigger instigating the successful tilapia aquaculture of Egypt as opposed to its African peers.

Even though tilapia farming is historically credited to Egypt (Hishamunda 2007), the sector only started to evolve into its modern-day industrial form when the state started to intervene in mid-1930s. As (Soliman and Yacout 2016) also point out, state's introduction of the semi-intensive culture system in 1930s, was the most important innovation in the history of the Egyptian aquaculture. This happened as the state founded number of industrial feed production mills along with two semi-intensive research farms in early 1960s. The second breakthrough took place between 1960s and 1970s when the Egyptian authorities established launched the "Comprehensive Aquaculture Development Plan" (FAO 2010). According to FAO, this step helped transform the sector on scientific basis such as the introduction of all-male culture systems which meant production of fish with larger body weights compared with mixed sexes. As a result, aquaculture production jumped from just 17,000 tonnes in 1970s to 45,000 tonnes in mid-1980s – most of which was Nile tilapia (Soliman and Yacout 2016). The state continued to play a major role in the development of the industry through establishing state owned commercial farms; providing farmers with fish improved seeds; relatively cheap industrial feed; and strong extension and training services. However, the state gradually pulled out as the sector took off. In 2013, 99% of Egypt's total aquaculture output was produced by the private sector (Shaheen 2013). As we know, fish feed is the most expensive aquaculture production input costing between 50% and 70% of the total cost (WorldFish 2009). That is because, biologically, to produce one kilogram of fish, we need approximately 1.5 kilogram of formulated feed. The most part of the types of feeds used in Egypt constitutes of two main ingredients, soybean and corn, both of which Egypt produces

little of (FAO 2010). The pressing question that might come to mind now is, how Egypt, a country that is even referred to by some as "the Land of Desert" manages to maintain such a high production of farmed fish? Well, with its 34 aquafeed production mills, the country is producing virtually its entire aquafeed needs (US Soybean Export Council 2018). However, they need to import practically all of the soybean they need. According to the US Soybean Export Council, Egypt imports approximately 90% of its soybean needs from the United States. As its largest consumer in Africa and the Middle East (Ibid), US's supply of soybean to Egypt is an important success factor to Egypt's tilapia industry, in my opinion.

In comparison, Egypt's robust state-driven strategy for the sake of aquaculture development, is unparalleled elsewhere in Africa. The African tilapia aquaculture, therefore, largely remains old-fashioned across the region. In fact, the analysis shows that the prime force behind the little portion of tilapia production in Africa is attributed the farmers' own struggles. While governmental initiatives to boost the African aquaculture are rare, when found, nearly all of them were initiated by international actors. However, as the results of this study reveals, the outcome of the international help is again negligible despite the considerable amounts of money injected into Africa in the name of aquaculture development.

There are two main justifications behind the failure of the international aid. The first is the mistake international aid institutions historically committed, namely following the modernisation approach to the development of the sector. As my analysis show, the international donors have generally been disinclined to support small-scale aquaculture. While aquaculture in Africa is predominantly small-scale, international donors tend to look after large scale companies instead. Secondly, there is lack of both states' will and the capacity to make use of the internationally sourced resources. All that states contribute is limited to experience-sharing visits of fish farmers between countries, training activities, promotion of aquaculture, and extension services – all of which are initiated by foreign donors such as the World Bank and FAO. This issue was also pointed out by FAO (2004). As FAO outlines, aquaculture development initiatives were introduced in sub-Saharan Africa since the 1950s under the colonial administrations just prior to independence. However, the national regimes taking over failed to follow on the footnotes of the colonials. Then, supported by international aid, dozens of aquaculture modernisation initiatives followed across the continent. However, FAO (2004) claims that the majority of these plans were destined to drastic failures. They say that, based on theoretical approaches e.g. neutralisation, the programmes were designed with little inputs from the beneficiaries. What is more, in

administrative terms, the initiatives were often planned in a top-down style, generalised, and regionally oriented. This further alienated these projects making less desirable to the national governments and targeted farmers (Ibid). FAO argues that lack of qualified human resources to run these initiatives, was the main reason for their style of project design.

Further advancement of the tilapia aquaculture has its constraints in Egypt and in Africa in its entirety. Regarding Africa, my study indicates that the most critical limitation is defective policies. In line with what FAO reported in 2004, most of the African countries lack strategic plans for aquaculture development. In fact, aquaculture is hardly mentioned in the national plans of the African countries. As a result, aquaculture research, proactive institutional frameworks, and effective extension services are missing. Market dynamics act as another key constraint. As mentioned above, the results show that Africa's fish needs have been satisfactorily supplied by the capture fisheries and only recently, demand began to outstrip supply. So, tilapia farming is expected to flourish in the face the new circumstances. Still, as Tall (2016) also points out, factors such as poor market infrastructure, impaired market information dissemination, and negative consumer perception are the stumbling blocks confronting tilapia producers. Combined with disadvantageous states' policies, these factors foster an inhibitive environment towards the development of aquaculture. While most of the societies in the region generally have little understanding of the potency of aquaculture industry, tilapia farmers have poor access to manufactured feed, quality fingerlings, financial services, faciliatory infrastructure, and technical knowledge of tilapia farming.

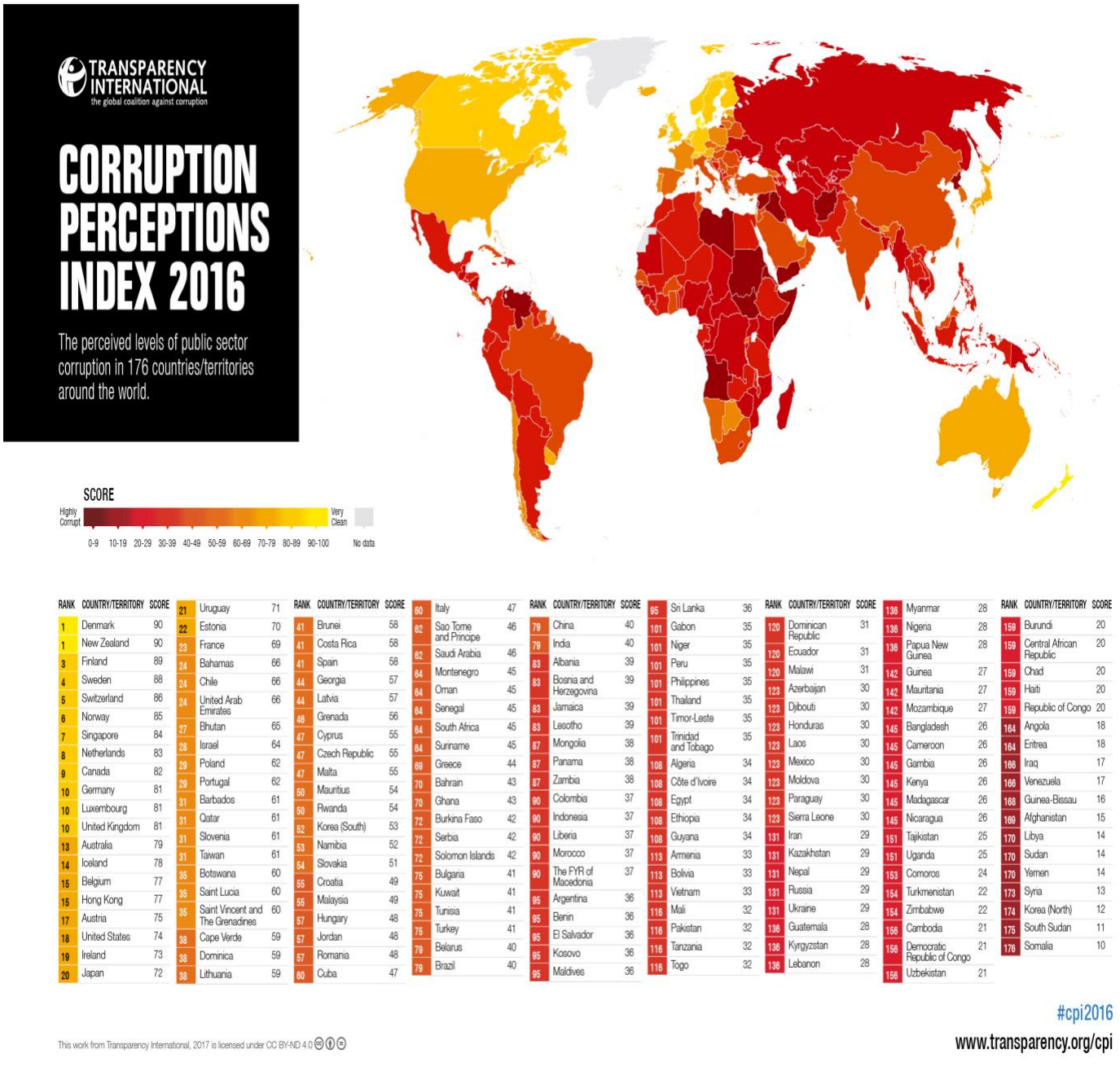
In Egypt, however, the challenges have a different sequence. The results uncover that water scarcity is most stubborn obstacle threatening the future of the tilapia farming business. Egypt draws 95% of its fresh water needs from the Nile as Paisley and Henshaw (2013) noted. Moreover, country's fast-growing population puts a tremendous pressure on the Nile water resources, causing the nation to sacrifice further expansion of the fresh-water dependant tilapia aquaculture. The water is increasingly prioritised for drinking and cereal crop production. Moreover, access to land is also a problem. As stated earlier, only about 5% of Egypt's landmass is fertile. Arable land is therefore prioritised for crop production. This situation inflicts that, nowadays, new or renewal of aquaculture licences is only allowed where other forms of agriculture are not possible. What is intriguing is that for the aforementioned conditions, more and more fish farmers use the waters draining from irrigation. Added to farmers' limited knowledge of fish health and water management, this situation leads to high mortality rates, given the poor quality of water. In some instances, the

products are contaminated and thus inedible as Soliman (2017) has reported. As an answer, aquaculture in desert areas (desert aquaculture) and marine fish farming are being promoted by the state as alternatives for future aquaculture. Unfortunately, both ideas are irrelevant for the tilapia industry. While the former is economically inefficient, the latter is biologically unsuitable for most of the tilapia species (Soliman 2017). The industry itself, however, is far from giving up. By the help of international research and development organisations such as the WorldFish Centre, the Swiss Agency for Development and Cooperation, and the US Soybean Export Council, a new technology of production is currently being developed (The WorldFish 2018). If successful, WorldFish says, the new system of *In-pond Raceway System* will allow the Egyptian tilapia farmers to triple their production within the present limits of water use. Additionally, with less severity though, Egyptian tilapia farmers also suffer from inequitable market practices. For instance, a few monopolies of wholesalers exploit the value chain in two ways. Due to lack of or expensive formal loans, farmers tend to borrow from fish dealers who themselves will later buy the fish. Here, these informal lenders dictate unfair fish prices besides deciding harvest seasons unfavourable to the farmers. Secondly, fish traders cooperate to control supply as well as manipulating fish prices causing considerable losses for the producers. This point was also raised by El-Sayed et al. (2015). This indicates and underlying weakness that the industry lacks an operational framework that would regulate the relationships between the different actors as well as insuring satisfactory product quality standards. Financial services system too is in need of restoration so as to prevent farmers from falling preys to unfortunate alternatives.

Zooming out to a macro level of analysis, Egypt's success and Africa's failure in aquaculture development can be boiled down to three root causes: differences in terms of market, political motivation, and institutional causes. First and foremost, in Egypt, aquaculture development in general and tilapia farming in particular, was most importantly motivated by great market demand for the fish to meet country's mounting need for food-fish which constitutes 50% of Egyptians' daily protein intake. As Egypt's population continues to grow in the face of scarce yet dwindling capture fisheries, Egyptian authorities realised early on that aquaculture is the only viable alternative for bridging the gap between supply and demand of fish in the country as Soliman and Yacout (2016) confirm. Conversely, in most of Africa, wild fisheries managed to keep up with the fish market demands until fisheries started to drop.

In his book *Asia-Africa Development Divergence*, Henley (2015) argues that variations in political choices of governments is what makes South-East Asia outcompete Africa concerning economic development. Similarly, I maintain that political will to develop aquaculture, is the second junction where Egypt divert from its African counterparts. The present study shows that the Egyptian state, despite the political shuffles, have recognised tilapia farming as a powerful tool for food security as well as for employment and livelihoods. Soliman and Yacout's study from 2016 confirms this statement. Similar political motivation for aquaculture, however, is unmatched in Africa as wildly caught fish supplies kept up with the fish demands. Now, though supplies from the traditional sources are no longer meeting the region's fish needs, aquaculture development is still not on African leaders' top agenda. As FAO (2004) pointed out, improving education and health are the two issues occupying the political attention in most of the African countries. What is more, also international donor support that was available for promoting aquaculture in the region, is now reallocated to more pressing issues, such as public health (FAO 2017b).

Thirdly, there is the institutional dilemma. From the results of my study, it is evident that aquaculture bureaucracies in Egypt and in the rest of Africa, are incredibly incomparable. Egypt has a large multilevel administrative body governing the aquaculture compared with its African counterparts. Interestingly though, the two groupings score more or less the same on the corruption index. As it is clear from the picture below by Transparency International Organisation (2016), the whole region is highly corrupt.



RANK	COUNTRY/TERRITORY	SCORE
1	Denmark	90
1	New Zealand	90
3	Finland	89
4	Sweden	88
5	Switzerland	86
6	Norway	85
7	Singapore	84
8	Netherlands	83
9	Canada	82
10	Germany	81
10	Luxembourg	81
10	United Kingdom	81
13	Australia	79
14	Iceland	78
15	Belgium	77
15	Hong Kong	77
17	Austria	75
18	United States	74
19	Ireland	73
20	Japan	72
21	Uruguay	71
22	Estonia	70
23	France	69
24	Bahamas	66
24	Chile	66
24	United Arab Emirates	66
27	Bhutan	65
28	Israel	64
29	Poland	62
29	Portugal	62
31	Barbados	61
31	Qatar	61
31	Slovenia	61
31	Taiwan	61
35	Botswana	60
35	Saint Lucia	60
35	Saint Vincent and The Grenadines	60
38	Cape Verde	59
38	Dominica	59
38	Lithuania	59
41	Brunei	58
41	Costa Rica	58
41	Spain	58
44	Georgia	57
44	Latvia	57
46	Grenada	56
47	Cyprus	55
47	Czech Republic	55
47	Malta	55
50	Mauritius	54
50	Rwanda	54
52	Korea (South)	53
53	Namibia	52
54	Slovakia	51
55	Croatia	49
55	Malaysia	49
57	Hungary	48
57	Jordan	48
57	Romania	48
60	Cuba	47
60	Italy	47
62	Sao Tome and Principe	46
62	Saudi Arabia	46
64	Montenegro	45
64	Oman	45
64	Senegal	45
64	South Africa	45
64	Suriname	45
69	Greece	44
70	Bahrain	43
70	Ghana	43
72	Burkina Faso	42
72	Serbia	42
72	Solomon Islands	42
75	Bulgaria	41
75	Kuwait	41
75	Tunisia	41
75	Turkey	41
79	Belarus	40
79	Brazil	40
79	China	40
79	India	40
83	Albania	39
83	Bosnia and Herzegovina	39
83	Jamaica	39
83	Lesotho	39
87	Mongolia	38
87	Panama	38
87	Zambia	38
90	Colombia	37
90	Indonesia	37
90	Liberia	37
90	Morocco	37
90	The FYR of Macedonia	37
95	Argentina	36
95	Benin	36
95	El Salvador	36
95	Kosovo	36
95	Maldives	36
95	Sri Lanka	36
101	Gabon	35
101	Niger	35
101	Peru	35
101	Philippines	35
101	Thailand	35
101	Timor-Leste	35
101	Trinidad and Tobago	35
108	Algeria	34
108	Côte d'Ivoire	34
108	Egypt	34
108	Ethiopia	34
108	Guyana	34
113	Armenia	33
113	Bolivia	33
113	Vietnam	33
116	Mali	32
116	Pakistan	32
116	Tanzania	32
116	Togo	32
120	Dominican Republic	31
120	Ecuador	31
120	Malawi	31
123	Azerbaijan	30
123	Djibouti	30
123	Honduras	30
123	Laos	30
123	Mexico	30
123	Moldova	30
123	Paraguay	30
123	Sierra Leone	30
131	Iran	29
131	Kazakhstan	29
131	Nepal	29
131	Russia	29
131	Ukraine	29
136	Guatemala	28
136	Kyrgyzstan	28
136	Lebanon	28
136	Myanmar	28
136	Nigeria	28
136	Papua New Guinea	28
142	Guinea	27
142	Mauritania	27
142	Mozambique	27
145	Bangladesh	26
145	Cameroon	26
145	Gambia	26
145	Kenya	26
145	Madagascar	26
145	Nicaragua	26
151	Tajikistan	25
151	Uganda	25
153	Comoros	24
154	Turkmenistan	22
154	Zimbabwe	22
156	Cambodia	21
156	Democratic Republic of Congo	21
156	Uzbekistan	21
159	Burundi	20
159	Central African Republic	20
159	Chad	20
159	Haiti	20
159	Republic of Congo	20
164	Angola	18
164	Eritrea	18
166	Iraq	17
166	Venezuela	17
168	Guinea-Bissau	16
169	Afghanistan	15
170	Libya	14
170	Sudan	14
170	Yemen	14
173	Syria	13
174	Korea (North)	12
175	South Sudan	11
176	Somalia	10

Figure 12: A world map showing the corruption perception index in 2016. Source: Transparency International.

However, an effective central administration is a necessity when it comes to the issue of development as Fukuyama (2014) argues. According to Fukuyama, Africa's poverty can be traced directly back to the region's lack of strong national institutions. In the broader sense of institutions as way of life in a society, the most prominent institutional advantage separating Egypt aside from the rest of the continent is country's history of the Nile water management.

As it came to be known as "the Gift of the Nile" (Zahran and Willis 2009:1), the Nile is Egypt's umbilical cord that they must take ultimate care of. As Paisley and Henshaw (2013) point out, concentrated along the banks of the Nile, Egyptians have for centuries mastered the river and the art of agriculture. In fact, thanks to their supreme understanding of the Nile's dynamics, ancient Egyptians were able to harvest their fields multiple times a year (Tvedt 2012)[8]. To me, aquaculture is undeniably the legitimate child of this historic marriage of Egyptians and the Nile. As it is native to the Nile, ancient Egyptian farmers naturally adopted techniques for rearing the Nile tilapia for human consumption beside their traditional agriculture (Popma and Masser 1999). Apparently, the tradition has been well preserved. Though the technologies nowadays incomparably surpass what it used to be, agriculture and tilapia farming are still the backbone of Egypt's food security (FAO 2016b; Tvedt 2012). Not only that, the two activities got along so well that agri-tilapia integrated farming is one of the promising aquaculture innovations in Egypt, particularly integrated in rice farming. In 2012 for instance, this technique contributed nearly 5% of Egypt's total tilapia output (Shaheen 2013). All that would not have been possible without proper management of the Nile waters. Indeed, Egypt's Aswan High Dam and its Lake Nasser, the largest manmade lake on earth (Dumont 2009), is the clearest proof. Located near the Sudanese borders in the south, the Dam controls a volume of 44,300,000 cubic metres of water. Strategically positioned, Aswan High Dam not only supplies the nation with electricity and drinking water, but it is also the valve securing the fish farms downstream an uninterrupted stream of water year-round (Ibid). Such an institution of water management is unprecedented elsewhere in Africa – with the exception of Madagascar (FAO 2004). In Madagascar, water management dates back to the 18th century when the King Andrianampoinimerina introduced water management for aquaculture purposes, but the enterprise perished with his kingship (Ibid).

The second institutional factor putting Egypt ahead is its significantly powerful executive system. Most of the remaining African nations, do not poses similarly effective regimes. Even though there originally was an inclination towards tilapia farming in Egypt, Egypt and many nations in the region received comparable international support to develop the sector. While most of the international development initiatives have been oriented towards industrialising fish farming, Egypt was institutionally better positioned to herness the opportunity than most of the African nations (FAO 2004). This is partly a consequence of

[8] Own translation from Norwegian.

colonisation. In sub-Saharan Africa, colonials left behind economically and institutionally impoverished states, a situation that jammed the opportunities of the indigenous societies (Henley 2015). He further indicates, the distorted institutions blocked autonomous economic growth. As understood from Henley's reading, the broken states and malfunctioning institutions Africans inherited from the colonisers, have deteriorated even further in the following decades pushing Africa into severe political instabilities. This unlucky political epidemic has since distracted the Africans from developing their nations, not to mention the development of the aquaculture industry.

Finally, there is a subtle compounding factor enabling Egypt's lead position over its counterparts, namely education. While a country's ability to develop and grow economically is firmly associated with its education level (Benhabib and Spiegel 1994), Henley argues that Africa is generally short in skilled labour. Egypt, however, is among those scoring highest on Education Index across the continent as UNDP (2013) reports. Besides innovativeness, an educated population more easily adopts new ideas which appears to be true in the case of Egyptian tilapia farming development (FAO 2004). Furthermore, although Africa is more in need of developing its human capital for the subsector compared with Egypt, Egypt's model of tilapia aquaculture development is in fact more human capacity building oriented compared with the modernisation-oriented initiatives of the development organisations in most of the other African countries. Since the early start of aquaculture development, through state-owned pilot projects and research centres, Egypt engaged in training programmes based on active participation of the farmers (Soliman and Yacout 2016). In comparison, consistent with FAO's (2014) reports, in most of the other African nations, aquaculture development strategies are often imported by global actors such the World Bank, UNDP and FAO. Most of these proposals are based on the modernisation concept. To make things worse, almost all of these packages are top-down designed that rarely trickle down to the actual users on the ground, thus the African aquaculture remains maldeveloped (FAO 2004). Thus, the alternative development methodology is perhaps more appropriate.

5.2 Conclusion

The analysis of the African tilapia aquaculture shows that the development status of industry is to a great extent similar in all countries in the region, except for Egypt. Egypt's large and rapidly expanding population, densely spread over 1% of the country, created a market with enormous demand for food, including fish. This stimulated the unwavering political will to develop aquaculture, especially tilapia farming, to meet the dietary protein needs of a nation that otherwise has few choices for animal protein supply. Land and water restrictions are the two major challenges facing further expansion of the activity in Egypt. Luckily, despite these restrictions, the future of tilapia farming appears bright, largely thanks to agricultural advancements and efficient water management such as tilapia-agriculture integrated farming and in-pond raceway culture systems (Heijden 2011; WorldFish 2018). However, Egyptians have to improve in two areas. First, there is a need for a comprehensive business-legal framework to balance the power distribution throughout the value chain besides setting stricter product quality standards. Second, farmers should be provided with insurance services so as to encourage the financial system to lend to the farmers and prevent unsound borrowing arrangements.

Comparatively, given ample supplies of wild fish and other food staples, most of the African countries, until newly, saw no matching need to invest in the aquaculture sector. However; with the current pace and the assumed population growth; rapid urbanisation (The World Bank 2015), deteriorating wild fish stocks (The Guardian 2014), and dwindling crop yields due to the climate change (FAO 2016c) – Africa seems to have no choice but to follow on Egypt's footprints and grow its aquaculture. Multiple international organisations e.g. FAO, the World Band, NORAD, the German Development Fund, USAID and others, believed that the continent has a large potential for aquaculture growth. Consequently, they invested immensely to stimulate the sector (FAO 2017b). unfortunately, most of these initiatives proved unsuccessful. The reasons are complex. From an organisational perspective, the failure is attributed to mismatching political views of Africa's leaders; lack of local human and institutional capacities; in addition to little stakeholder participation. From technical perspective, challenges include lack of quality fish seeds; lack of manufactured aquafeeds; weak farmers' training and extension services; and poor market development. Even though the international development community is now focussed more on tougher challenges such as AIDS and combating terrorism, their role is still relevant (FAO 2015). Nevertheless, I argue that they must revise their strategy. Their tendency to commercialising the African

aquaculture, is not benefiting the farmers, and might even turn counterproductive. Aquaculture in Africa is predominantly small-scale, family-based enterprise who are generally uneducated, hence incapable of running large scale businesses. Therefore, even though industrialising some segments such as fingerlings and feed production is vital to industry's progression, rapid upscaling of the sector to a free-market may adversely affect the small-scale farmers. Instead, in line with many papers it has reviewed, this study suggests focussing on employing the alternative development ideology. This is essential to, first, educate the politicians understand the importance of the sector in terms of food security. Second, it is crucial to shape solid institutions so as to attain sustainable development of aquaculture, instead of importing projects that countries are incapable of handling. Furthermore, instead of the top-down designed programmes, farmers should be closely integrated in the creation of these plans to reflect farmers' needs. Furthermore, as Egypt successfully did, a learning-by-doing design of the extension services should be adopted. In this way of coaching, farmers are more likely to absorb the necessary knowledge and skills to take the production to next level. Additionally, infrastructure and market information flows must be improved in order to facilitate effective value chain management. Finally, farmers' and other professional organisations should be encouraged to maintain a healthy power sharing across the value chain. Finally, farmers should be stimulated to organise themselves into professional associations so as to facilitate better communication and skills sharing amongst them.

Last but not least, this study tried to decode the puzzle: *why aquaculture flourishes in Egypt while it flops in most of the African continent*? However, fisheries puzzles are inherently wicked, and the example of this study is no exception. So, this thesis does not claim to present a complete answer to the intriguing paradox. To better unscramble the dilemma, a more specific comparative study that analyses aquaculture in all of the countries individually, is needed.

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7 Annexes

7.1 A list of the data analysed in this study

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