1. Introduction
A recent quick scan study of the freshwater aquaculture sector in Kenya provided insights on the main issues affecting its performance and sustainable development. The analysis focused on current supply chain, institutional governance and innovation systems aspects of the sector. The study highlighted a number of challenges and existing opportunities as well as weaknesses and threats to the sustainability and the growth of the sector (Obwanga and Lewo, 2017).

Building on the quick scan, a follow-up comparative study of successful commercial aquaculture sector development in Africa was conducted. Within Africa, Egypt, Nigeria and Ghana have a leading role in freshwater aquaculture production. In Table 1 the aquaculture production systems and apparent average per capita fish consumptions in the three countries, as well as in Kenya, are provided.

Table 1: Overview of production and consumption trends in the selected countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Production 2015</th>
<th>Top farmed fish species</th>
<th>Top production systems</th>
<th>Fish consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td>1 174 800</td>
<td>Tilapia (75.5%)</td>
<td>Semi &amp; intensive earthen ponds (85%) - Tanks and FAS developing</td>
<td>15.0</td>
</tr>
<tr>
<td>Nigeria</td>
<td>316 700</td>
<td>Catfish (74%)</td>
<td>Intensive urban peri-urban tanks-ponds; intensive cages (on farms with high interest &gt; investment)</td>
<td>17.1</td>
</tr>
<tr>
<td>Ghana</td>
<td>46 250</td>
<td>Tilapia (95%) Catfish (5%)</td>
<td>Intensive cages (90%)</td>
<td>25.0</td>
</tr>
<tr>
<td>Kenya</td>
<td>18 658</td>
<td>Tilapia (75%) Catfish (18%)</td>
<td>Semi &amp; intensive ponds (70%) - Intensive commercial farms (interconnected cages)</td>
<td>3.4</td>
</tr>
</tbody>
</table>

2. Study approach
This brief summarises findings of a comparative study whose main objectives were 1) to learn lessons from the experiences of the aquaculture sectors in Ghana, Nigeria and Egypt, and 2) to identify factors that are determinant for the development of the aquaculture sector in Kenya.

The study was conducted in two steps. First, an extensive literature review identified key factors that supported the transition to a commercial sector in the three countries. Two, the review was discussed in a workshop in Nairobi with selected aquaculture experts and stakeholders to identify lessons relevant for Kenya.

3. Insights from the study
The study characterised and analysed seven key factors that have played a crucial role in the development of commercial aquaculture in Ghana, Nigeria and Egypt. Table 2 below summarises the findings.
Table 2: Summary of key factors in aquaculture development in Egypt, Ghana and Nigeria

<table>
<thead>
<tr>
<th>Key factors</th>
<th>Lessons learnt from the comparative study</th>
</tr>
</thead>
</table>
| **Market demand**            | • Identification and farming of species preferred by consumers (catfish vs tilapia: Nigeria) is important.  
                              • Production located close to peri-urban and urban markets to reduce transport costs and assure farmers of an ever-ready market (Nigeria)                                                                 |
| **Environment**              | • Choice of farming environment and production system should take into account:  
                              o Intensive production is achievable in earthen ponds (Tilapia, Egypt).  
                              o Tapping in abundant water reservoirs or lakes to practice cage culture (Tilapia, Ghana).  
                              o Entrepreneurs focusing on tanks and recirculating aquaculture systems (RAS) to produce catfish intensively in backyards on small land area in and near cities (Nigeria).  
                              • Choice of farmed species should take into account experiences in Nigeria:  
                              o Focused on the catfish, the most preferred fish for consumers, which is easy to farm due to its hardness and ability to withstand high stocking densities that are common in RAS and tank systems. |
| **Infrastructure**           | • Poor state of infrastructure increases costs of production (Egypt and Ghana).  
                              • Use of diesel run generators or installation of power systems increases fish production (Nigeria, Egypt).  
                              • Role of the private sector in driving infrastructure investment should be considered.  
                              • In Nigeria the growth of Fish Farming Estates (FFE) has motivated the Government to fund and facilitate the development of roads to ease market accessibility; as well as to improve the accessibility to water and drainage. However, due to poor planning, FFEs have contributed to degrading environmental conditions and may be a source of conflict due to poor waste water disposal. |
| **Technological capacity**   | • Growth of commercial farming has led to demand for improved technical capacity in feed manufacturing and fingerling production in modern hatcheries (Ghana, Egypt and Nigeria).  
                              • Research has contributed to the production of the Akosombo (Ghana) and the Abassa (Egypt) strains of tilapia and to the shortened time in fish production.  
                              • Improved technology shortens the cycle of fish production; hence, ensuring that farmers get maximum profits when using cages (Tilapia, Ghana), tanks and RAS (Catfish, Nigeria) and intensive fish pond (Tilapia, Egypt).  
                              • Despite the vibrancy in feed and fingerling production the three countries still have problems with quality production of fingerlings and feeds. |
| **Investment**               | • Incentives such as waivers on imported cages, tax breaks/tax holidays have worked to encourage investment in the sector for Ghana and Egypt. However, the incentives seem to favour large-scale farmers at the expense of the small-scale ones.  
                              • The Egyptian Government stimulated farmers to commercialize, which in turn resulted in the private sector investing in the aquaculture sector specifically in the feed and fingerling industry.  
                              • The private sector-led industry in Nigeria has developed to a point that entrepreneurs who invested in FFEs have gained economic and political influence in the sector. |
| **Human capacity**           | • Challenges of low human capacity to implement policy and sector strategies are noted as a key issue affecting the sectors in the three countries.  
                              • There is also a lack of sufficient technological capacity among the personnel working for the governments, specifically in extension services, and the labour forces in fish farms. |
| **Institutional governance** | • Policies have shifted in all three countries to support commercialization of aquaculture, and also to encourage the private sector to take a lead role in the sector.  
                              • In all three countries, governments have formulated well-articulated policies and regulations, with the risk that weaknesses occur in the implementation phase, for instance, if not advocated by sufficient funding and human capital.  
                              • Professional associations, specifically the Fish Farmers Associations (FFAs), play a significant role in the three countries for advocacy, and generally influencing a good environment for the sector development. The three countries have supported the presence and formation of the FFAs. However, without grass-root support the FFAs lack influence and become obsolete. |

4. Lessons for Kenya

Core characteristics of Kenyan aquaculture are that it has focused on two main species: the Nile tilapia (*Oreochromis niloticus*) and the African catfish (*Clarias gariepinus*). The main focus for stakeholders promoting the sector has been on the Nile tilapia given its high consumer preference while the high potential of catfish for intensification and consumption has been neglected. There is need to re-orient aquaculture development to embrace diverse opportunities for a sustainable, commercial and competitive sector.

The lessons learnt from the comparative three countries study provide recommendations for consideration in Kenya’s aquaculture development context. These are summarised below.

**Market demand.** The debate on the existence or lack of a fish market in Kenya is complex. While some people say there is no market, others contend that there is a market but there has been failure to tap into it and sustain demand. Majority of consumers also prefer wild fish over farmed fish based on size and taste. The Kenyan Government has for a long time advocated for tilapia farming due to its popularity among consumers, unlike catfish which has low consumer preference. A consumer insight study in selected towns across Kenya by Farm Africa (2016a) showed that fish preference is based on price, taste and ease of access. Tilapia is the favourite species of choice among the rural and urban population and is followed by Omena (*Rastinebola argentea*), Nile perch (*Lates niloticus*) and finally catfish. However, demand for catfish, which is cheaper was found to be higher among people aged...
between 18 and 24 years and among persons from traditionally non-fish eating communities. Farmers close to urban areas should explore production potential of catfish targeting low income groups, as well as value added catfish products for potential high income groups.

Kenya imports fish from Uganda, the rest of Africa, Europe and China. Total fish imports increased by 73% between 2009 and 2014 from 3,378 to 5,853 tonnes. Frozen tilapia imported from China represented 30.8% of all imports in 2014 (Farm Africa, 2016b). The Chinese frozen tilapia is cheap (KES 210 per kg); making it difficult for farmed Kenyan tilapia (KES 270-280 per kg) to compete.

The roundtable recommends to stimulate through consumer campaigns a shift in consumer preferences from harvested to cultivated fish to increase overall per capita fish consumption. In addition, fish farmers should receive technical support to increase supply and access to markets.

Environment. Kenya has an abundant and diverse environment suitable for aquaculture production (Rothuis et al., 2011; Munguti et al., 2014a, b). Some of these environments have been explored while some remain untapped. Intensive earthen ponds for tilapia and catfish farming has potential in the Western parts of the country, close to Lake Victoria.

Fish mobile market. Source: Lattice Consulting Ltd.

In addition, cage culture of Nile tilapia has taken off on Lake Victoria increasing from 1,663 cages in 2016 to 3,696 in 2017 with an average annual production estimated at 2,522 tonnes and valued at USD 8,827,000 (Aura et al., 2018). However, there is need to balance the ecological demands on the lake for fish farming with other needs of other resource users (Aura et al., 2018; Njiru et al., 2018). The Government and other stakeholders have identified ideal sites for cage culture in Lake Victoria. There are many reservoirs in the country where cage culture has not been explored. Nonetheless, loopholes in policy and legislation and lack of finances hamper the implementation and enforcement of such guidelines. Regulations should be put in place first to guide sustainable cage farming in open water systems.

There is also opportunity to produce fish under Recirculating Aquaculture Systems (RAS) in small plots of lands which are close to urban areas specifically Nairobi. These can be taken up by counties close to the city like Kiambu, Muranga and Machakos. The roundtable experts and stakeholders propose identifying production systems that suit different counties based on characteristics such as proximity to market, climatic conditions among others, taking into account environmental sustainability and climate resilience.

Technological capacity. There is need for more investment by the private sector in high technologies in the production of fingerling and feed (two critical inputs) in the country. Kenya lags behind in advanced technology uptake in fingerling and feed production comparable to Nigeria, Ghana and Egypt. About 14 fish feed suppliers operate in Kenya (Opiyo et al., 2018). It is noted that most farmers feed their tilapia using mash and sinking pellets with a feed conversion ratio (FCR) of 2.51 and 2.48 respectively (Farm Africa, 2016c). Despite floating pellets having superior quality of FCRs (between 1.2 and 1.8), the feed costs of imported feed (between USD 2/kg-USD 1.2/kg) are considered too high by local fish farmers. Production of extruded feeds remains a challenge since only two animal feed companies (Una Holdings Ltd and Sigma Feeds Ltd) have the technology to produce floating fish feed.

Fingerling demand in Kenya stands at more than 100 million fingerlings/year while the 127 authenticated hatcheries in the country, owned by both the private-sector (82%) and Government (18%), have a production capacity of 96 million fingerlings/year (Obwanga and Lewo, 2017; Opiyo et al., 2018). The Government of Kenya through KMFRI and KEBS has introduced standards for hatchery operation guidelines, although implementation and monitoring is still limited (Nyonje et al., 2018).

The stakeholders recommend incentives for the private sector such as tax breaks to stimulate fingerling and feed production.

Infrastructure. Poor infrastructure remains a big challenge in Kenya just like in Nigeria, Ghana and Egypt. Fish being a perishable commodity and suitable production sites often being located at a distance from markets, there is need for improving infrastructure to serve the sector and reduce post-harvest losses.

It is recommended to develop infrastructure like cold rooms, and handling and testing facilities for quality assurance of the farmed products. The Government of Kenya could explore private-public-partnerships (PPPs) in infrastructure development similar to what worked in Ghana and Nigeria.

Investment. The investment environment for the Kenyan aquaculture sector can be improved through the farmers striving for an improved market position to obtain improved access to inputs, credit and higher product prices.

Human capacity. The aquaculture sector still suffers from acute shortage of human capacities in extension, research and training and there is an urgent need to develop these extensively.

The roundtable recommends relevant and practical training to enhance capacity and applied research that is linked to industry so as to ensure relevance. A national central platform for data on research findings for all aquaculture stakeholders should be developed.

Institutional governance. Despite private sector playing the lead role in the Kenyan aquaculture sector, their influence on sector development is yet to be felt. The Government plays the facilitator and regulator role, but its commitment to sector development is wanting. Devolution has created confusion about roles and levels of policy implementation, and there is need for a clear framework which will identify roles.

There is need for private sector deliberate involvement in steering sector development. The roundtable recognized that the creation of the Kenya Fisheries Service (KFS) provides opportunities for membership of representatives for an aquaculture stakeholders’ platform as well as advocacy at the highest level. Enhanced sector growth driven policies and a better articulated National Aquaculture Policy could benefit the county level by means of a trickledown effect.
References


3R Kenya Project

The 3R Kenya (Resilient, Robust, Reliable. — From Aid to Trade) project is a learning initiative supported under the Agriculture and Food and Nutrition Security (FNS) program of the Embassy of the Kingdom of the Netherlands. 3R Kenya seeks to assess evidence and lessons from FNS and other related programmes that support competitive, market-led models in spurring agricultural development. It focuses on the aquaculture, dairy and horticulture sectors. 3R Kenya is executed at a time when the Dutch government’s bilateral relations with Kenya are transitioning from a focus on Aid to a focus on Trade to enhance the development of agri-food sectors. Through evidence generation and stakeholder dialogue, 3R seeks to contribute to an understanding of effective conditions for sustainable inclusive trade for transforming resilient, robust and reliable agri-food sectors.

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The brief is a summary of a more comprehensive research report available at http://www.3r-kenya.org/

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