Aquaculture business opportunities in Egypt

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WAGENINGEN UR
For quality of life

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LEI Wageningen UR

LEI develops economic expertise for government bodies and industry in the field of food, agriculture and the natural environment. By means of independent research, LEI offers its customers a solid basis for socially and strategically justifiable policy choices.

IMARES Wageningen UR:

- an independent, objective and authoritative institute that provides knowledge necessary for an integrated sustainable protection, exploitation and spatial use of the sea and coastal zones;
- an institute that provides knowledge necessary for an integrated sustainable protection, exploitation and spatial use of the sea and coastal zones;
- a key, proactive player in national and international marine networks (including ICES and EFARO).
- cooperating with AFI and LEI in “Wageningen Aquaculture”.

Wageningen Aquaculture:

- A consortium of IMARES, LEI and the Aquaculture and Fisheries Group of Wageningen University.

NUTRECO:

Nutreco is a global leader in animal nutrition and fish feed. Our advanced feed solutions are at the origin of food for millions of consumers worldwide. Quality, innovation and sustainability are guiding principles, embedded in the Nutreco culture from research and raw material procurement to products and services for agriculture and aquaculture. Experience across 100 years brings Nutreco a rich heritage of knowledge and experience for building its future.

PUM:

PUM Netherlands senior experts connect entrepreneurs in developing countries and emerging markets with senior experts from the Netherlands each of whom has gained at least 30 years of experience in a business environment. These senior experts voluntarily devote their knowledge to the execution of short-term, solid consultancy projects at the work floor.

Contents

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Summary

Egyptian fish farming has witnessed a spectacular development resulting in an industry that is number 7 worldwide and number 2 in tilapia production. As such the industry is an important contributor to Egypt's economy as well as a major provider of cheap fish protein. However, there are a number of developments that potentially could result in a stagnation or even collapse of the industry. The main issues and consequences are:

- Low fish prices and increasing fish production costs resulting in eroding profitability of farms and thus no investment in technology development and innovation.
- Lack of processing and freezing capacity which results in an inability to access new export markets.
- Fish farms are only situated in areas unsuitable for agriculture, and using water only from lakes and drainage canals.
- Erratic cage culture policy and often no spatial planning for aquaculture areas.
- Low priority of government, no operational extension service, weak professional organisations and weak linkage between research and industry.
- Rather traditional farming technology (tilapia) including use of low quality feeds and wild fry (marine aquaculture).

Our study illustrates that within the currently available land and water resources, Egypt can potentially increase its total tilapia production from 700,000 tonnes to 1,400,000 tonnes, resulting in an increase in the economic value of the sector to over 1% of the current GDP. In order to realize this potential, the first requirement is to increase the current farm profitability. When this is realized, capital will become available that allow farmers to invest into new production technologies, market innovations and new organisational structures, that will than result in more fish and new markets.

We identified a number of measures that will enhance the profitability of tilapia farming, listed a number of technical and market innovations and identified specific business opportunities for Dutch companies.

The Netherlands is a small player in the global aquaculture industry. However, its strength lies in the close cooperation between the (supportive) industry and research & knowledge institutions. Therefore we recommend the Embassy of the Kingdom of the Netherlands (EKN) to facilitate:

1. Business-to-Business activities that will contribute towards the further development of the Egyptian aquaculture industry as well as towards business development for Dutch companies: thematic workshops, facilitation of Dutch investment into new feed mills and/or transfer of fish feed technology, and a pilot fish processing facility for the Al Fayoum association. For the facilitation of these activities, the EKN could consider joining efforts with the US Embassy since the American soy bean export council and USAID have a similar interest in aquaculture.

2. Government-to-Government activities: start a political lobby through the Egyptian National Competitiveness Council (ENCC) to stimulate the Egyptian government to develop a clear and realistic vision for aquaculture, to make and revise legislation and to invest into research and innovation, to build capacity on the planning and management of aquaculture, and to integrate sustainable marine fish and crops (aquaponics) production systems through the "More Crop per Drop" program of "Water Mondiaal".

1 Introduction

On request of the Embassy of the Kingdom of the Netherlands in Cairo, a team of Wageningen University and Research centre (the institutes IMARES and LEI), the fish feed company Skretting and PUM Netherlands senior experts, carried out assessment of the Egyptian aquaculture industry.

The aim of this research project is threefold, namely:

- To prepare an analysis of the Egyptian aquaculture sector.
- To identify opportunities and constraints for the Egyptian industry and business opportunities for Dutch companies.
- To provide recommendations to the Netherlands Embassy for further actions on aquaculture development in Egypt.

This document is the result of an intensive collaboration between business and science. This type of collaboration, both at project and sector level, has been the basis for the successful development of the Dutch agro-food sector. It is the interaction between the different partners that leads to new insights, innovations, business opportunities and economic development. As such, this approach can be used as model for the new way of development cooperation.

2 The Egyptian aquaculture sector

2.1 Production

Egypt's main sources of fish production for its fast growing population (1.922% in 2012) include marine and inland capture fisheries and brackish and fresh water aquaculture. According to FAO total fisheries production increased from 724,408 tonnes in 2000 to over 1.3 million tonnes in 2011. This increase was completely obtained from an increase in aquaculture production. The aquaculture sector in Egypt is now a mature one having developed over a period of more than 30 years. In 2011 the total production value of the aquaculture sector amounted to approximately USD 2 billion or just below 1% of GDP. In Egypt aquaculture production is strongly concentrated in the delta region north of Cairo. Besides a limited production of crustaceans (766 tonnes in 2011) the aquaculture sector produces predominantly fish.

Tilapia, carp and mullet compromise of the majority of aquaculture production indicating a narrow production basket. In 2011 the share of tilapia had increased to 62%. However, according to a survey conducted by Macfadyen, G. et al. (2011) 89% of the volume of farm production in 2010 was accounted for by tilapia. These figures are considerably higher than official figures. Other major species are mullet (140,000 tonnes, carp (200,000 tonnes), and to a lesser extent also seabass (17,000) and seabream (14,000 tonnes). Finally since 2008, production of meagre started and reached 12,000 tonnes in 2011.

Egypt is a global player in the aquaculture industry. Egypt's aquaculture production is by far the largest of any African country (about 64% share of total production in 2011). Furthermore, its fish farm production volume ranks seventh of all fish farming nations (see figure 2.1). When taking a closer look at tilapia as the most important farmed fish species, Egypt ranks second behind only China (see figure 2.2) with a total value of about 900,000 USD.

Figure 2.1 *The seven most important fish farming countries in 2011 (in tonnes).*
Source: FAO-FIGIS.

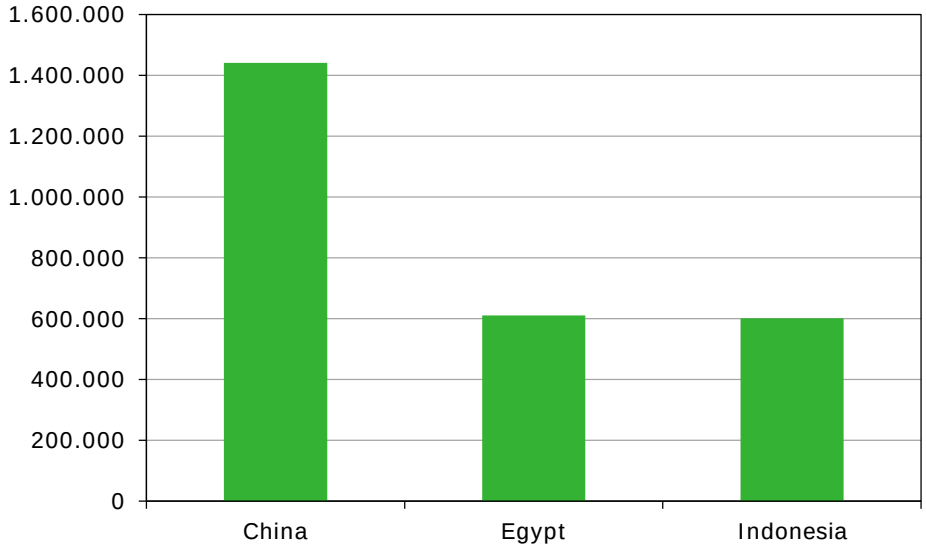

Figure 2.2 *The three most important tilapia farming countries in 2011 (in tonnes). Source: FAO-FIGIS.*

2.2 Aquaculture production systems

Semi-intensive pond culture

Semi-intensive aquaculture in earthen ponds is the most dominant fish farming system in Egypt representing approximately 85% of the total production. Fish ponds vary in size from 0.5–13.0 ha with a depth of 50–150 cm. Nile tilapia (*Oreochromis niloticus*), mullets (*Mugil cephalus* and *Liza ramada*) are the major culture species. The stocking densities, energy and feed input, level of management as well as the size and type of infrastructure vary greatly among different farms (El-Sayed, 2007). Tilapia fry are obtained from hatcheries that produce all-males through the administration of hormone treated feed. A typically farming cycle starts in January with the production of fry and fingerlings in tanks covered by simple greenhouse structures. The grow-out ponds are stocked in March-April and harvested from September-November. Production in semi-intensive systems varies from 5–10 tonnes/ha/production cycle (7–12 months).

Intensive production in ponds and tanks

Intensive pond culture is developing in many areas in Egypt, especially in the newly reclaimed agricultural lands in the desert (El-Sayed, 2007). These systems use smaller and deeper constructed earthen ponds (sometimes lined with polyethylene sheets), stocking densities are higher and intensive feeding and aeration are provided (FAO, 2010). Nile tilapia (mainly monosex) is the major cultured species in intensive systems. Also tanks are used for intensive fish production. In desert aquaculture, fish tanks are integrated to agriculture and this form of aquaculture is expanding rapidly particularly in the western desert region (2011 & 2013 MP/GTZ financial services). Egyptian desert aquaculture comprises more than 100 small rural intensive farms and 20 large commercial aquaculture farms. Nile tilapia and African catfish are the main cultured species when freshwater from underground reservoirs is used. Often the effluent from this type of fish production is used to irrigate fruit trees, vegetables and flowers (Heijden, 2012). Fish culture in Recirculation Aquaculture Systems (RAS) is new and emerging, mostly on pilot/experimental scale and sometimes integrated with the production of vegetables (aquaponics). The total contribution of these intensive systems is <5%.

Intensive production in cages

Cage farming is common especially in the most northern branches of the Nile Delta. It contributes circa 10% of total aquaculture production. The number of cages in operation is much affected by erratic government policy to restrict and then re-allow cages to operate. Nile tilapia is the principal cage culture species. The sizes of the cages vary from small cages of around 32 m^3 to larger cages of around 600 m^3, with a productivity of 5-35Kg of fish per m^3 depending on management.

Marine aquaculture

Marine aquaculture is a new activity; its current production represents only 5% of the total aquaculture production in Egypt. The major species are seabream, seabass, meagre, and shrimp (*Penaeus indicus*), that are cultured in semi-intensive brackish-water ponds, often in polyculture with mullet, mainly in the Dibah Triangle Zone located between Damietta and Port Said. Meagre is of particular interest because its high demand (domestic and for export), its fast growth rate and tolerance to a wide range of salinities. The current production in this area is estimated at 12.000 MT. Next to the coastal environment, marine fish (particular seabass) are also produced in tanks using brackish ground water, or in cages situated in brackish lakes. Although requests have been put forward to the governmental authorities, at present no cage farms are operational at the Red Sea. There is also an initiative to farm seabass in cages in brackish water lakes near Al Fayoum in the desert.

Traditional extensive production systems

With the “hosha” farming system enclosures are made in natural waters like lagoons, rivers and lakes. Fish (mainly tilapia) are trapped in the hosha and rely on natural food. The system is characterized by low levels of intervention, limited use of inputs, low capital investment, and low yields of approximately 250 kg/ha. Because of environmental damage and interference with lake fishing the *hosha* system is now prohibited although it still continues illegally in some places (El-Sayed, 2007). Another traditional extensive production system is rice-fish farming, however due to due to the decline in the rice farming area in parallel to the limited available water, the fish production from this systems is declining rapidly (2012 GJFAR study). Fingerlings (mainly Nile Tilapia obtained from hatcheries) are stocked in rice fields and yield on average 300–500 kg/ha (El-Sayed, 2007).

2.3 Inputs

2.3.1 Water

Egypt has more than 2,450 km of coastline, as well as 8,700 km^2 of inland water: the Nile River with many irrigation canals, six northern coastal lagoons opening to the Mediterranean and two opening to the Suez Canal, and the great reservoir behind the Aswan's High Dam (Lake Nasser; FAO, 2010). Fresh groundwater resources contribute 20% to the potential water resources in Egypt. One of the groundwater resources is the Nile Valley and Delta system with the storage capacities of 200 billion m^3 and 300 billion m^3, respectively (JARC, 2006). The Ministry of Water Resources and Irrigation allocates irrigation quotas for water use for agricultural crops, but not for fish farming (Macfadyen, G. et al. 2011). Although aquaculture is a major industry, the sector is not allowed to use irrigation/Nile water (with the exception of hatcheries), and is generally dependent on water from agricultural drainage channels and groundwater. As a result, while not universally the case, it is certainly true that many farms face problems with water quality, especially when they are located at the downstream end of agricultural drainage channels. In such instances water may be used in turn by fish farms, with increasingly poor water quality, especially when fish farms are not well designed with proper inlet and drainage structures (GTZ, 2011). This practice of re-use of water, coupled with inadequate farm design, also means that if there is a disease outbreak, disease can quickly spread through the farms. According to the World Bank in Egypt the unmet water demand (in Million Cubic Meters) for the current situation and the future for the average climate projection is expected to increase from 2,858 (2000-2009) to 22,364 (2020-2030). This is the result of an increased water demand for irrigation as well as a growing urban population. This means that future fish production systems should be based on more efficient fresh water use, such as RAS and integrated cultures, and that marine aquaculture should be developed more.

2.3.2 Capital access

Egyptian Small and Medium Enterprises (SMEs) which represent more than 90% of private companies in Egypt, have poor access to financial services. Loans from banks to the agricultural sector, including aquaculture, represent just 2.5% of total outstanding loans. Banks are usually hesitant to lend to

SMEs due to the perceived risk and lack of registration of SMEs. Both state-owned and private banks are reluctant to finance aquaculture projects because they do not know the sector and are not prepared for carrying out proper risk assessments. Furthermore, loans are granted only after the verification of the customer's ownership of the land but most of SMEs in the aquaculture sector do not own the land. Specific guarantees such as fixed assets (e.g. house, buildings), movable assets (e.g. agricultural machineries and equipment) or savings certificate are also asked and most SMEs are not able to provide these guarantees. Accordingly, only large aquaculture enterprises have been able to obtain credit from the formal financial sector so far, at a commercial interest rate between 12% and 14%. Soft loans to the aquaculture sector have been provided by the Multi Sector Support Programme (MSSP) and the Agricultural Research and Development Fund (ARDF). However, the sector has not been successful in obtaining such soft loans which currently represent only 1.5% of ARDFs outstanding loans. Another source of soft loans for SMEs is the Social Fund for Development (SFD) but, again, the extent of SFD credit provided to the aquaculture sector is very small (fisheries and aquaculture case study series egypt.pdf; GTZ, 2011; Ulrich Kleih, John Linton, Ana Marr, Murdoch Mactaggart, Diego Naziri,and John E.Orchard, 2013).

The most used source of credits by farmers is the purchase of inputs (feeds and seeds) on a credit basis from the suppliers, mostly wholesalers. The input suppliers do not charge any interest for the differed payment of the input but require the payment of the inputs as soon as possible at harvest time, regardless of which may be the best time to market the fish. Thus, farmers are somehow forced to harvest and sell their fish during the main season, in October- November, when the market prices are the lowest. Several traders offer farmers the opportunity to receive credit for the purchase of inputs. The contract between the farmer and the trade entails the sale of the fish at an agreed price usually lower than the market price at harvest time. Small and medium-scale aquaculture enterprises rely predominantly on informal sources of credit that, while important, are often either inconsistent or have unfavourable terms and conditions.

2.3.3 Labour

An estimated 160,000 people were directly and directly employed in aquaculture in 2007 (FAO, 2010). They range from people running small scale family fish farms, to hired staff in fish hatcheries and larger aquaculture farms, to consultants, feed mill staff, engineers, transport, processing and other support activities.

2.3.4 Land

By law, fish farming should never develop on agricultural lands. Salty lands are temporarily allowed to aquaculture for a specific period and switch to agriculture once salt is leached and land suits agricultural production. Consequently, fish farms are mostly concentrated in the Delta regions around Northern lakes (Burlus, Edku and Manzalla) where the water resources and non-agricultural lands are available (CIHEAM, 2008). Farmers in Egypt usually rent land, mainly from the government through the General Authority for Fish Resources Development (GAFRD). Rents are low but leases are short, traditionally only 3-5 years. Farmers willing to install infrastructure for intensive farming prefer to buy land if possible in order to gain security of tenure and avoid the risk of losing expensive fixed infrastructure. However, the government discourages land sales and prices are fairly high, typically between USD9,000 and USD26,000 a feddan (MP financial, 2013; GTZ, 2011). According to GAFRD officials the legislation has recently been changed and the 5 year lease contract will now be more or less automatically extended (up to a maximum of 25 years) provided that the lease taker has not violated the lease conditions.

2.3.5 Energy

Many farms are not connected to the electricity grid and are prevented from installing electricity on rented land. This means that their power costs are increased because of the need to use generators and/or diesel pumps. Power/fuel costs have risen in recent years and is periodically unavailable in some locations (Macfadyen, G. et al. 2011).

2.3.6 Feed

Macfadyen, G. et al. (2011) reports there are 25 fish feed mills in Egypt, producing more than 300,000 tonnes of fish feed each year. Five mills produce extruded fish feed and their production represents around 20-25% of total fish feed production. Feed mills also provide a wide range of different feed formulations to match the requirements of different stages of the growth cycle (e.g. different protein content). In addition to the registered mills, there are around 50 small-scale pelletizing units, the annual production of each is 3,000 – 4,000 tonnes of fish feed with total annual production of 120,000 to 240,000 tonnes. These pelletizing units use simple technologies and are not equipped with air driers, and simply offer the service of pelletizing farmers' feed ingredients.

Feed industry estimates the total potential feed market at 1.5 million tons in Egypt; at the moment 9% is extruded, 60% is pelleted; and 31% is feeding by products (such as wheat bran). The market for extruded feeds is growing and in 2013 several extruder projects are in-progress (pers. inf. this study).

More than 60% of raw materials for fish feeds have to be imported in Egypt. Increasing world market prices of raw materials resulted in an increase of fish feed prices with 200–250% over the last 6–7 years (Macfadyen, G. et al. 2012). In 2012 feed prices increased from 450 to 550 Euro/MT for 32% protein feed. These prices will seriously affect profitability of the farmers as fish prices did not increase.

2.3.7 Fingerlings

GAFRD in 1997 issued licences for private hatcheries, which produce mainly mono-sex (using hormone treated feed for sex-reversal) and/or mixed sex tilapia (CIHEAM, 2008). The number of fish hatcheries has increased from 14 in 1998 to over 600, of which many are unlicensed private hatcheries (GAFRD, 2009). The production of fry from hatcheries is about 347 million units of a different species, mainly Tilapia, carp and catfish. Apart from the efforts made by WolrdFish, there are usually no specific breeding and selection programmes. There are doubts about the quality of fry and sex reversal is often less than 100%.

The supply of mullet (spp.) and meagre fry, and to some extent sea bream and sea bass, are dependent on collection from the wild. There are several fry collecting stations in seven governorates, where wild caught fingerlings are collected for distribution. There are also indications of large scale illegal collection of wild fry that may affect wild stocks considerably.

2.4 Value chain organisation

The domestic value chain for farmed fish is short and efficient. Key features of the value-chain include a very short time-period (1-2 days) from harvest to final consumption by the consumer and low post-harvest losses (Macfadyen, G. et al. 2011). This reflects an efficient domestic distribution system with production located close to major population centres and currently limited export volumes. Within Egypt, the value-chain for farmed fish in Egypt is comprised of three main stakeholder groups before fish reaches the consumer. As can be seen in figure 2.3 these are respectively the fish farmers, fish traders/wholesalers and the retail and food service sector.

Figure 2.3 *The domestic value chain for farmed fish in Egypt.*

There are two main types of farmed fish retailers in Egypt. The first group engage in 'informal' street sales, which take place usually by individual operators who purchase fish from wholesale markets or traders, and then set up shop by the roadside to sell their product. The second group is more formalised, with sales taking place from retail shop facilities, and retailers may also have fridges and or freezers for storing fish if it cannot be sold the same day it is purchased (Macfadyen, G. et al. 2011). Traders/wholesalers are key players in the value-chain, especially in terms of determining prices. Furthermore, the traders/wholesalers play a key role in providing finance to many of the fish farms, along with feed mills/traders in many cases (Macfadyen, G. et al. 2011).

Capacity to process, freeze (-35°C) and store fish for later sale is limited. A cold chain in the sense of an unbroken temperature-controlled supply chain which maintains a temperature range of below -18-20°C (instead of 0°C or -6-10°C) is currently not in operation in Egypt.

The value chain for imported fish does not differ much from the domestic value chain for farmed fish. Following import, imported fish enters the domestic value chain at the level op trader/wholesaler and subsequently the retail and food service sector.

2.5 Market and prices

Fish is the cheapest source of animal protein in Egypt. Per capita fish consumption in Egypt is estimated to be between 16 and 20 kg/year, which is around the world average. In general three main domestic market segments can be identified:

1. *Poor*
   This segment is price dominated at a price of 3-4 EL/kg. Quality is not an issue. Mostly cheap imported fish. Preference for small sizes. For tilapia 5 fish/kg.
2. *Upper lower*
   In this segment people are able to pay 10 EL/kg for a tilapia. More attention for quality. Preference for slightly larger sizes. For tilapia 3-4 fish/kg.
3. *Middle and up*
   In this segment people go for anything they like. Quality is the main issue. Preference for larger sizes. For tilapia >500 gram fish.

There is a traditional distrust of the quality of farmed fish as well as frozen and processed fish (filleted). Consumers prefer chilled or live fish above frozen fish and frozen whole fish above frozen fillets Macfadyen, G. et al. (2011). Most fish species are generally sold either fresh or on ice. However, in Fayoum governorate there appears to be a growing trend for the sale of live tilapia. Here tilapia is almost all sold live, and transported in drums/tanks with oxygen by traders/wholesaler and to retail and foodservice. Trade data confirms the idea that Egyptian consumers prefer to buy whole fish. There is a drastic decline in the imports of fillets while imports of whole fish increase.

Currently, mullet commands the highest price for farmed (fresh)water fish, followed by tilapia, catfish and carp. Farm gate prices vary according to the size of the fish. For example tilapia of 100 gram is sold for about 8 EL/kg, while tilapia of >500 gram is sold for approximately 14 EL/kg. In Egypt there is a strong seasonal as well as daily fluctuation of fish prices. Fish prices fluctuate strongly throughout the year. During the winter supply is low and the price of fish increases. This low supply is the result of the low temperature during the winter, which increases the likelihood of crop failure as a result of mass mortality. When fish are harvested there is a supply glut causing a strong prices decline of domestic fish. Besides seasonal price fluctuations due to changes in supply volume, there are also daily price fluctuations as a result of poor health and hygiene in wholesale and retail markets.

Average farmed fish prices (farm gate) have only risen slightly over the past 10 years. From figure 2.4 it becomes clear that when taking into account an average inflation of about 7% during this period farmed fish prices have fallen in real terms (UNDATA, 2012).

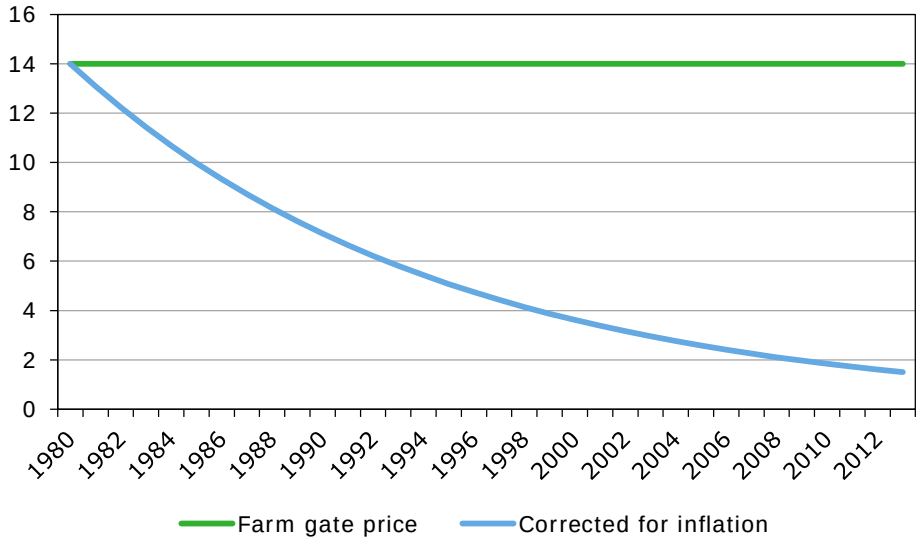

Figure 2.4 *Farm gate prices corrected for inflation (indicative); period 1980-2012.*

This net price decline is a result of several reasons. First local fish demand that has failed to keep up with the increased fish supply. Despite a rapidly growing population (1.922% in 2012) the average annual per capita consumption of tilapia has increased from approximately 2.4 kg in 2001 to about 11.6 kg in 2011. As a result the domestic market has become increasingly saturated. Second there is a general lack of market differentiation. In the domestic markets there are fish farmers that are now experimenting with how to access higher market segments through improved quality and marketing, while exports of farmed fish are limited at present. Third there has been virtually no new product development (lack of value addition and processing). The only real trend that could be identified in this respect was from trade in whole fish to trade in live fish. Fourth, the above mentioned seasonality in supply. Fifth the limited capacity to process, freeze and store fish for later sale that was mentioned in section 2.4. Finally, the above mentioned poor consumer perceptions of the quality farmed fish.

2.6 Fish trade

Fish imports fill the gap between domestic fish production and consumption. Based on FAOSTAT data Egypt is currently approximately 85% self-sufficient as far as fish are concerned. Macfadyen, G. et al. (2011) reports that the national aquaculture strategy targets to produce 1.5 million tonnes of fish by 2017 of which 1 million tonnes is contributed by aquaculture in order to become independent of imports. When taking into consideration that the majority of fish imports constitute cheap fish for the lowest market segment it seems unlikely that this strategy of substituting cheap imports with more expensive tilapia will work unless of course the disposable income of the poor increases.

According to the latest FAOSTAT data in 2009 Egypt imported about 224,000 tonnes of fish (mainly frozen fish blocks) with a total value of approximately USD 385 million. In 2010 Egypt sourced 26% of its total imports from the Netherlands. Other important suppliers are Vietnam (14%) and Norway (9%) and a number of other suppliers such as Yemen, Spain, China and Pakistan which all contribute about 4% to total imports. While the contribution of fish fillets and fresh fish decreased, the imports of frozen whole fish, crustaceans and molluscs increased. The imports of frozen whole fish, which are the most relevant for this study, increased from 88,185 tonnes in 2008 to 133,409 tonnes in 2012. Frozen whole fish represents 74% of total imports. The most important suppliers of frozen whole fish were in 2010 the Netherlands (29%), Japan (20%) and Norway (11%) (COMTRADE). According to different sources in 2012 the total import volume of fish from the Netherlands was estimated at around 180,000 tonnes and about 250,000 tonnes from other countries. The total estimate (about 430,000 tonnes) is considerably higher compared to the 2009 FAOSTAT data.

In 2009 Egypt exported approximately 4,400 tonnes fish (mainly fresh or chilled) with a total value of about USD12 million (FAOSTAT). Trade statistics do not reveal whether Egypt's exported fish is wild or cultured. At this moment only 10 establishments have been approved to export fish to the EU. According to the Veterinary Authority of the Ministry of Agriculture these establishments are only approved for exporting marine fish. The Veterinary Authority reported that EU approval for exporting fresh water fish has so far not been requested. Furthermore, a monitoring system for assessing the presence of contaminants in the fish tissue of fresh water fish is presently not in place making it difficult of obtain EU approval to export fresh water fish.

2.7 Institutional environment

The Ministry of Agriculture and Land Reclamation (MOALR) is responsible for the management of fisheries and aquaculture. Implementation of sector policy and legislation has been delegated to the General Authority for Fisheries Resource development (GAFRD). Other ministries that share responsibilities towards aquaculture are the Ministry of Water Resources and Irrigation (MWR), the Ministry of Environment, and the Ministry of Defence. Main research bodies are the Central Laboratory for Aquaculture Research (CLAR), National Institute of Oceanography and Fisheries (NIOF), WorldFish centre, and various universities (Macfadyen, G. et al. 2011).

According to information obtained from GAFRD, Egypt has a national aquaculture 2030 strategy. Main elements are the further development of fresh water aquaculture including cage farming and desert aquaculture with a focus on enhancing the quality of fish, and the development of marine aquaculture including the zoning of coastal areas for aquaculture development, establishment of pilot and demonstration farms for training and extension services, and cage farming.

However, under the current political situation it is unclear if the capacity and resources are available to implement the aquaculture strategy. At this moment aquaculture is not a real priority for the Egyptian government. Extension services are not operational, no specific financial support is available for aquaculture, the licensing procedures for new aquaculture farms are slow because of the different Ministries involved, and the linkage between government, research and industry is weak.

Currently two professional organisations are operational: the Cooperatives and Union of Aquatic Cooperatives (1,796 producers), and the Egyptian Fish Producers and Exporters Association (26 members: fish producers and feed suppliers). Neither of these are fully representing the industry, both lack finance, and consequently the sector organisations have a limited role as towards political lobby, technology sharing and marketing.

2.8 Conclusions

Egyptian fish farming has witnessed a spectacular development resulting in an industry that is number 7 worldwide and number 2 in tilapia production. As such the industry is an important contributor to Egypt's economy as well as a major provider of cheap fish protein. However, there are a number of developments that potentially could result in a stagnation or even collapse of the industry. The main issues and consequences are listed in table 2.1.

Table 2.1

Main issues and consequences for aquaculture development in Egypt.

Issue	Consequence
Eroding profitability of farms. Low fish prices and increasing fish production costs	No investment in technology development; No innovation
Saturated domestic market	Possible threat of a sector collapse
Lack of processing and freezing capacity which results in an inability to access new export markets	Possible threat of a sector collapse
Monitoring system for assessing the presence of contaminants in the fish tissue of fresh water fish is in not in place	Cannot export fresh water fish to EU
Fish farms only in areas unsuitable for agriculture, and water only from lakes and drainage canals.	Reduced productivity; Increased production costs Reduced fish quality; implications for export
Erratic cage culture policy	No investments
Often no spatial planning for aquaculture areas	Water and energy infrastructure is weak resulting in sub-optimal fish productivity
Low priority of government; No operational extension service; Weak professional organisations; Weak linkage between research and industry	No investment in technology development; No innovation
Rather traditional farming technology (tilapia) including use of low quality feeds and wild fry (marine aquaculture)	Industry does not achieve its full production potential

3 Development potential

3.1 Food security and Markets

The importance of fish as a crucial element in diets is now widely recognised. Besides providing nutritious and healthy food, fish are also very efficient converters of feed, compared to other livestock. The contribution of aquaculture to food security can be divided into the direct and the indirect contribution. The direct contribution is through the provision of high quality food, self-employment and income; the indirect contribution is through food supply to communities, employment opportunities for communities and infrastructure improvement (Rothuis et al., 2012).

Based on FAOSTAT data the calculated per capita fish consumption in Egypt is about 19 kg. In order to maintain this level of fish consumption in 2022, the total annual fish production has to increase by approximately 900,000 tonnes. In order to maintain the current level of tilapia consumption (based on domestic production) in 2022, the total annual tilapia production has to increase by approximately 560,000 tonnes. This increase in tilapia production can theoretically be achieved by digging an additional 80,000 ha of semi-intensive ponds thereby increasing the pressure on already scarce land resources. However, this increase in production volume can also be achieve through intensification, namely by increasing productivity from 7 tonnes/ha/yr. to 14 tonnes/ha/yr. This will be discussed in section 3.2. As was discussed in section 2.5 at present the domestic market for tilapia is saturated. This is related to consumer purchasing power as well as the current state of technology. The latter interferes with proper production planning (see section 4.2). Therefore if productivity increases faster than domestic demand new products need to be developed and new markets need to be found in order to ensure further growth of the sector. As the global population is predicted to increase from its current seven billion to most likely around eight billion in 2030 new markets will also continue to develop outside Egypt if tilapia can be produced at the right quality and at a competitive price. Furthermore changes in the size and nature of global per capita demand as a result of future levels of GDP growth will have an effect on the demand for fish. If GDP levels increase the demand for fish will increase substantially, at least in line with other protein foods (The Government Office for Science, 2011). The majority of this demand will need to be met by aquaculture.

In 2012 frozen tilapia fillets were imported to the Netherlands for on average €3.87/kg (EUROSTAT). Even when Egypt obtains approval to export fresh water fish to the EU it will be difficult to compete at this price when taking into account fillet yield, glazing, plant costs, labour cost for filleting and processing, cost for packaging and transport. However, in the same year (minor quantities of) fresh tilapia fillets from South-America were imported to the Netherlands for on average €6.21/kg (EUROSTAT). Considering the relatively short distance from Egypt to EU countries compared to countries that are currently supplying fresh tilapia fillets to the Netherlands, exporting fresh tilapia fillets from Egypt to the EU market appears to offer some potential.

3.2 Technology and Management

The present average productivity in semi-intensive pond based Tilapia farming is approximately 7 tonnes/ha/yr. However, if we consider pond culture of tilapia production in countries like Ecuador and Costa Rica, productions of 12-15 tonnes/ha/yr. are possible. Aeration allows higher stocking rates and double cropping is feasible with bigger fingerlings in spring. The same applies to cage farming. Current productivity of tilapia in Egypt is approximately 20-30 kg/m^3 while a potential productivity of 100 kg/m^3 is possible. This illustrates that Egypt can increase its fish production within the currently available land and water resources. In case the pond productivity can be doubled to 14 tonnes/ha, the total tilapia production will increase from 700,000 tonnes to 1,400,000 tonnes with a subsequent increase in the economic value to the sector to over 1% of the current GDP.

3.3 Foreign investments

International fish feed companies like Nutreco (Skretting), Aller Aqua, De Heus and Cargill are moving in to the Egyptian aquaculture sector. Very recently Nutreco announced that (together with two other partners) it acquired full ownership over Hendrix Misr. Nutreco had, since 2001 a share of 33% in Hendrix Misr. Hendrix Misr is Egypt's market leader in extruded fish feed (mainly tilapia) which is sold under the trade name Skretting, and a leading producer of poultry feed concentrates. Total revenue in 2012 was approximately €25 million. Nutreco intends to expand the current fish feed capacity of 25,000 tonnes to 75,000 tonnes by 2015. Full ownership of Hendrix Misr offers Nutreco a good base to expand its activities in this growth market.

4 Realization of potential

4.1 Introduction

In order to realize the full potential of Egyptian (tilapia) aquaculture, the first requirement is to increase the current farm profitability (see figure 4.1). Only when this is realized, capital will become available that allows farmers to invest into new production technologies, market innovations and new organisational structures, that will than result in more fish and new markets.

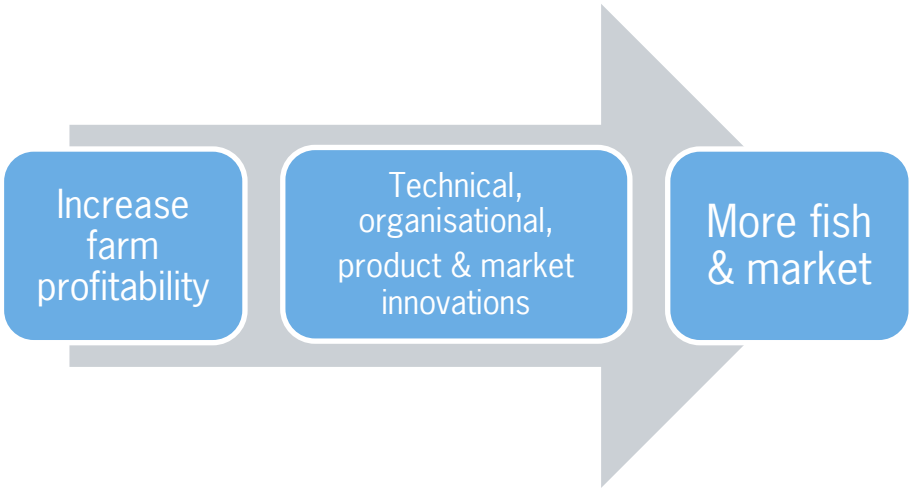

Figure 4.1

4.2 Increase of farm profitability

With regards to the aquaculture sector there is currently no value-addition at all in terms of processing. As mentioned in section 2.5 there is a strong distrust of frozen fish, and also to some extent of processed fish. As a result options for value-addition for the Egyptian market seem to be limited at this time. Nevertheless there are still opportunities to obtain higher market prices.

These are the following:

1. *Production planning*
   By overwintering of fish (risks and management/technical solutions) supply can be spread more equally over the year. Through proper production planning farmer can supply the market with fish with the right characteristics at a time when supply is relatively low thereby increasing the chances of obtaining a higher price.
2. *Product differentiation*
   As opposed to the lower market segment, in the higher market segment there is an increased focus on product quality and a reduced focus on price. This provides an opportunity for improved marketing of fish through branding (incl. packaging) and either working with chain stores and retail outlets or larger companies establishing and selling their own brand of fish.
3. *Organisational development and institutional strengthening*
   Cooperatives and export associations exist. However, their performance is currently hampered by a variety of issues like lack of trust and initiative among the members and/or financial difficulties. Nevertheless well developed and strengthened producer organisations have in different countries (e.g. the Netherlands) proven to be able to reduce the cost of purchasing inputs and improve marketing through joined efforts.

4. *Improved feed management & feed quality*
   Next to feed quality is the issue of feed management. Most farmers do not feed according to specified feeding tables that relate the daily feed amount to the actual fish biomass in the pond. It is estimated that with using appropriate feeding management the Feed Conversion Ratio (FCR) can be improved from 2.1 towards 1.3 – 1.4.

Once farm profitability is improved, capital will become available for investments in new technical and market innovations, which will be discussed in detail in the following sections.

4.3 Technical innovations

A number of technical innovations and improvements can be considered for increasing the productivity (and/or further reducing the cost price) of aquaculture in Egypt. For the intensification of tilapia pond culture:

- Improvement of the water quality.
- Improved fry and fingerlings
- Improved feeds
- Extended production period
- Alternative production systems.

4.3.1 Water quality

Available oxygen concentration is of direct influence on the fish productivity. Low oxygen levels can be increased by enhanced water exchange (provided that the intake water is of sufficient quality), and by the use of specific aerators such as paddlewheels. The water quality of the intake water can be improved through the construction of specific sedimentation ponds for the removal of solids and/or bio-filters for the reduction of nitrogen compounds and dissolved organic matter. On a regional/cooperative level the water quality can be improved by (re-) designing the water supply and drainage infrastructure in such a way that intake and effluent water is strictly separated and not re-used by other farms. Aeration and proper mixing can also enable biofloc production in tilapia ponds. Bioflocs are tiny aggregates of active sludge microbes that clean the water and the microbial biomass gain (microbial protein) can be directly consumed by tilapia. This will improve nitrogen retention significantly, moreover water quality improves and feed costs can be reduced.

4.3.2 Fry quality

Significant improvements in terms of growth rate and survival can be realised through the utilization of improved tilapia strains. World Fish has recently introduced an improved tilapia strain that grows 30% faster than the most commonly used strains in Egypt. Also the application of specific on-farm breeding programmes will result in high quality fry with improved production performance.
The YY ‘super’ male technology offers certain advantages, such as higher degree of males, over the currently used sex-reversal technique using methyl-testosterone. Furthermore, hormone treatment might involve risks associated with improper use (environmental as well as human health risks) and negative market acceptance.

4.3.3 Feeds

Extruded feeds are known to improve growth and feed efficiency through higher nutrient digestibility (especially of starch), as well as that floating feeds allow for easy feed management and reducing feed losses by more durable pellets. However, the majority of the farmers are not aware of these benefits. Most farmers by feed based on the price per kg of feed instead of cost-of-feed/kg tilapia produced.

Table 4.1

Feed from farm data: Kafr El Sheikh.

	Feed price LE/kg	Feed conversion ratio	Cost-of-feed/kg tilapia
Extruded feed	4.4	1.5	6.6
Pelleted feed	3.7	2.1	7.8

The table illustrates that while pelleted feed is much cheaper per kg, the extruded feed converts much more efficient into kg tilapia and thus has the lowest cost of production. In this example, taken from average farm data there is a saving of 1.2 LE/kg tilapia when switching to extruded feeds.

4.3.4 Extended production period.

Due to the cold winter months most tilapia farmers harvest their ponds between September and November. The large supply of fish in these months results in low prices. If year round production would be possible, farmers can adjust their production cycle (stocking and harvest) to the market needs. The first step could be to overcome mass mortality of fish kept throughout the winter months, by bringing the fish in optimal condition before the temperatures start to drop. This could be done by feeding specific “overwintering feeds” rich in energy and essential micro-nutrients. Other more experimental technology to make year round production possible include the use of (stored) thermal underground water, greenhouses (for intensive tank culture) and Recirculation Aquaculture Systems (see below).

4.3.5 Alternative production systems.

In aquaculture production systems where fish are fed a formulated feed, nutrient recovery in harvested fish represents typically 25% of applied nutrients. Aquaculture can improve nutrient utilization efficiency by considering waste nutrients as resources and designing systems to promote recovery. One option is the biofloc technology (BFT), based on microbial control of water quality within the pond. Protein utilization in BFT systems can be twice as high as in conventional ponds. Thousands of hectares of commercial shrimp and tilapia production ponds, located in many countries, currently use the BFT approach (Bosma et al, 2011).

In Recirculation Aquaculture Systems (RAS) fish is cultured under fully controlled environmental conditions independent of their natural environment. RAS are land based fish production systems in which water from the rearing tanks is re-used after mechanical and biological purification to reduce water and energy consumption and to reduce nutrient emission to the environment. In RAS water temperature can be adjusted to the specific needs of the species concerned (Schneider et al, 2010). However, RAS are also technology and capital intensive which probably means that commercial application in Egypt will be restricted to hatcheries and nurseries. At present only one (largely experimental) RAS farm is producing tilapia. Probably the biggest short term potential for RAS is to produce fingerlings of 50 grams during winter. These fingerlings can grow to market size before the summer, allowing double cropping schemes.

Another option of enhanced aquaculture production is to enlarge and/or involve new production areas and species for aquaculture. This concerns the development of marine aquaculture, i.e. coastal pond culture and cage culture in the Red Sea or brackish water lakes (Fayoum), and the development of new species such as meagre. Another option is the use of brackish ground water for the integrated production of fish and salt tolerant crops. At Wadi El Natroun, an experimental farm is growing sea bass, sea bream and red tilapia, using saline underground water. The saline fish farm effluent is used to develop an integrated aquaculture - horticulture system. Currently salt-tolerant plant species (Samphire Salicornia europaeae), Mediterranean salt bush (Atriplex halimus), and sea blite (Suaeda vermiculata), are tested (Heijden et al, 2012).

4.4 Product & market innovations

Besides these opportunities to improve profitability on the domestic market, there might be further opportunity to obtain higher market prices on the export market. In order to achieve this goal product planning and product differentiation are a prerequisite. Furthermore there are opportunities to increase processing and freezing capacity and improved value chain organisation to anticipate on export opportunities to export fresh or chilled fillets to first of all the Gulf States and the capitals of other African countries. Trade analysis does show that there are considerable markets for cultured fresh water fish in especially the Middle East. If Egypt can produce at a competitive price, exports to these markets is an interesting opportunity. Not only to increase the export volume but also to increase export value through value-adding opportunities. Furthermore, once a monitoring system for assessing the presence of contaminants in the fish tissue of fresh water fish is in place and approval to export fresh water fish to EU is obtained, Egypt may also be able to compete on the European market with fresh or chilled tilapia fillets. This will require market intelligence for the different product requirements (e.g. size) that are necessary to compete.

4.5 Business opportunities

Despite a rather small fish culture industry in the Netherlands, the Netherlands-based supportive industry is large, international oriented, and includes multinationals like Nutreco and Intervet (MSD Animal health). Since the fishing industry in the Netherlands is much larger than the aquaculture industry, there are numerous companies that supply products for fisheries, fish handling and fish processing. Many of these products are also used in aquaculture, either directly, or are used in the value chain (processing of fish).

Based on the present study, specific business opportunities are:

Feeds
Within the present feed market (approximately 1.5 million MT) the share of extruded feeds is growing and several new extruder projects are in-progress. Given the growth potential of the industry, it is estimated that the extrusion capacity needs to be increased from 100 kT to at least 500 kT. This could mean 10-12 new projects or additional production lines. This means business opportunities for companies that are active in animal and fish feed technology, such as Ottevanger Milling Engineers BV, Almex Extruders, fish feed manufacturing companies such as Skretting (Nutreco Holding NV), Coppens International B.V., and De Heus Voeders B.V., companies producing feed premixes, additives and concentrates such as Provimi BV and DSM, and consultants such as Aquaculture Experience BV.

Extended production period
The Dutch horticulture industry has considerable knowledge and advanced products for climate control, energy efficient greenhouses, utilization of stored thermal underground water etc. These technologies could be used to improve hatcheries and nurseries and/or grow-out under intensive conditions.

Recirculation Aquaculture Systems
RAS systems were developed in the early 1980s at Wageningen UR, and the Netherlands has a strong reputation in this field. Companies that design and manufacture RAS systems include Fleuren & Nooijen B.V., HESY Aquaculture B.V. , Aquaculture Consultancy & Engineering (ACE) etc.

Water quality management
A large number of Dutch companies are active in water treatment. Specific for aquaculture companies such as Multivis waterbehandeling B.V., Paques B.V. , Holland Aqua B.V., Viqon B.V, provide advice and water treatment equipment.

Aquaponics (including integrated aqua-agri systems using brackish ground water)
Companies like Priva, AquaTerra Nova, Green Q and Groen Agro Control, have been involved in technology development for aquaponics through the “EcoFutura” project.

Breeding
Til-Aqua International B.V. is a company producing natural male tilapia without hormones (YY technology).

Knowledge
Besides products the Netherlands has considerable knowledge in aquaculture. Wageningen UR, especially Wageningen Aquaculture (IMARES, AFI and LEI) is active in technology development, market innovation, capacity building and contract research, ranging from low costs breeding programmes for SME's to market intelligence for large sea food companies. Furthermore, a number of private consultancies companies provide advice on fish production, fish health management, fish quality standards etc.

Unfortunately, above indicated business opportunities are affected by the present political and this economic situation in Egypt. The country is in urgent need of foreign capital in order to keep importing and subsidizing food (i.e. wheat) and energy (fuel, cooking gas), with resulting high inflation rate (13% in the last 12 months), and weak stock markets. Coupled to the unstable political situation, the unfavorable business climate scares foreign private investments in Egypt. Sales of goods and services are probably less affected by this situation.

5 Recommendations

The present study clearly indicated the scope for further growth – both in volume and value - of the Egyptian aquaculture industry provided that a number of constraints are dealt with.

Our observations are in line with other recent studies such as undertaken by WorldFish Centre (WF). WF has its headquarters in Egypt, at the Abbassa Research Center. WF's IEIDEAS Project (implemented together with NGO's) focusses on the Egyptian aquaculture industry, especially on the dissemination of the genetically improved tilapia "Abbassa strain", the development of Best Management Practice guidelines & BMP training, support for women retailers, expansion of aquaculture in Upper Egypt, and improving the policy environment for aquaculture. Furthermore WF will also assist Egyptian authorities to set up the required procedures and infrastructure for export of farmed fish to the EU. These activities will contribute towards solving some of the constraints identified in the present study.

The Netherlands is a small player in the global aquaculture industry. However, its strength lies in the close cooperation between the (supportive) industry and research & knowledge institutions. Therefore we recommend the Embassy of the Kingdom of the Netherlands (EKN) to facilitate: 1). activities that will contribute towards the further development of the Egyptian aquaculture industry as well as towards business development for Dutch companies, and 2) activities directed towards the Egyptian government.

1. Business-to-Business activities
   - *Thematic workshops*
     The objectives of these workshops are twofold: transfer of knowledge and generation of business opportunities. As such the workshops will also contribute towards collaboration and exchange of information between farmers and will contribute to a better organisation of the industry in general. The set-up consists of two parts: technical (or market related) presentations by private companies and knowledge institutes, followed by discussions on the applicability of new technologies and the formulation of an implementation plan. The target group are fish farmers and Egyptian companies. Possible topics (first priority) are: water quality management, breeding & genetics, and value chain organisation. Other topics include: RAS aquaculture, aquaponics, climate & water temperature control (greenhouse technology), market intelligence, producer organisations, farm certification & branding/ marketing.
   - *Feed*
     The facilitation of Dutch investment into new feed mills and/or transfer of fish feed technology. This can be done through technical seminars that focus on the benefits of extrusion technology for fish performance and environment, and the importance of feed management. Next, to this a trade mission is recommended..
   - *Pilot plant fish processing*
     Identify a Dutch partner to set up a pilot plant for fish processing with Al Fayoum association. Simple processing (cooling on ice, short term storage, packaging) will contribute to value chain organisation and profitability. It will also promote animal welfare as live transport of fish is a severe stress under high temperature conditions. PUM can play a role with the facilitation of this activity.

For the facilitation of above activities, the EKN could consider joining efforts with the US Embassy since the American soy bean export council and USAID have a similar interest in aquaculture.

2. Government to Government activities:
   - *Political lobby*
     Aquaculture is low on the political agenda. The EKN could start a political lobby through ENCC (food security) to stimulate the government to develop a clear and realistic vision for aquaculture,

to make and revise legislation and to invest into research and innovation. Key message is that Egyptian aquaculture has already a value of 2 billion USD today!

- *Capacity building on the planning and management of aquaculture*
  Aquaculture can only be sustainable when it is developed in line with the surrounding ecosystem, its processes and functions. The key issue is that the farms should be adapted to the carrying capacity of the environment. This capacity is needed to break-down the organic material from the farm effluent, recycle nutrients and for the provision of clean intake water. In many areas of Egypt aquaculture has not developed based on such a planning, but is rather the result of opportunistic actions from individual farmers. A lack of knowledge at responsible governmental authorities sustains this situation. Therefore we recommend to initiate a program that builds capacity on the principles of carrying capacity assessment, optimization and increase of carrying capacity by Integrated Multi-Trophic Aquaculture (techniques and tools), inventory of its consequences for farm planning and farm management, required legislation etc.
- *Marine water resources*
  Egypt also has considerable potential to develop its marine aquaculture output. Attention needs to be drawn to the subprogram ‘More Crop per Drop’ of Water Mondiaal that envisions sustainable marine fish and crop (aquaponics) production systems in Egypt.

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Justification

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The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

Approved: Ir. Edward Schram
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LEI report 2013-039
IMARES report C091/13

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