EGYPTIAN MARINE SHRIMP FARMING: PROBLEMS, CHALLENGES AND PROSPECTS FOR FUTURE DEVELOPMENT

Sherif Sadek
Aquaculture Consultant Office, 9 road 256, 11435 Maadi, Hellwan, Egypt
E-mail: aco_egypt@yahoo.com

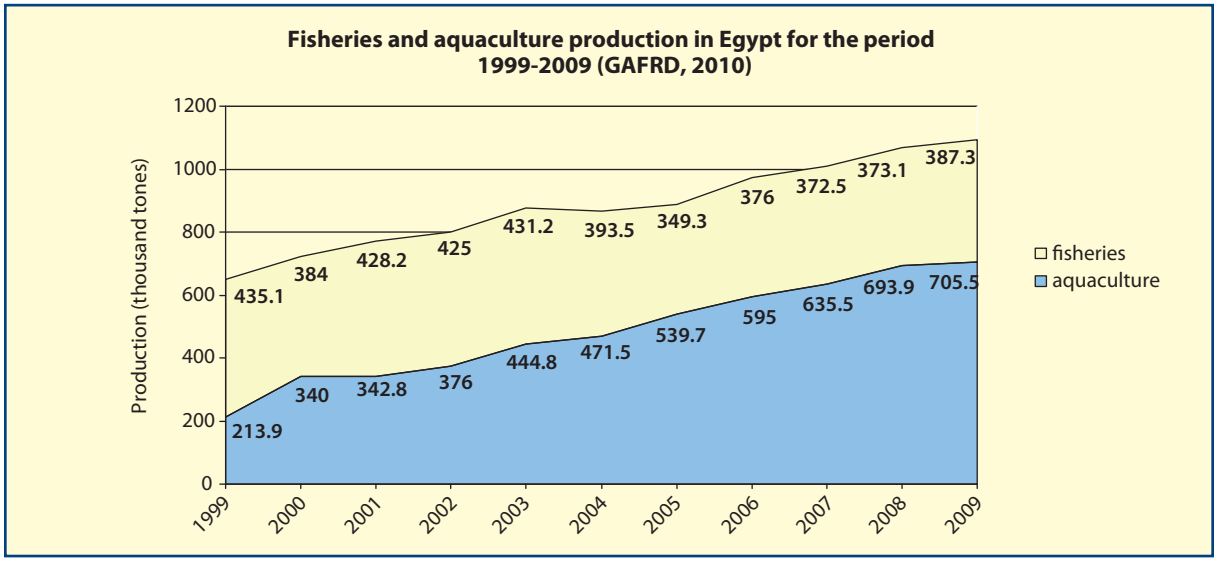
This paper reviews the shrimp aquaculture development and describes the lessons learned to date in Egypt, as well as the problems and prospects for future development. During the last three decades, there has been increasing investment in shrimp farming in Egypt and there are clear indications for further investments, but still the production results are not commercially positive. Egypt is just beginning to develop its potential, and the government is encouraging shrimp farming. Three crustacean species are in the production *Penaeus semisulcatus*, *P. japonicus* and *P. indicus*. Today Egypt has two marine commercial private hatcheries operate with a yearly production capacity of 400 million PL/year, and several farms in production with a total surface of around 1000 ha. In addition two university research bodies operate marine finfish and shrimp hatcheries for research and training purposes at Alexandria and El-Arish. By the end of year 2009, the estimated annual heads-on production would have achieved 500 metric tons, which will represent only less than 2% of the Egyptian shrimp fisheries.
Shrimp farming in Egypt is characterized by extensive culture in Qarun inland lake and semi-intensive production systems using fertilizer and commercial feed. Most shrimp aquaculture is undertaken northeast and northwest of Nile delta near the Mediterranean Sea as well as along the Red Sea coast. Records of the production characteristics data for 24 artesian and commercial *P. semisulcatus* farms on different water salinity and soil types revealed difference in growth, survival and yields during the period 1993-2010. The management and production of these shrimp farms during 90-150 days of grow-out are ranging for stocking densities (5 to 20 post larvae (PL)/m^2), survival rates (< 5 to 82%); average animal weight at final harvest (<10 to 32 gm) and shrimp yields average 26 to 864 kg/ha per year.
Shrimp culture can develop rapidly in the coming decade if the government and NGO bodies could mitigate the technical and institutional constrains mainly (quality of seed production and their limited seasonality from April to August; competition and restrictions on coastal land; availability of specialized feeds; shortage of technical manpower; lack of information on the environmental impact and impact of disease stress). Overall shrimp sustainable development production efficiency will be facilitated by evaluating the production parameters of the different shrimp species in the two different ecosystems in the Red Sea and the Mediterranean Sea coasts; decreasing the cost of PL and juvenile around the year; enhancing the availability of skilled capacity staff; achieving in applied scientific research; enhancing high quality formulated feed and understanding of shrimp pathogens and microbial ecology, by the use of environmentally friendly aquatic drugs).

1. Status and trends of the Egyptian aquaculture

Egypt is located in the North-Eastern and South-Western corners of Africa and Asia respectively. The Nile Delta is the only delta in Egypt with a 230 km long, 360 km wide and triangular in shape. The Nile Valley and the Delta occupy about 33,000 km^2, which account for less than 4 percent of the total area. Egypt is covered almost entirely by desert, 99% of Egypt's population living in just 5% of its land area, mainly concentrated along the Nile valley and the river's northern delta, which splinters out into the Mediterranean.

According to the General Authority for Fish Resources Development (GAFRD) statistics (GAFRD, 2010) and the Central Agency for Public Mobilization and Statistics (Capmas, 2010a and b), the aquaculture activity has been tremendously increased during the last 10 years 3.3 times, where in 1999 aquaculture production was 214 thousand tons and becomes around 706 thousand tons in 2009 (Figure 1).

Figure 1. Fisheries and aquaculture production in Egypt for the period 1999-2009 (GAFRD, 2010).

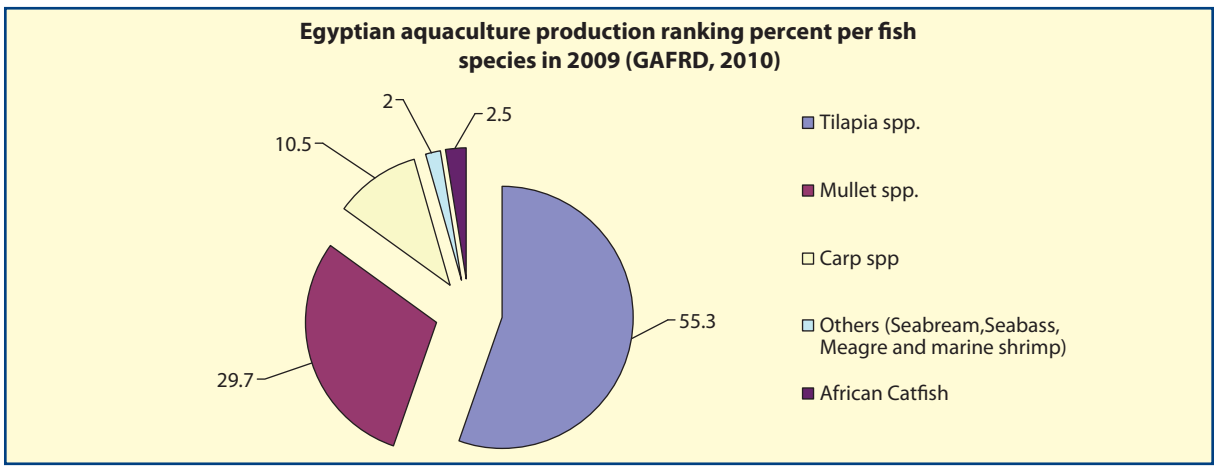


In 2009 the total fish production in Egypt was 1,092,888 tons where 705,490 tons were produced through aquaculture or about 65 percent of the country's total freshwater and marine fish production, providing a cheap source of protein for the country's 75.2 million people in 2008. Egypt has built the largest aquaculture industry in Africa, accounting for four out of every five fish farmed on the continent.

GAFRD plans to develop the country's aquaculture industry further, and has set a goal of 1.2 million tons of farmed fish, or about 75 percent of total fish production, by 2017. Its two-pronged strategy aims to increase the productivity of aquaculture operations using underground water, while encouraging investment in mariculture (Prof. Dr. Mohamed Fathy Osman, GAFRD's chairman - personal communication).

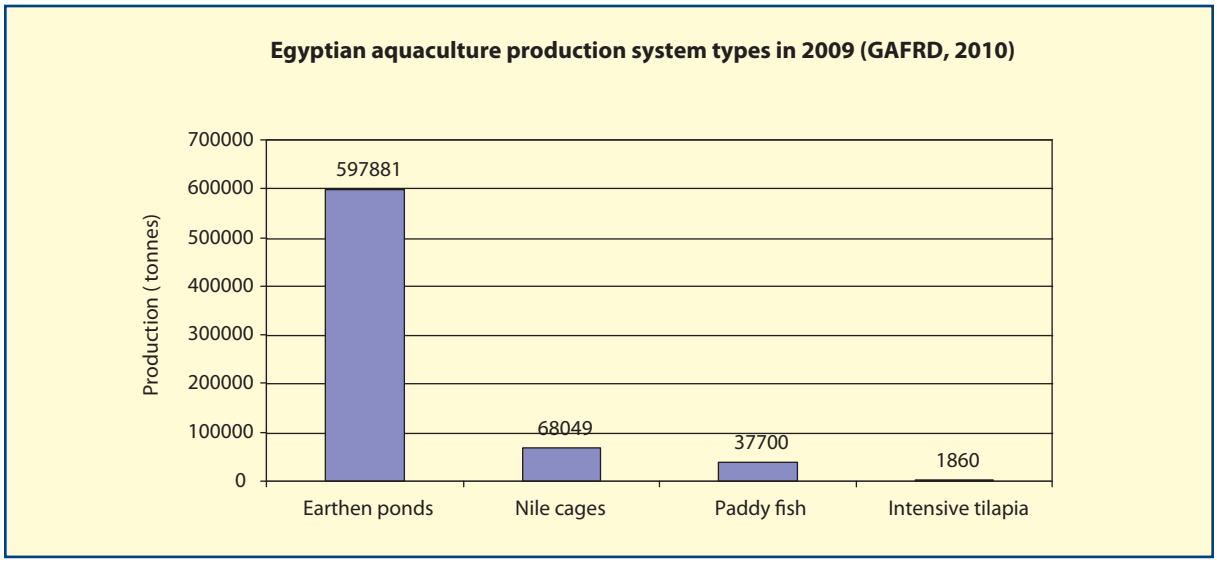
Three decades ago tilapia and mullet were the main species reared in extensive earthen ponds. Today ten finfish (Tilapia, Mullet *spp.*; Grass Carp, Silver Carp; African Catfish; Bayad; Gilthead seabream; European sea bass; Meagre and Solia besides four crustacean species; *Macrobrachium rosenbergii*, *Penaeus semisulcatus*; *P. japonicus* and *P. indicus*), are playing an important role in the aquaculture production. During 2009 tilapia has chaired 55.3% of the total aquaculture production, followed by Mullet *spp.*, Carp *spp.*, African catfish and other species (Gildhead seabream, European seabass, etc.), 29.7%, 10.5%, 2.5% and 2% respectively (Figure 2). During the period from the period from 1999 to 2009 the tilapia total production in Egypt has increased 2.3 times, where in 1999 tilapia culture was 216.8 thousand tons and becomes around 495.3 thousand tons in 2009, due to a shift to intensive rearing methods and to faster growing species such as mono-sex tilapia (GAFRD, 2010).

Figure 2. Egyptian aquaculture production ranking percent per fish and shrimp species in 2009 (GAFRD, 2010).



From the actual major culture system, earthen ponds production rank in the first with 84.8 % of the total Egyptian aquaculture production, while cage culture follow by 9.7 %, paddy field come next with 5.3 % of the total and at lastly 0.2 % for tilapia intensive culture production in cement tanks mostly in the desert and arid zones and integrated with agriculture activities (Figure 3).

Figure 3. Egyptian aquaculture production system types in 2009 (GAFRD, 2010).



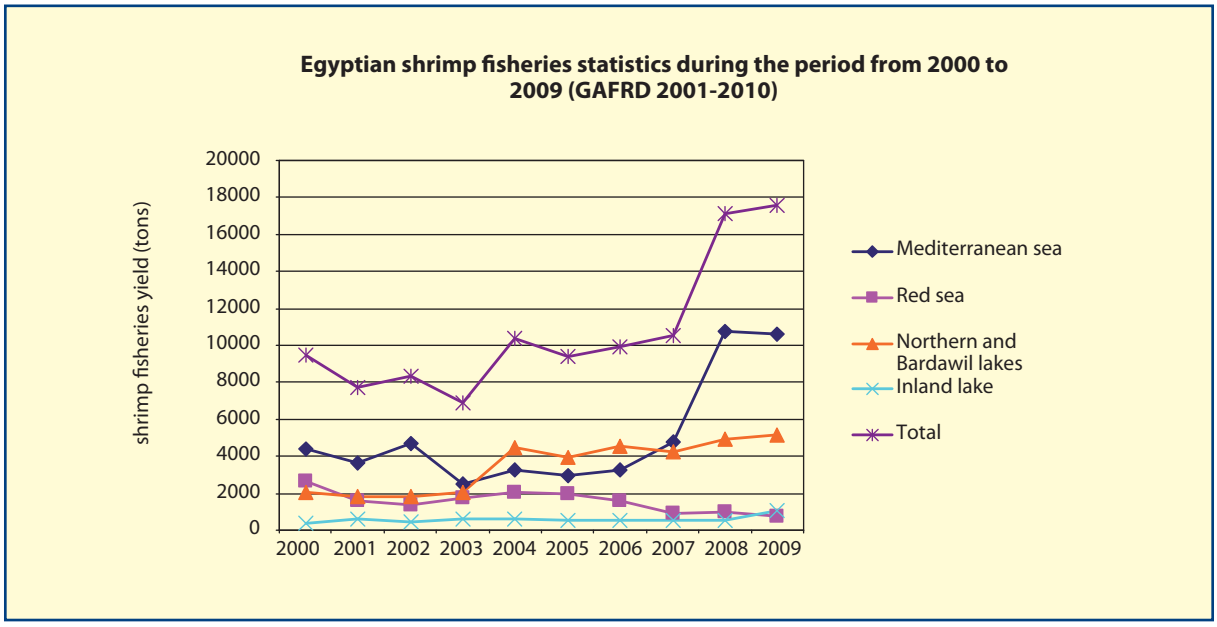
Extensive and semi intensive earthen ponds for a total surface of around 151,818 hectares practiced in Egypt. The public sector is charring only for less than 5% of the total surface and > 95% for the private sectors. The private sector is producing > 99.0% of the total aquaculture production, and the public sector contributes only with < 1.0%. The public sector is contributing more with the fry and fingerlings, extension support, artificial feeds and research support. The number of finfish fry currently produced from 113 authorized hatcheries has increased several folds compared to a few years ago, to reach 305 million seeds in year 2009. GAFRD (2010) is reporting the tilapia fry production from authorized hatcheries for the period 1999-2009. In addition more than 500 Nile tilapia not authorized hatcheries are charring with fry production for an estimated production of more than one billion fry. The public sector is charring for 71% of the total seed production and 29 % for the private sectors. From the total fry produced 92% are fresh water species mainly Nile tilapia; common carp; grass carp and silver carp. The 8% remain are marine aquatic finfish and crustacean species mainly Gilthead seabream; European sea bass; Solia and Green tiger shrimp.
Wild finfish fry mainly mullet species are collected from the nature, during the last 10 years (2000-2009), the maximum yield has reached 137.0 million in 2002 and the minimum capture was 41.0 million in 2006. In year 2009 the wild mullet fry cached was estimated to 57.4 million.

2. Shrimp farming potentiality in Egypt

2.1 Shrimp fisheries and aquaculture status

In the mid-1990s, when Egypt's catch of wild-caught shrimp began to decrease in size, the government began to encourage the private sector to develop shrimp farming. The goal was to create an industry capable of producing large commercially valuable shrimp.
From 2000-2009, the annual total shrimp fisheries production from Egypt's Mediterranean and Red Sea coasts—including the Suez Canal-Bitter Lakes, the coastal lagoons of Manzala, Burullus and Bardawil and inland lakes of Qarun averaged 8,401 MT (Figure 4) and represented less than 2% of the total fish and shellfish landings in Egypt. The majority of shrimp fisheries production consists of small species (*Metapenaeus stebbingi*, *Trachypenaeus curvirostris*, *Parapenaeus longirostris* and *Solenocera crassicornis*), while larger sized species (*P. japonicus*, *P. semisulcatus*, *P. kerathurus*, *P. latisulcatus* and *Metapenaeus monoceros*) are caught only in small quantities.

Figure 4. Egyptian shrimp fisheries statistics during the period from 1998 to 2009 (GAFRD 1999-2010).



In 1985 a shrimp farm near Alexandria was the first commercial shrimp hatchery and farm to be established in Egypt. The farm went bankrupt early in 1992 due to financial and managerial problems that arose from inadequate site assessments. One year later, a private firm began to develop a farm on the coast of the Red Sea (Sadek 89 a, b; Sadek 1993; Sadek 1997 and Sadek *et al*., 2000). Today Egypt has two marine commercial private hatcheries operate with a yearly production capacity of 400 million PL/year, and several farms in production with a total surface of around 1,000 ha. In addition two university research bodies operate marine finfish and shrimp hatcheries for research and training purposes at Alexandria and El-Arish. By the end of year 2009, the estimated annual heads-on production would have achieved 500 metric tons, which will represent only less than 3% of the Egyptian shrimp fisheries.

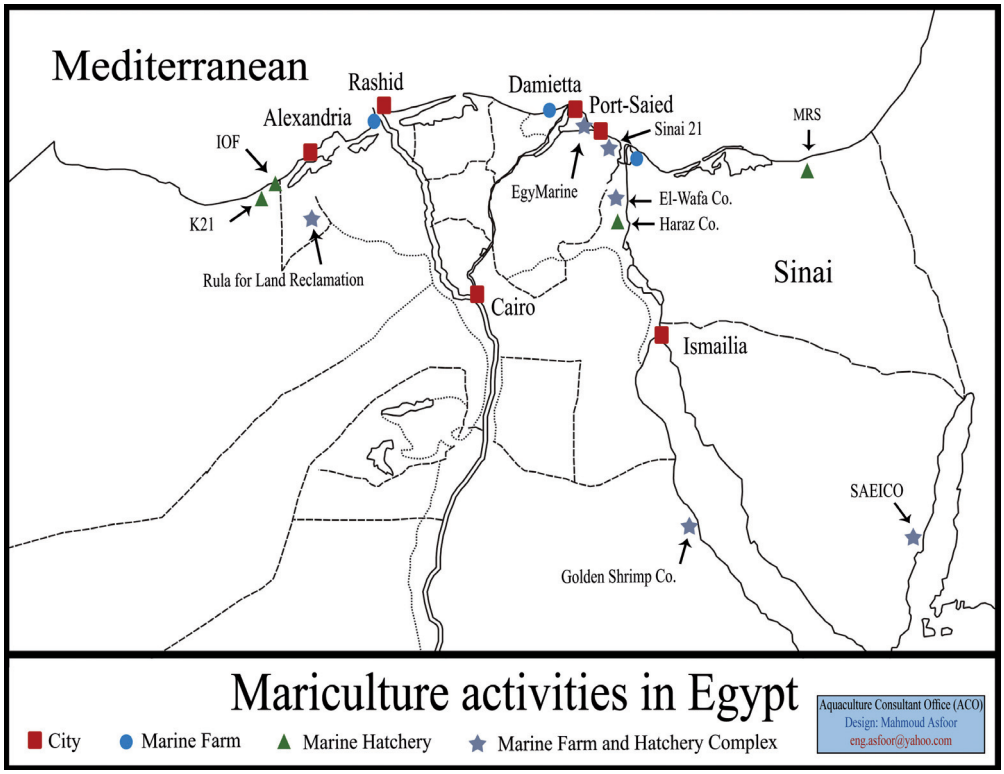
2.2 Land and water use for shrimp culture industrial development

The aquaculture map in Egypt is divided into four regions: (a) the Nile Valley and Delta (which are made up of four sub-regions—the Northern Littoral Region, the Delta, Middle Egypt and Upper Egypt); (b) the Eastern Nile Delta; (c) the Mediterranean Sea Coast; (d) the Red Sea Coasts (Balarin 1986).

Egypt has selected sites for mariculture projects (7 sites for extensive farming in coastal lagoons, 3 sites in artificial lakes, 32 sites for floating cages, 23 sites for semi-intensive culture in earthen ponds and 13 sites for enclosures). During a recent survey, about 68 sites covering an area of 83 thousand hectares (77% on the western Egyptian Red Sea coast and 23% on the eastern Egyptian Red Sea coast) were found to be suitable for mariculture (GAFRD 1996a and b).

Sadek (1997); Sadek and El-Gamal (1997) and Sadek and Osman (2006) studied the possibility of culturing marine finfish and shrimp in a new marine complex located in the northwestern area of the Sinai Peninsula. The Egyptian Company For Fisheries and Equipments (ECFE) identified 11,350 ha for mariculture, and the land has already been leased for mariculture projects. Thousands of hectares contain soil unsuitable for aquaculture due to its high porosity and poor compacting qualities. Seawater supplied from the Mediterranean Sea is used in these operations. Most shrimp aquaculture is undertaken northeast and northwest of Nile delta near the Mediterranean Sea as well as along the Red Sea coast. Marine shrimp farming areas are distributed in the following areas Alexandria, Damietta, Port Said, North Sinai, South Sinai and Red Sea (Figure 5).

Figure 5. Mariculture activities in Egypt.



Drawing by Eng. Mahmoud Asfoor - Aquaculture Consultant Office (ACO).

2.3 Shrimp hatcheries

The National Institute of Oceanography and Fisheries (NIOF) at Qait-Bay near Alexandria city and the Suez Canal University (SCU) near El-Arish city are operated research marine hatcheries, in addition for training purposes. Two commercial shrimp faculties, Sinai 21 company and Haraz and partners company, grew out the PL in small ponds before stocking them in the grow-out ponds. Both companies prefer to grow out the PL from PL8 to PL20 before stocking.

Seed stock is not a problem in Egypt because it is easy to capture, mature and spawn *P. semisulcatus* and *P. japonicus*. Professional fishermen collect spawners from coastal waters. There are two pronounced spawning seasons for *P. japonicus* in the Mediterranean and Red Sea, December to March and June to September.

Rearing of *Penaeus semisulcatus* has been conducted by the NIOF and SCU's shrimp culture project since 1980. Hatchery production has improved rapidly since 2000 due to modifications in tank design, live food production, and feeding practices with local and imported live and non-live food. Baert and Goneim (1990) have reported the feasibility of producing Artemia due for the increasing demand and high cost of Artemia in Egypt, a commercial Artemia production venture was started in 1990 at the Nasr Salt Co. (NSC) in Port-Said. Production of the brine shrimp Artemia is largely based on integration with existing salt pond systems. *Artemia franciscana* is introduced into the normally unstocked highly saline evaporation ponds. Artemia cysts and biomass are harvested. A production of 1 and 1.2 MT of cysts and 10-15 and 20 MT of biomass has been estimated to be produced for the years 1992 and 1993, respectively. Egypt has different saline depressions and lakes, which could be developed for the production of Artemia. No governmental or private projects actually were under commercial production, but NSC is planning to restart a commercial project near Alexandra.

2.4 Farming Systems

Extensive

Shrimp were first stocked in Qarun lagoon where salinity was 38 ppt, during the winter of 1977. The lake was stocked with 3 million shrimp collected from the Mediterranean coast near the Damietta branch of the Nile Delta. The study showed that *P. kerathurus*, *M. monoceros* and *M. stebbingi* were the most adapted species. *M.*

stebbingi can be increased through a continuous control of the fisheries, while the other species *P. kerathurus* and *M. monoceros* can be increased through a program of realizing a monthly growth-rate of 10.0 mm for females and 5.0 for males (condition factor 0.62 and 0.58, respectively). Growth rates and local conditions in Lake Qarun do not vary much from those observed in stocks in the Mediterranean Sea. In Lake Manazala, *M. monoceros* and *M. stebbingi* have the same growth rates as the species in Qarun, 5 and 3 mm/month respectively. The average annual production of Lake Qarun as an extensive culture system is 12 g/ha/yr of marine species (Bishara 1976; Isak *et al.* 1980; Abdel-Razek 1991).
Recently Lake Qarun has been restocked in 1999 with two million postlarvae of *P. semisulcatus*, which the Sinai 21 Company has devoted to the development of the lake fisheries. In fact no evaluation of this restocking has been done to define if a PL restocking program could be continued in the future (Sadek and Dahawi, 2002)

Semi-intensive
Sadek (1989a; 1989b; 1993) have recorded that the average weekly weight gain is 1.91g for ponds enriched with fertilizer and commercial feed, while 1.44 g for ponds enriched only with fertilizer. Annual yield varied from 360 to 864 kg/ha for *P. japonicus* using fertilizer and commercial feed. It takes approximately 4 months to produce 33 shrimp per kg and 7 months to produce 12 to 15 shrimp per kg. Pond stocking densities vary between 3 and 15 shrimp/m^2 and harvest size is between 20 and 41 g. Farmers average one crop per year, either in the Mediterranean or Red Sea Coasts, and production per hectare ranges from 600 to 2,250 kg of shrimp per year.

Sadek (2011) has reviewed the production characteristics data record for 24 artesian and commercial shrimp farms (*P. semisulcatus*) on different water salinity and soil types revealed difference in growth, survival and yields during the period 1993-2010. The document has summarized the following remarks:
- management and production of these shrimp farms during 90-150 days of grow-out;
- stocking densities (5 to 20 post larvae (PL)/m^2);
- survival rates (< 5 to 82 %);
- average animal weight at final harvest (<10 to 32 gm) and
- shrimp yields average 26 to 864 kg/ha per year.

2.5 Shrimp Feed

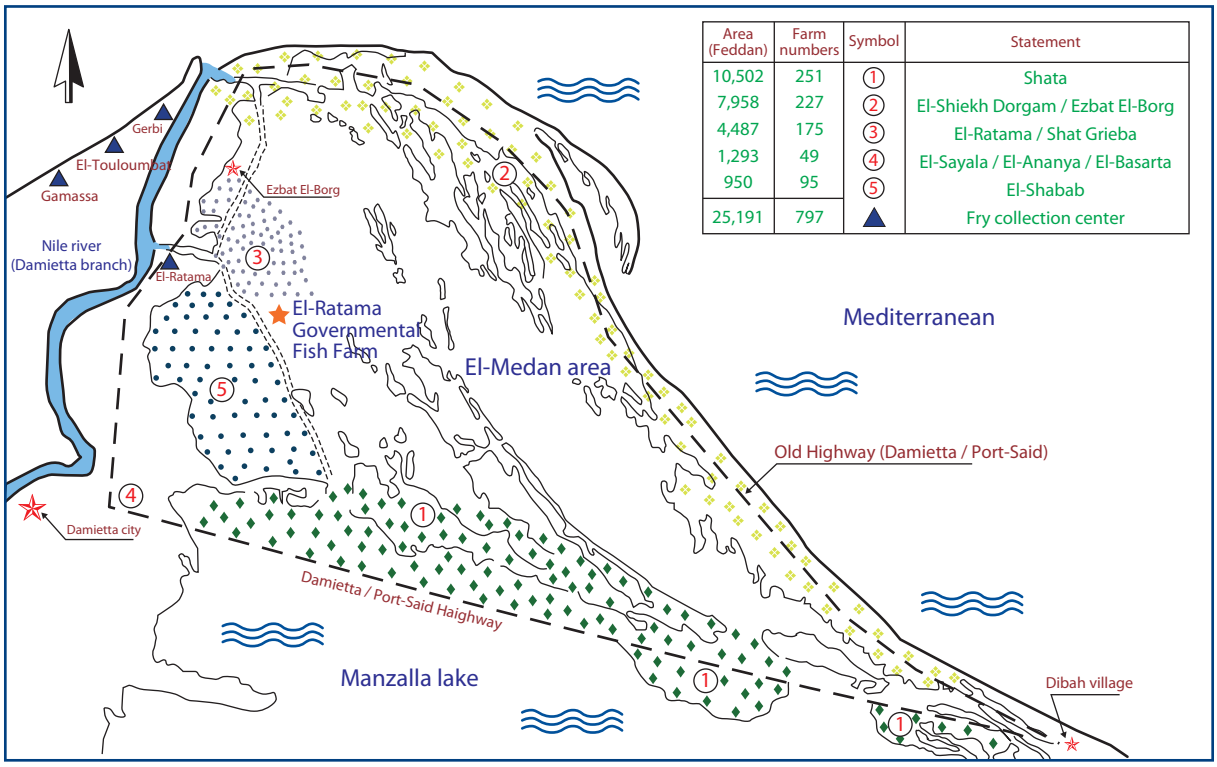
The production of marine fish and shrimp feed for commercial farming is being attempted domestically for the first time. Egypt has more than 20 facilities of aquatic feed (5 of them are extruder) capable to produce around 500 thousands tons/year. Zoocontrol company is the only one produced shrimp feed. Few of the shrimp private farms manufacture their own feed on the farm. The main composition of the shrimp feed is fish meal (either local or imported), local shrimp meal, concentrates, soya meal, corn meal, local fish and vegetable oil, and perimex (soya lecithin, cholesterol, vitamin, mineral and binder). The percentage of crude protein can fluctuate from 38-45% for *P. semisulcatus* and from 42-50% for *P. japonicus* based on the age of the animal.

3. Actual and future projection of the Egyptian shrimp farming sites:

The Egyptian aquaculture map showed that shrimp farming activities are more concentrated in sub-regions of the Nile delta, where the water resources are available and non-agricultural lands. Other very few projects are located in Upper Egypt region, the Mediterranean Sea coast and the Red Sea coasts.

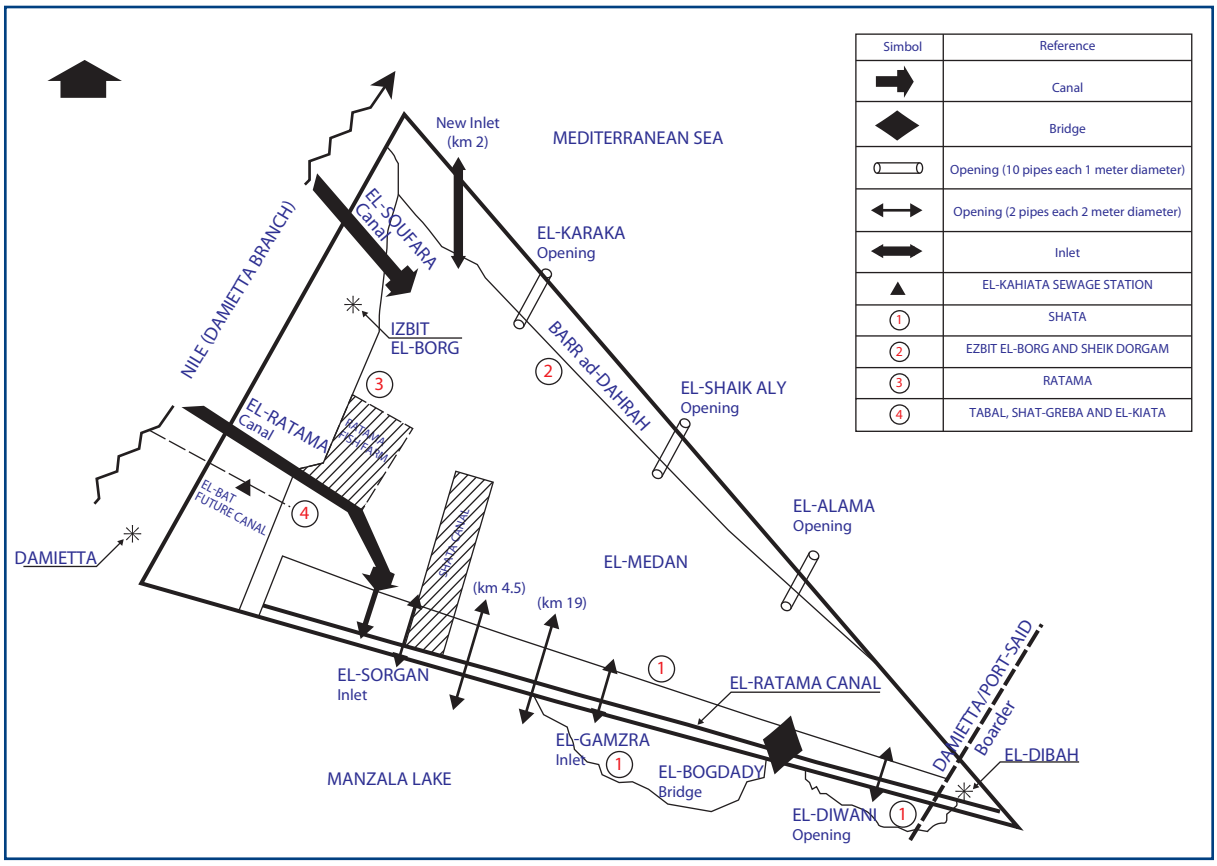
Sadek (2010) has clarified the importance of Dibah Triangle Zone – DTZ (Figure 6) in Damietta and Port-Said Governorates. DTZ is part of a wider ecosystem that include all the Manzalah lake and boarder the whole Nile delta. The water area including a long sand beach with exchanges with the Mediterranean Sea, Manzala lake and freshwater from the Nile (Damietta branch), with many fish and shrimp ponds (Figure 7). It has already been an important aquaculture production fish area (especially Sea bream; Sea bass; Mullet and Meagre) and in addition marine shrimps (*Penaeus semisulcatus*). The total surface of the DTZ is around 23,110 hectares, from which 46% for aquaculture and 54% for open fisheries. The TDA's water body complex has increased from 161 km^2 in 1987 to 168 km^2 in 2000, due the increase of mariculture farms. Ended this industry has increased an unstable environment for the area.

Figure 6. Distribution of aquaculture in Dibah Triangle Zone. Damietta – Port-Said, Egypt.



Drawing by Eng. Mahmoud Asfoor - Aquaculture Consultant Office (ACO).

Figure 7. Distribution of different water resources in Dibah Triangle Zone - Damietta – Port-Said, Egypt.



Drawing by Eng. Mahmoud Asfoor - Aquaculture Consultant Office (ACO).

4. Technical and Institutional Constraints

Seed

Attempts are being made to secure the availability of PL through domestic hatcheries. At this time, however, there is no gap between demand and supply of PLs from hatcheries in Egypt. Producers are trying to obtain wild caught PL beside the supply from marine hatcheries. Production in hatcheries is seasonal (from April to August) so prices also fluctuate according to the demand of shrimp farms along the Mediterranean coast where temperature decline in winter and rearing stops in December at the latest. Current prices for *P. semisulcatus* or *P. japonicus* are US$ 13 for one thousand PL10 and US$ 17 for one thousand PL25. Prices often decline by as much as 20–25 % in July and August when hatcheries are in full production compared with April to June when they have a high demand for starting the shrimp growing season. The future development of shrimp culture in Egypt depends on developing a better hatchery system that can produce PL earlier in the year as well as reducing the overall cost PL.

Competition and Restrictions on Coastal Land

The jurisdiction of the land along the Egyptian coasts is increasingly divided among the Ministries of Tourism, Urbanism, Petroleum and Defense. The Tourism Development Authority (TDA) has seized Sea Coasts for tourism projects and is planning to seize other land for future projects. However, such lands are still important candidates for petroleum production, industry and urbanism as well as for conservation of protected areas. The Egyptian Environmental Affairs Agency (EEAA) has proclaimed seven areas for protection in the Mediterranean and Red Sea (Zaranik lagoon and El-Amid in the Mediterranean Sea; Ras Mohamed, Nabq, Ras Abu Galum, Tiran Iland and Safanir Island in the Golf of Aqaba; Abrak, El Daib and Gabal Elba in the Red Sea; Lake Quarun in Fayum). The EEAA has protected 24 islands in the Red Sea.

Availability of Specialized Feeds

The existing feed manufacturing infrastructure has the overall capacity to support the growing aquaculture industry to a certain extent. However, marine shrimp culture normally requires high quality feed, which in turn requires some ingredients that are lacking in the local market especially high quality fishmeal. It is difficult to obtain supplies of good quality raw material in local markets, especially attractants, binders and cholesterol. It is also clear that all the available feed manufacturing plants in Egypt are not adapted to produce shrimp feed. Specialized larval feed such as enriched live food and microencapsulated larval feeds may also be required. However an economic analysis is required in order to assess the feasibility of mariculture projects using such expensive feeds.

Sadek (2010) has reported the changes in the prices of main raw materials used in fish feed industry during the period 1992-2009. During the same period, the price of tilapia feed (25% protein) has increased from $US 165/ ton in 1995 to $US 217/ ton and in 2009 ($US550/ ton in 2009). The development of the shrimp farming will need more to import shrimp feed ingredients, but this will demand increase the supply of foreign currency for a such need.

Manpower and Research

Shortage of technical manpower exists in the shrimp aquaculture industry. This includes in shrimp breeding, culture, disease detection and treatment, processing, marketing, extension, socio-economics, environment, water quality and soil profiles. All the shrimp projects were managed through Egyptian aquaculture specialized. Only Sinai 21 company has designed and constructed the project with the help of Ecuadorian expertise. In general aquaculture research priorities are mostly academic.

Environmental Assessment

There is a lack of information regarding the impact of nutrients and sediment from pond discharge on the local environment. The Egyptian Environmental Affairs Agency (EEAA), which is the sole environment protection authority, requires, as a precondition, an Environment Impact Assessment (EIA) for any aquaculture project. The EEAA required the Egyptian law "The Law and the Executive Statutes of the Law on Environment; No. 4 for year 1994" to be addressed in all EIA's (EEAA 1994). The law describes the different stages of data collection,

and outline, and the specific information required from companies in order to develop a full EIA of tourist and urban establishments:

- Executive summary
- Description of the proposed establishment
- Legislative and regulatory considerations
- Description of the Environment (Physical/chemical environment, Biological environment and Socio-cultural environment)
- Determination of the potential impacts of the proposed project
- Alternatives to the proposed project
- Development of a monitoring plan
- Public participation
- Environmental Assessment Report

For aquaculture projects, the law has defined a good set of baseline data that is required in the EIA from which it will be possible to compare the potential impacts over time. The aquaculture guidelines also require specific information with regard to the use and /or disposal of certain materials that might end up in either freshwater or marine environments.

5. Mitigation measures to reach a sustainable marine shrimp culture industry

During the last two decade farmed shrimp production activities developed quickly in Egypt. Both *P. semisulcatus* and *P. japonicus* are farmed. These species are indigenous and available in the Egyptian environment either from the Mediterranean or the Red Sea. There appear to be several possible reasons that these indigenous species have been cultivated to the exclusion of imported species—they perform well in the single crop/year production systems common in Egypt, they do best in low stocking density systems also common in Egypt, they are both acclimatized to high water salinity in the Red Sea, and both appear to perform well with low quality shrimp feed.

It is not clear which of the two species, in the two locations, actually perform better. Monitoring performance over time should make the answer clearer. It is quite likely that one of the species will outperform the other, but that is not yet clear. Even if one of the species performs better in one of the sites, which does not mean that cultivation of the other would not also be profitable. At any rate, to date there have not been disease problems in either of the grow out areas with either of the species.
It is recommended that Egyptian aquaculture could benefit from experiments conducted in other countries. However, it is essential that these "lessons" be adapted to physical, technical and social conditions in Egypt before being adopted and put into practice. Also Egypt must learn from its own mistakes. The failures and problems that have appeared in different Egyptian companies should also help to shape future activities.

6. Conclusion & Recommendation

Several constraints to the shrimp culture could be avoided by the following:

- Decrease the cost of seed by decreasing the operating costs and increasing the intensity of Production;
- Evaluating the available GAFRD aquaculture sites north the Nile delta;
- Evaluate production parameters for both *P. semisulcatus* and *P. japonicus* in the two different ecosystems, e.g. the Red Sea and the Mediterranean Sea coasts;
- Evaluating the technical and economical of the future shrimp farm projects integrated in Egypt (fish/shrimp/salicornia/tourism;
- Enhance the availability of skilled staff and increase the capacity of unskilled staff.
- Support investments in the production of shrimp feed and ensure that necessary quality standards are met;
- Enhance a sustainable marine shrimp aquaculture research based on both a short and long term Vision;
- Encourage the private sector to establish local dealer companies to import feed and equipment needed for the industry (aeration systems, feeders, etc);
- Establish a pilot shrimp farm in the area of the Red Sea to study the impact of pollution on the ecosystem as well as to identify and analyze the costs of mitigation methods;
- Facilitating the authorization of documents needed for starting up shrimp farm projects (cooperation of governmental authorities and NGO bodies).

Reference

Balarin J. 1986. *National reviews for aquaculture development in Africa, 8 Egypt*. FAO Fisheries Circular, (770.8): 128 p.

Abdel-Razek F. 1991. *Biological observations on the transplanted prawns in Lake Qarun (Egypt)*. Journal of Egyptian German Socitey of Zoology 5:29-45.

Baert P. and Ghoneim S. 1990. *Results and Remarks Concerning Artemia Introduction in the Ponds of the EL Nasr Salina Company in Port Fouad*. Second progress report, Joint Artemia project EEC, SEM 02/220/08, pp 34.

Bishara N. 1976. *Contributions of the biology of Penaeid prawns in Lake Manzala, Egypt. I. Growth studies and length-weight relation ship*. Aquaculture, 8, 337-349.

General Authority for Fish Resources Development (GAFRD). 2010. *Statistics of fish production of year 2009*. GAFRD, Ministry of Agriculture and Land Reclamation, 104 pp.

General Authority for Amiria Affairs Presses (GAAAP), 1993. *Decree law issued by the Minister of Foreign Trade & Industry no. law No 124/1983 issuing "Fisheries, aquatic neighborhoods and fish farming organization"*. Edition No II. 140 pp.

Central Agency for Public Mobilization and Statistics (Capmas). 2010a. *Annual book for the fisheries statistics in 2009*. Reference: 71/12413-2009. 65 pp.

Central Agency for Public Mobilization and Statistics (Capmas). 2010b. *Study on the Egyptian fisheries wealth (1998-2009)*. Reference: 90/14321-2010). 33 pp.

EEAA, 1995. *Law number 4 of 1994 promulgating the environment law*. http://www.eeaa.gov.eg/English/main/about.aspv.

Egyptian Environmental Affairs Agency (EEAA).

Ishak M., Alsayes A. and Abdel Razek F. 1980. *Bionomics of* Penaeus kerathurus *transplanted into lake Qarun (Egypt)*. Aquaculture 21:365-374.

Sadek S. 1989a. *Hatchery production of* Penaeus *in Egypt*. Aquaculture'89. Bordeaux, France.

Sadek S. 1989b. C*ommercial aspects of* Penaeus japonicus farming in northeastern Nile delta in semiinetensive ponds. Aquaculture'89. Bordeaux, France.

Sadek S. 1993. *Notes on Research and Production Plan Progress made in Developing Mass Culture Techniques for Prawn and Shrimp in Egypt*. The International Conference on Future Aquatic.

Resources in Arab Region, Alexandria, Egypt, February 6-8 1993. 24 p.

Sadek S. 1997. *Evaluation of* Penaeus semisulcatus *and* P. japonicus *for Mariculture*. Technical reports, The Egyptian Company for Fisheries and Equipments. 12 p.

Sadek S. and El-Gamal A. 1997. *Egyptian Aquaculture with Special Emphasis on Mariculture in Regards to Status, Constraints and Potential.* Aquaculture Europe '97, Martinique, 8 p.

Sadek S., Rafael R., Shakouri M., Rafomanana G., Ribeiro F.L. and Clay J. 2002. S*hrimp Aquaculture in Africa and the Middle East: The Current Reality and Trends for the Future*. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Work in Progress for Public Discussion. Published by the Consortium, 42 pages.

Sadek S. and Dahawi A. 2002. Egyptian shrimp mariculture, today and tomorrow. *The EAS conference "Sea farming - Today and Tomorrow Conference" (Trieste, Italy, October 16-19, 2002)*.

Sadek S., Osman M.F 2006. *Experience in shrimp culture using brackish groundwater: Institutional constraints and mitigation measures*. Workshop on the use of brackish groundwater in agriculture and aquaculture: seeking the future. CAIRO, 2-5 DECEMBER 2006. The Ministry of Water Resources and Irrigation/Advisory Panel Project, in cooperation with the International Center for Biosaline Agriculture Research (ICBA) and the World Fish Center; 13 pp.

Sadek S.S. 2010. *Aquaculture site selection and carrying capacity estimates for inland and coastal water bodies in Egypt*. A worldwide expert workshop on "Aquaculture site selection and carrying capacity estimates for inland and coastal water bodies" at the Institute of aquaculture, University of Stirling, Stirling, during the 6th to 8th December 2010.

Sadek S.S. 2011. *Reviewed of the production characteristics data record for 24 artesian and commercial shrimp farms* (P. semisulcatus) *on different water salinity and soil during the period 1993-2010*. (under press).