

Tilapia Fish Farming Assessment using Water Wells in Fayoum and Egypt: Case Study

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ABSTRACT

According to the importance of fish farming in Egypt, this research was initiated with the objective of studying the parameter effected on economics of fish farming using water wells under several Egyptian conditions. In the primary phase of the study, the literature in the field of fish farming was assembled, reviewed, analysed, and categorized to deduce data about fish farming locations and to analyse such data. The research problem definition is concentrated in the lack of quantities of fish availability in Lake Qarun. Methodology is to identify many different variables such as the influence of environmental factors, water availability and water quality, the physical and chemical properties of water, climatic factors, fish death conditions, and weather in order to achieve the research objectives, which are to provide fish farming using surface well water as an accepted water quality for fish farming, to consider the soil as a filter for water and study the water quality from wells. This study was undertaken in Shakshouk Research Station of Fayoum governorate in Egypt during 2020 to 2022 to assess and evaluate the Tilapia Fish Farming Assessment using Water Wells in Fayoum governorate in Egypt. Based on the investigation outcomes, it was concluded that total direct and indirect cost comprised the capital and variable items of Egyptian pound (EGP). The cost of producing one kilogram of Tilapia fish was 25.4 EGP, and the selling price was 30 EGP for each kilogram of fish with markup including profit, risk contingency, financial charge, and market requirements for supply and demand all these items was estimated 4.6 EGP. This indicates that fish farming is a good way to take advantage of the enormous supply of water in the research station, and that it could be a substantial source of income in the case of increasing the awareness of regional people and an allocating a suitable market in the area.

Keywords: Fish Farming, Tilapia, Water Wells, Fayoum, Egypt.



Introduction:

Fish farming possesses a major share for Egypt agriculture income [1], as well as a vital source of income for people living along the coast and the Nile River, in addition to the fisheries in the canals, river Nile, lakes, ponds, Mediterranean Sea, and Red Sea that are considered other key activities in the country. Despite this, the country's gross domestic product is dominated by fisheries, it also contributes to foreign exchange revenues by exporting [2].

Fish has a high nutritional value, with protein content ranging from 15 to 30%, low cholesterol, and other dietary supplements. Egypt ranks the first of fish farming in Africa and sixth worldwide. Egypt ranks the third in the world's production of tilapia fish [3]. Figure 1 show tilapia fish type.



Figure 1: Tilapia fish

Egypt is approaching near to self-sufficiency in its fish needs. In this regard, decision makers mentioned that fish farming has been expanded, especially with increased expansion of reclaimed land and reliance on well water. Moreover, hatcheries have been developed to produce fry, especially coastal areas, and fish farming. Examples of expansion of fish farming through national projects include: Ghalioun Pond, Al-Dibba, Shark Eltafriaa, Suez Canal Company, ..etc as shown in Figure 2. The focus on the development of fisheries has its impact on the development of lakes such as Manzala, Burles, Meriut and Bardawil Lakes, where the fish production was about 183,000 tons [4].

The total production of Egyptian fish about 2 million tons of which 1.6 million tons of fish farming and 400 thousand tons of natural fisheries (lakes, and Nile), with a self-sufficiency rate of 85% in 2022. The total exports 2019 was about 35 thousand tons, while the total imports during 2019 reached 325 thousand tons; including mackerel, herring, sardines.

The study in hand is considered an effort by the researchers to estimate the total cost of the infrastructure for commercial Tilapia fish farming and to determine the profitability of this enterprise in Al-Fayoum areas. Al-Fayoum is a one of governorates in Egypt's located in Western Desert, 25 kilometres from the Nile River and 90 kilometres south of Cairo the capital of Egypt [5]. It has an arid climate, with a long, dry summer and a short winter, with nearly 1 to 2 centimetres of rain on average each year as shown in Figure 3 illustrates Al-Fayoum governorate and Qarun Lake in Egypt [6].



Figure (2): Sample for Fish Farming Ghalioun project in Egypt

From the present literature, it was clear that many researchers investigated fish farming. Among the research carried out, are the following:

- Documented that Egypt Law No. 146 of 2021 for Lake and Fisheries Protection and Development law [7]
- Documented that Egypt of General Authority for Fish Resources Development [8]
- Documented of ground water table in Fayoum governorate in Egypt [9]
- Documented of Fishery and aquaculture statistics [10]
- Documented of Tilapia fish farming in Egypt [11]

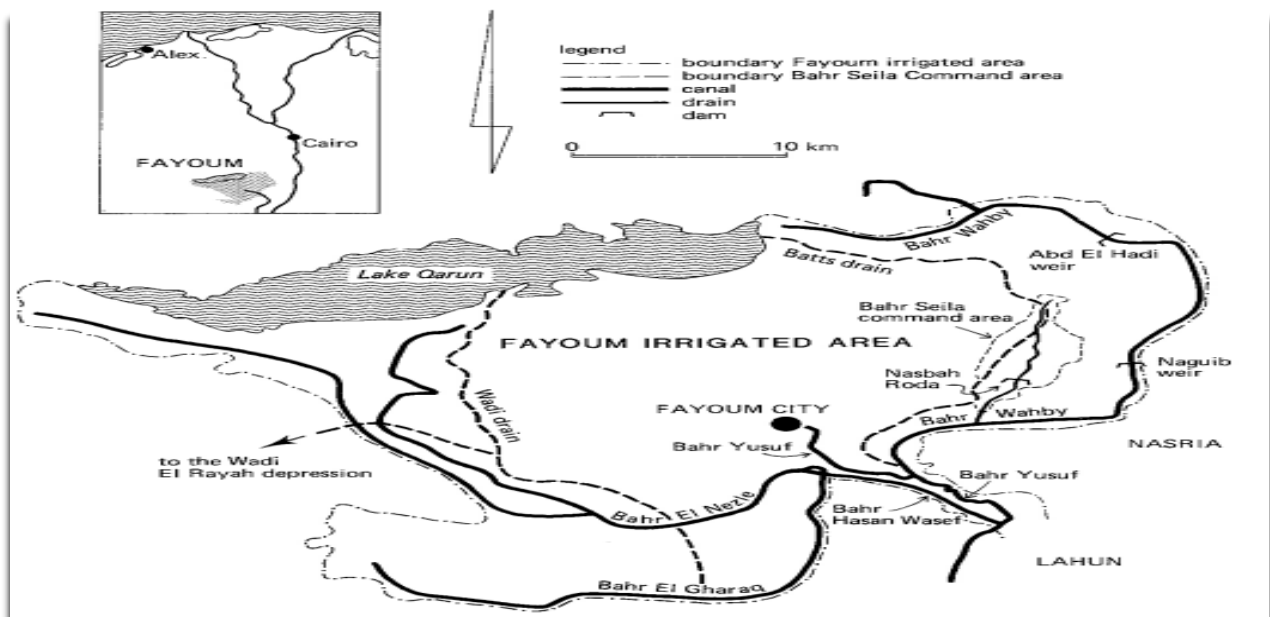


Figure (3): Al-Fayoum governorate and Qarun Lake in Egypt.



Problem of Research:

The researcher was challenged to resolve the problem confronting the Qarun lake, which in fact, it is two main problems. This is summarized, as follows:

- Lack of quantities of fish availability in Lake Qarun
- Ongoing so as upcoming economic and population increment conditions, acquires a decisive importance to assess water well technique with economic overall cost.

Objectives:

In terms of the importance of Economics to Egypt, water well technique for fish farming is due to be adopted in Al-Fayoum governorate. Accordingly, this research was initiated with the main objective of assessing such a technique, where Qarun Lake was taken as a case study because we have research station called "Shakshouk station" under water management research institute a branch of National water research centre Supervisor, the water well technique for improve water purify and Fisheries regions.

As for the consequential objectives, they are summarized, as follows:

- Assemble, comprehend, and scrutinize literature in the field of Surface water well technique.
- Carry out field trips to investigate the study area; assemble data; execute measurements; take samples and analyse so as processes them to perceive a complete data picture about the study area.
- Applied water well technique for improve water purify for some harmful fish fungi.
- Carry out experiments in a pond, constructed for the sake of the present research, to investigate the water well for fish farming technique potential to support the remote fragile societies.

Methodology

This research study was started on 2020 where pond was constructed in Shakshouk Research Station of Al-Fayoum governorate in Egypt where Tilapia fish farming is carried out on commercial basis in Egypt. The study is based on primary data; however, secondary data were also collected from various published and experimental research sources wherever deemed necessary. The primary data were collected through interview and questionnaires using a pretested comprehensive interview schedule, designed in the light of preset objectives and review of literature.

Design of Experiment

From collected data and field observations, it was shown that there were some fish farms established by the area farmers in which farms had started Tilapia fish farming on research scale.

1. Land, Water Quality and Quantity

The location of ponds and hatcheries is an important condition in fish farming. The pond must be water-retentive and suitable for fish growth. Continuous supply of clean and quality water, quick draining and easy filling of ponds are the main pre-requisites for Tilapia fish farming. It was stated that to accomplish the expansion of Tilapia culture, adequate year- round supply of quality water should be made available. Tilapia fish farming demands a constant supply of water with a temperature of 10° to 20°C.

In the study area, water quality and temperature around the year are good conditions for fish raising according to Egypt climate conditions. Besides, land properties are suitable for construction of ponds.

2. Pond Design and Construction

Water circulation in aquaculture systems must be adequate, and they must be easy to clean. The pond takes the rectangular shape with a circular edge. In comparison to other types of ponds, the elongated rectangular shape has a low construction cost, effective water consumption, and is easier to clean.



In the study area, Water Management Research Institute (WMRI) one of the Institutes of the National Water Research Centre (NWRC) has constructed an earthen pond that was square in shape and composed of clay soil above the geomembrane to control the seepage and square shape for efficient water circulation. Total part of the pond is 144 square meters (12×12 m) in the high level and slope of wall is 3:2 in addition to the pond has a depth of 3.0 m. Figure (4) shows the implemented pond design and dimension in meters.

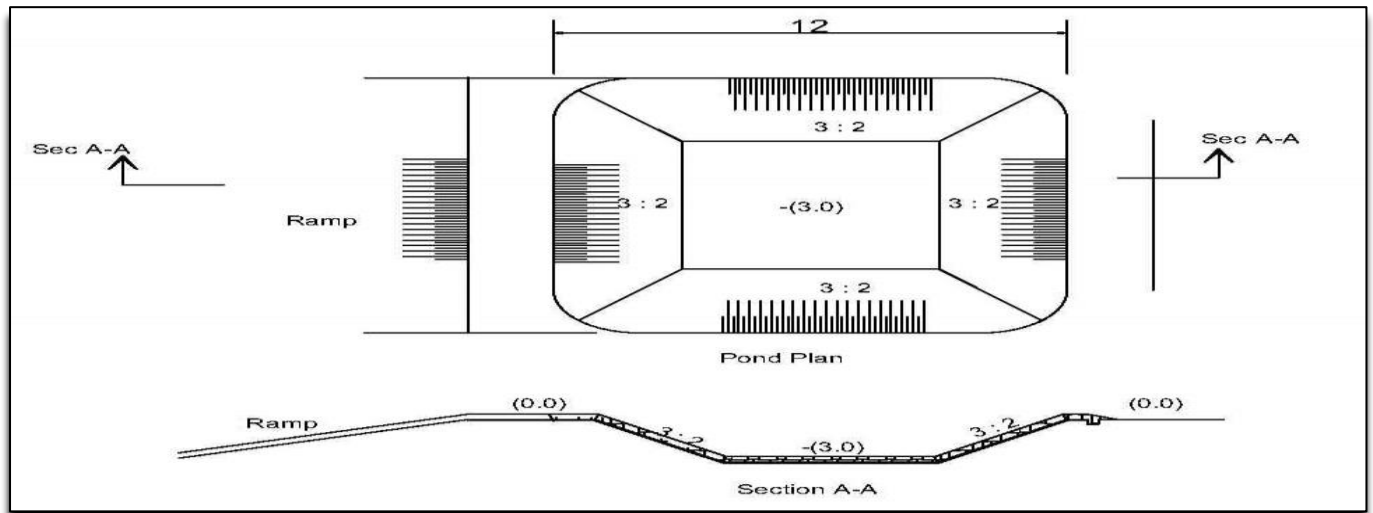


Figure (4): Pond Design and dimension

The bed and side walls were insulated with a synthetic insulation material geo-membrane thickness of 1.0 mm, which was designed, tested, and approved in accordance with American Society for Testing and Materials specification number D 1004, D 1238, D 1505, and D 1603, where it was tested in the Construction Research Institute (CRI) of NWRC [13], and the pond is depicted as shown in figure (5).



Figure (5): Implemented Pond for WMRI station



3. Well Design and Construction

Groundwater extraction keeps increasing around the world. It is projected that the groundwater use was doubled in half a century, between 1960 and 2010 [14]. It is necessary to drill new groundwater wells.

However, the number of boreholes is increasing due to a loss in the productivity of current assets as well as population growth. In Shakshouk Research Station, two wells have been constructed at a total depth of 15 meters, where static water table depth is 2 m from the ground surface. In addition, the discharge is in range of 8 cubic meter per hour as shown in figure (6), with a drawdown characteristic for a well in an unconfined aquifer. The water well was tested in site by instruments as shown in figure (7). The result readings of the water salinity for constructed water well from the beginning of 2020 to April 2022 showed that the average salinity of the first and second wells are 4700 ppm (Parts Per Million) and 6800 ppm respectively where the mean value of water salinity in Qarun lake reaches 30000 ppm.

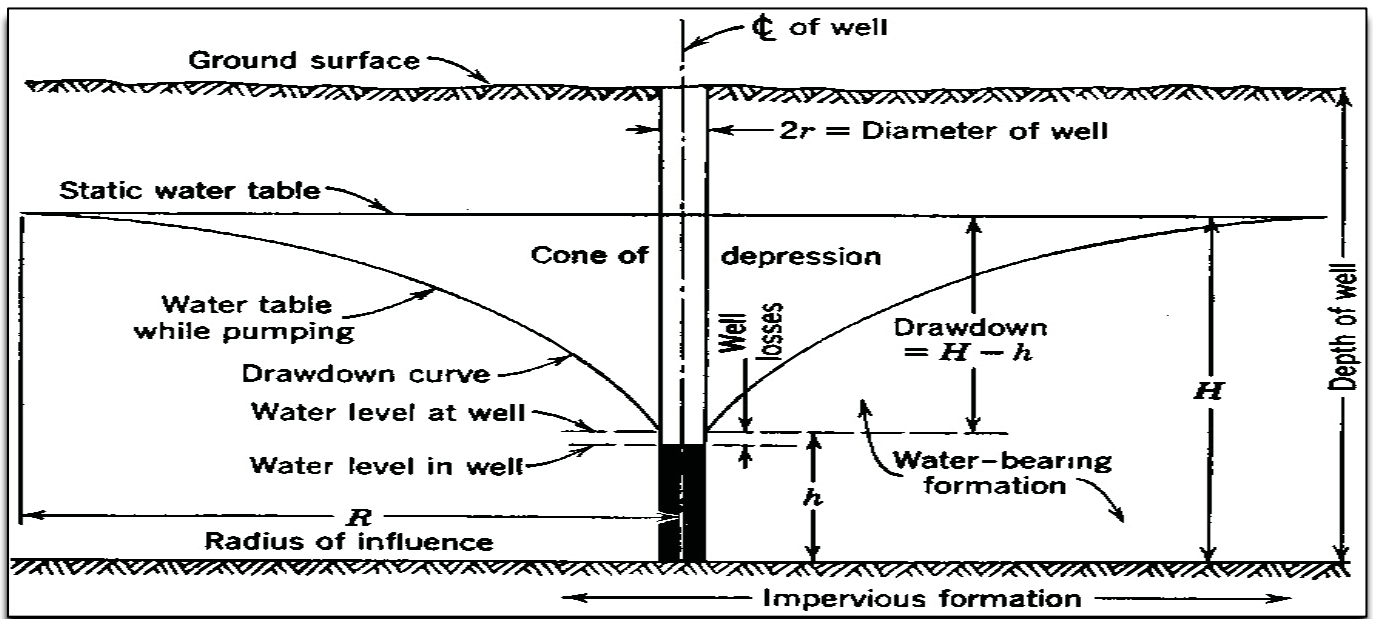


Figure (6): Drawdown characteristics for a well in an unconfined aquifer

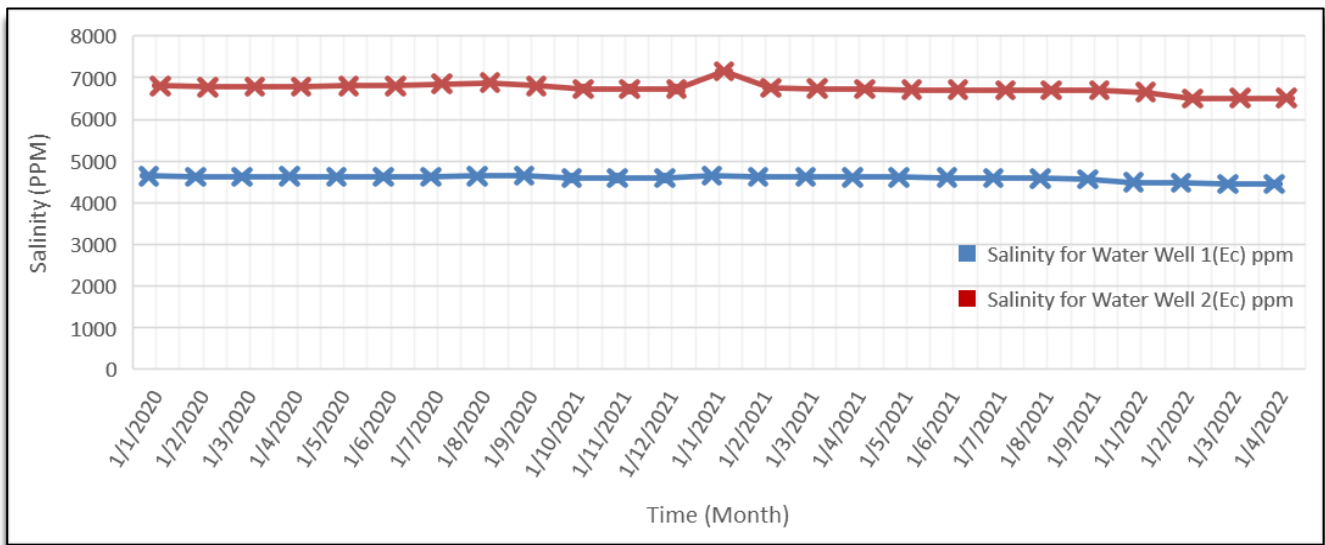


Figure (7): Water salinity for constructed water well



Data Evaluation and Analysis

The collected data was evaluated using an Excel spreadsheet for calculating averages, percentages, and cross tabulation. Furthermore, partial budgeting techniques were also applied to arrive at the benefits and cost of fish farming.

Results and Discussion

1. Farmers Characteristics

Education, age, family size and farming experience of sample respondents. Literacy status of farmers is an essential characteristic that determines farmers' receptivity to innovation and resource allocation efficiency, according to studies conducted in various parts of the world. The study results show that three farmers of the selected sample were at the young age group i.e., between 20 to 50 years. The average age was found to be at 40 years. Average labour for fish farming size in the study area was 10 persons in each household. Three farmers had up to 10 years of farming experience. These farmers have just newly started fish farming.

Farmers mentioned, by a questionnaire model, that there is a migration to Kafr Al-Sheikh and the North coasts of Egypt due to the lack of fishing production in Lake Qarun [12], which took place due to the increase in salinity and the decrease of fish production for the present time.

2. Farmers Income

The collected data were analysed for fish farming income. The results from questionnaire showed that farmers had private business and some farmer was government and others for companies. In general, farm management efficiency is higher in organizations, companies and administered farms than in small scale owned and operated farms.

3. Farm Characteristics

a. Hatchery

Size, capacity, and type of hatchery were all determined. Moreover, the quality and quantity of water effect, as well as the demand for fry to produce table fish were also studied. To incubate eggs and rear fry, the hatchery must have clean, cold water that is adjusted for silt and clay.

In the study area, Shakshouk research station in Al-Fayoum measures water quality and takes samples and tests at Central Laboratory for Environmental Quality Monitoring (CLEQM) of NWRC where the testes identify ions, cations, total suspended solid materials, and salinity ratios where these indicators that reflect water quality.

b. Feeding

There are no standardized feeding or fertilizing procedures, and most tilapia growers do not follow these standards. The most utilized organic fertilizer is poultry feed. Aquaculture uses around 6 to 7% of Egypt's poultry feed. Tilapia growers in some locations have stopped using organic fertilizers and use instead chemical fertilizers to feed their ponds. This is done only prior to fish stocking, as the urea and superphosphate are commonly utilized.

Egypt's commercial aquafeed industrialization business is fast growing. There were only five aquafeed mills in 1999, however, they became 31 in 2009. Aquafeed manufacturing is currently over 0.5 billion ton/year, with roughly 0.280 billion ton per year (65%) being used for tilapia, which have a crude protein level of around 25% [15].

Extruded aquafeed technology, on the other hand, was developed in Egypt where tilapia farmers prefer it since it is easier to digest and convert to body mass. Feed conversion ratios (FCR) for pelleted Nile tilapia diets range from 3:2 to 5:2, whereas extruded feeds have FCR ranging from 1.1:1 to 2:1.



The most typical feeding method is manual feeding twice a day in the morning and late afternoon. However, demand feeders built locally are becoming more popular, particularly among medium and large-scale farms. Processed feeds are thought to have contributed roughly 48% of overall tilapia production, with the rest coming from natural food obtained from pond fertilization. Egyptian tilapia growers rarely utilize farm-made feeds [16].

In the current research study, trustworthy feed supply and farmers relied on their own prepared feed pallets as the shown in figure (8). In addition to this, all the farmers practiced manual feeding.



Figure (7): Fish Feeding for tilapia fish type

c. Fingerlings Availability

Tilapia fish reach a weight of 500 grams during 3 to 4 months in summer and from 6 to 7 months in winter, with a food conversion rate of 1.2: 1.5 in the research study.

d. Marketing

Access to market is one of the factors to be kept in mind before initiating any economic activity. Tilapia is well recognized as a popular food fish of fish. The farmers were of the view that in the study area, the requirement for Tilapia fish is high. However, due to lack of a well-established market in Al-Fayoum, some farmers marketed their fish to clients at roadside marketplaces.

e. Capital and Variable Cost analysis

The initial capital components include raceway construction, land rent, water system/pipe, store/workshop, Also, variable cost of the Tilapia fish includes feed, watch and ward, fry, maintenance, fuel/electricity etc. show in Table 1.

*Table 1: Cost and price of Tilapia Fish Farming (EGP/Kg)*

No	Items	Cost (EGP)/ Kg	Cost %
1	Land	0.2	0.79
2	Pond Construction	0.2	0.79
3	Well construction and pumping	2	7.87
4	Water System and Pipelines	0.1	0.39
5	Store and Workshop place	0.1	0.39
6	Electricity and pumping	0.1	0.39
7	Graders/Balance/Tanks etc.	0.4	1.58
8	Other Tools (Tub, Bucket, etc.)	0.7	2.76
Total Initial Capital Cost		3.8	14.96
9	Feed	6.5	25.59
10	Glassware/Chemicals	0.5	1.97
11	Fuel/Electricity of water well and station	0.6	2.36
12	Oil/Medicine etc.	0.2	0.79
13	Fingerlings	2.4	9.45
14	Watch and Ward	6.8	26.77
15	Maintenance	2.4	9.45
16	Communication and supervisors	1.3	5.12
17	Transportation	0.9	3.54
Variable Cost (EGP)		21.6	85.04
Total Cost		25.4	100.00
Total Price		30.0	118.11
Mark up		4.6	18.11

Conclusion and Recommendations

The research was conducted at the Shakshouk Research Station in Egypt's Al-Fayoum governorate. The implemented ponds designed and implemented to estimate cost to Tilapia fish farms. The study concluded that Al-Fayoum governorate technically can use a shallow water well for Tilapia fish farming. The preliminary evaluations conducted on economic feasibility showed real beneficial outcomes from the private sector. Tilapia fish farming is a great element to the success of the governorate's plentiful supply of water. However, before promoting Tilapia production, a market must be established. In Egypt, there is a demand for Tilapia fish. Domestic Tilapia consumption is currently concentrated in a few hotels,



restaurants, and many Egyptian households. Decision-makers in Egypt are striving to provide with self-sufficiency in fish.

Based on case study and field observations, the following recommendations are prepared:

- Training for Economics of Tilapia fish farming to be imparted to the interested Decision makers and entrepreneurs.
- Supply of fry in the area to the farmers
- Availability of quality feed in the market be assured.
- Assuring the management of marketing system.
- Researching development of Tilapia and other types for fish farming is the major need nowadays according to Al-Fayoum governorate climatic condition.

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