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Assessing the Economic and Environmental Impacts of High Water Table Level on Soil Productivity in Ezbet Khalaf and Monsha'at Tantawi in Senoures District - Fayoum Governorate (Case Study)

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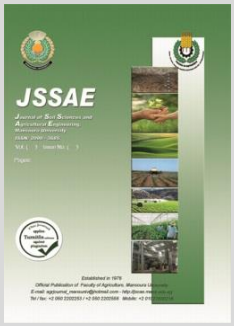

ABSTRACT

Drainage water from agricultural land in Fayoum Governorate discharges mainly to Lake Qaroun, because most Fayoum is below mean sea level. Lake Qaroun surface water level rises because drainage water from agricultural lands exceeds evaporation losses from the lake surface. Water logging and soil salinity increase in lower lands closer to the Lake, caused by seepage from the rising Lake water level, in addition to seepage from upstream higher lands. This problem causes great loss of crop productivity in the region. The selected study area is about 2000 feddans and it is representative of the problems of the lower lands near the lake shore. Attempts to leach excess soil salinity result in more water logging. The objective of this work is to evaluate the extent of water logging and salinity problems, and to suggest appropriate actions for improvement(s). Field investigation showed water logging variation in the study area from 5% to 100%. A statistical t-test compared the study area mean to Fayoum Governorate general average for the study crops, and it showed significant difference at 1% level. This study recommends the rehabilitation/maintenance of the cross-sections, bed levels and embankments of the canals/drains, and to lower drain bed levels to improve the drainage system in the study area. It also recommends the installation of tile-drainage network in the study area, and to construction a dike along Lake Qaroun shore line to protect low lands. It also recommends the construction of pumping/lifting station to raise drainage water to Lake Qaroun if necessary.

***Keywords*: -**land unit productivity - Water unit productivity - soil waterlogging - saline soil - agricultural drainage

INTRODUCTION

Fayoum Governorate is considered one of the most important Egyptian governorates in agricultural and food production. It is located in the Egyptian Western Desert, to the north-west of Upper Egypt. It lies about 92 km to the south-west of Cairo, and to the North-West of Beni-Swaif and Minya Governorates. Fayoum Governorate is surrounded by desert from all sides, except the South-East where Beni-Swaif governorate is located, which is mostly agricultural land. Fayoum governorate total area is about 6068.70 km^2, and it is called "little Egypt" because its surface topography resembles that of Egypt: like the Nile Valley between highlands, followed by Delta-like wider land and Lake Qaroun to the north (similar to the Mediterranean Sea to the north of Egypt). Fayoum governorate topography rolls from -2 m (below mean sea level) in the south and goes down to -40 m (below msl) at the shore of Lake Qaroun, which is one of the oldest lakes in the world. Most Fayoum land is fertile Nile deposits of clay and clay-loam, with relatively low hydraulic conductivity values.

The rolling terrain of Fayoum governorate drives the hydraulics of water distribution in the irrigation open channel distribution network by gravity. Saline and semi-saline soils comprise a significant portion of lands in Fayoum. Agricultural drainage in Fayoum depends mainly on open drainage collection system that runs by gravity. The drainage network generally goes with land slope from south to north, served by two main drains. El-Bats drain serves the east of Fayoum, while El-Wadi drain serves the west. These two drains discharge their waters to Lake Qaroun in the north. Some small drains serve the north-middle part of Fayoum and discharge directly to Lake Qaroun. Social life in Fayoum governorate varies from city, agricultural village communities, and beach communities to nomad (Bedwin) communities. Fayoum is subdivided into 6 administrative districts (known as Markaz: Fayoum, Senouress, Tamia, Etsa, Abshway, Youssef As-Seddique). The agricultural areas of these districts vary from (50 thousand feddans) for Abshway to (110 thousand feddans) for Etsa (Figure 1). Most Fayoum governorate is agricultural lands, and the most important crops produced by this governorate are: Cotton, Wheat, Rice, Clover, Sesame, Sugar Beets, Maize and some vegetables.

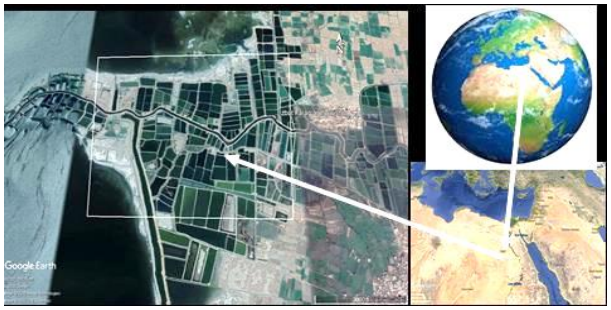

Figure 1. Study area.

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2. Problem Definition

Fayoum is a semi-closed basin with a single source of irrigation water from the main canal of Bahr-Youssef, which branches from the Nile River and carries fresh irrigation water for all the governorate. Most Fayoum governorate lands are below mean sea level (msl), and vary from -2m in the south, rolling down to about -42m in the north at the shore of Lake Qaroun. Many canals branch from Bahr-Youssef to distribute irrigation water to all parts of Fayoum, using the slopes in a gravitational water distribution system. Excess irrigation/ drainage/leaching water is collected by gravity to a network of open drains that run to the north to end in Lake Qaroun.

As mentioned above, agricultural drainage in Fayoum depends mainly on open drainage collection system that runs by gravity. The drainage network generally goes with land slope from south to north, served by two main drains. El-Bats drain serves the east of Fayoum, while El-Wadi drain serves the west. These two drains discharge their waters to Lake Qaroun in the north. Some small drains serve the north-middle part of Fayoum and discharge directly to Lake Qaroun.

All excess water in the canals, added to drain water discharges reach Lake Qaroun, exceed the amount of evaporation water for Lake Qaroun surface, and resulting in serious water imbalance in the lake. As a result, surface water level in Lake Qaroun rises, and re-fluxes in drain tail-ends at the lake. Moreover, lands nearby the lake shore are relatively low in elevation, and thus suffer from poor drainage and even from water logging. In addition, impeded drains by the lake higher water surface level generate backwater curves that extend waterlogging to even more lands. Slower open drains result in more underground seepage from higher lands to lower lands, which cause even more waterlogging to even higher lands.

An area of about 2000 feddans (which representing all the prevailed problems of the lower lands near the lake shore) was selected for the study. The main common problems of the area are DRI, (2019):

1) Rising groundwater in many lower lands near the lake shore, causing waterlogging and soil salinization. One of these lower lands is the area selected for the study of 2000 feddans within the area served of Ezbet Khalaf and the surrounding area of Monsha'at Tantawy, located within Markaz (district) Senouress. DRI, (2019).
2) There are illegal intake ducts/pipes along the sides of El-Bats drain to supply fish farms with water, which damaged the side-banks of the drain.
3) Seepage of sewage water from urban areas provided with (septic tanks) at study area mixed with ground water and create surface water pools that cause environmental and health problems to residents.
4) Lack of sufficient agricultural drainage networks in the area resulted in rising water table. Waterlogging problems are obvious in agricultural lands and residential buildings in the area. Soil salinization is spread in the area, sever land degradation and deteriorated agricultural productivity are observed. Figure (2) shows seepage and soil salinization in the study area.

3. Study Objectives

The objectives of this work is are;

1) Assess the impact of waterlogging on the unit water use and unit land use productivity efficiencies as compared to those of Fayoum Governorate.
2) Identify the limiting factors for unit water use/unit land use productivity in the study area, in order to determine recommended means to raise/improve unit land use productivity in respect to crop yield.
3) Estimate/quantify crop yield losses due to waterlogging in the study area, and rising salinity, and use economic analysis to estimate the economic losses.
4) Suggest possible solutions for these problems (waterlogging and salinization).

Figure 2. Seepage and Soil Salinization in the Study Area

4. Research Methodology and Data Sources

This study used descriptive, quantitative analysis with application of statistical methodology for provided data. Productivity standards, such as unit land productivity efficiency and unit water productivity efficiency were estimated. In addition, tables and graphs were used to elaborate comparisons and indicators, Maxwell (1979), which were all used to achieve the study objectives. In addition, the statistical t-test was used to examine the significance of differences between crop yields means, of the study area and that of Fayoum Governorate. Dixon and Massey (1983).

Used published and unpublished data from various sources (Central Agency for Public Mobilization and Statistics; CAPMAS, Ministry of Agriculture and Land Reclamation; MALR, Ministry of Water Resources and Irrigation; MWRI, National Water Research Center; NWRC, and its Research Institutes, in addition to some other sources). The data core of this study was mainly obtained from the MWRI Central Administration for Irrigation of East Fayoum, MALR Fayoum Administration, in addition to the field survey to the study area (Ezbet Khalaf and the surrounding area of Monsha'at Tantawy) using specifically-designed Questionnaire that targeted the economic effects of waterlogging on the studied crops in the study area.

The Study Area

The study area in Ezbet Khalaf and the surrounding area of Monsha'at Tantawy is about 2000 Feddans. Although Lake Qaroun is located in the north of Fayoum, Lake Qaroun Shore is located to the west of the study area and forms its western boundary. This is because the study area is located to the east of the Lake. The study area is bounded from the north by Bahr Wahby Canal, and is bounded by Abu-Harawa Drain from the south, and two villages from the east. Bahr Wahby Canal runs through some other Ezbets in the north. The general slope of the study area is rolling from the east to the west in the direction down to Lake Qaroun shoreline.

The irrigation system in the area is free gravity flood irrigation system. Irrigation water for the study area is fed by two sources: Bahr El-Rafie Canal (in the south) which in turn is fed by East Bahr Senoress Canal (outside the map area, and the other source is Bahr Wahby Canal Extension. However,

since these two canals don't provide sufficient water, farmers reuse drainage water from El-Bats drain (which runs across the study area) for irrigation purposes.

Drainage in the area is served by El-Basir Drain, El-Bats Drain and Abu-Harawa Drain. El-Basir Drain is located in the northern part of the study area, and drains to El-Bats Drain, which in turn runs near the middle of the study area and goes westwards to Lake Qaroun. Abu-Harwa drain, as mentioned above, is the southern boundary of the study area. Figure (3) shows Drains in the study area.

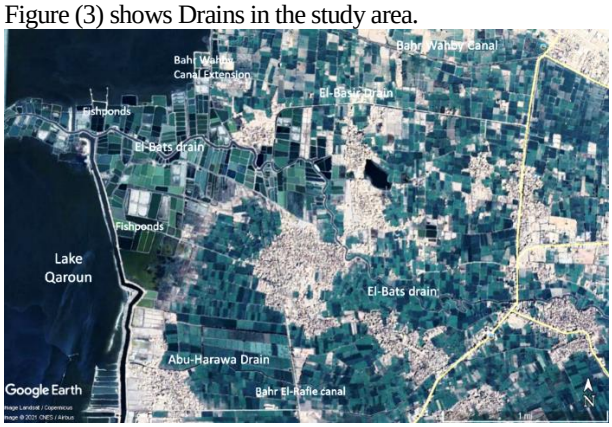

Figure 3. Drains in the study area.

Field Investigation and Sampling

Comprehensive data collection for the entire 2000 feddans of the study area would be too expensive for this study. Thus, the methodology of "Stratified Random Sampling" are applied. CAI EF, (2019); DRI, (2015).

Stratified random sampling is a method of sampling that involves the division of a population into smaller sub-groups known as strata. In stratified random sampling, or stratification, the strata are formed based on the studied variables.

Seven layers of data for the study area were generated, based on the following variables: 1. Size of the cultivated area. 2. Date when surface effects of waterlogging first appeared, and cause of waterlogging (agriculture/fishponds). 3. Type of activity (agriculture/fishponds). 4. Type of irrigation system (flood/sprinkler/drip) and adequacy/inadequacy of irrigation water amounts. 5. Types of crops. 6. Productivity of each of the planted crops. 7. Irrigation water quality (canal, drain, mixed) and source of irrigation water.

The fields of the selected sample comprised a total area of 190 feddans, which is about 0.33% of the total area served within Markaz Senoress that totals 57.6 thousand feddans. Total cultivated field tenures of the selected sample (by owner and/or by renter) during the winter season are 127 Feddans, which comprise 66.8% of the area served of the study area. Meanwhile, cultivated field tenures during the summer season are 105 feddans (20 feddans less than the winter season), and comprise 55.3% of the total area served in the study area.

5- Description of Environmental and Economic Indicators of the Study Area

Part of the environmental and economic data were obtained from a specially-designed and conducted questionnaire. Collected data included information about the cultivated area such as type of activity (agriculture/ fishponds), types of crops, productivity of each crop in the study area, type and quality of irrigation water, adequacy/inadequacy of irrigation water, and date when waterlogging started in the study area. Questionnaire data showed the following:

Sizes/Distribution of Land Tenures (Size/Owner/Renter) in the Study Area

About 62% of the study sample tenures (by owner) have less than 5 feddans. About 18% own 5 – 10 feddans and 11% own 10 – 20 feddans, while 9% own >20 feddans (as shown in figure 4). It also showed that 97% of the study sample land holders are land owners. DAHFG, (2019).

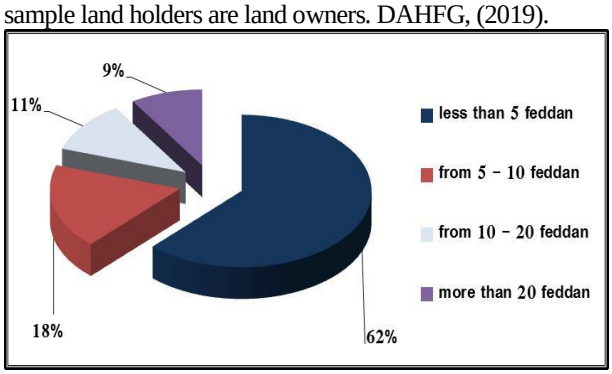

Figure 4. Proportion of land size ownership in the study sample

Cultivated Lands in the Studied Sample

Questionnaire data showed that for the winter season of 2017-2018, 59.8% of the study sample, farmers of actually cultivated wheat with a total area of 76 feddans, or about 40% of the study area sample. Meanwhile, 13.4% of the study sample, farmers cultivated Clover that comprised about 17 feddans, or 8.9% of the sample study area. About 18.1% of the study sample, farmers cultivated sugar beets; about 23 feddans or 12.1% of the study area sample. About 8.7% of the study sample farmers cultivated vegetables, about 11 feddans at a ratio of 5.8% of the sample study area. Non-cultivated lands (due to waterlogging) for winter season of 2017-2018 were about 63 feddans or 33.2% of the sample study area (see table 1).

Table 1. Area of cultivated crops and its ratio to the total sample area for the season 2017-2018.

Season	Crop	Area (feddans)	% of cultivated land	% of total area of the study sample
Winter	Wheat	76	59.8	40
	Clover	17	13.4	8.9
	sugar-beet	23	18.1	12.1
	Vegetables	11	8.7	5.8
	fishponds/uncultivated	63	--	33.2
	Total area	190	--	100
Summery	Maize	35	33.3	18.4
	Fodor maize	41	39	21.6
	Sesame	15	14.3	7.9
	Vegetables	14	13.3	7.4
	fishponds/ uncultivated	85	--	44.7
	Total area	190	--	100

Collected field questionnaire for the study area for the season 2017/2018.

For the summer season of 2017-2018, 33.3% of the study area sample were cultivated with maize, with a total area of 35 feddans (18.4% of the total sample area). Meanwhile, 39% of the study area sample were cultivated with Fodor maize, about 41 feddans (21.6% of the total sample area). About 14.3% of the study sample area was cultivated with sesame, which is about 15 feddans (7.9%). About 13.3% of the study sample area was cultivated with Vegetables, which is about 14 feddans (7.4% of the total

sample area). Waterlogged lands (uncultivated and fish pools) during the summer season were about 85 feddans, or 44.7% of the total study sample area (see table 1).

Source of Irrigation Water in the Study Area

The study area is irrigated from a number of sources, with surface flood irrigation as the prevailing system. About 62% of the farmers use fresh water from Bahr Al-Rafie canal and Bahr Wahby Canal Extension, while 38% of the farmer's re-use drainage water from El-Bats drain and Abo-Harawa Drain. However, irrigation water supply to the study area is insufficient especially during the summer season, despite the supplementary reuse of drainage water in irrigation [5].

Groundwater Problems in the Study Area

Questionnaire data that were collected from the study area farmers, in addition to data from Fayoum Agricultural Administration show that the study area and its surroundings suffer from waterlogging and lateral subsurface seepage. Relative saturation with high water table in the study area fields varies from <5% to 100%, as shown in Figure (5). CAI EF, (2019); DAHFG, (2019).

Questionnaire data showed that the main reason for waterlogging is poor agricultural drainage system and/or lack of tile drainage system network in the area. Only open drains exist in the study area (El-Bats drain and Abo-Harawa Drain), which are polluted with sewage. Moreover, rising surface water level in Lake Qaroun increases water logging and soil salinization problems.

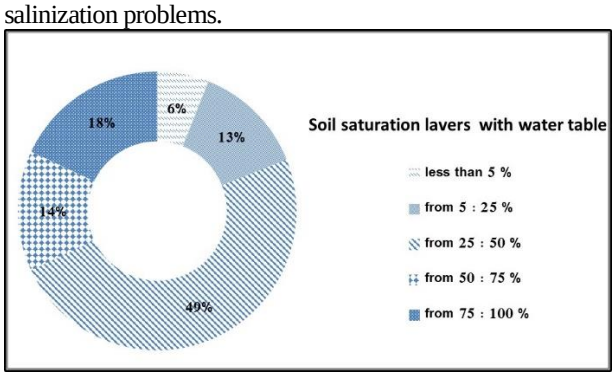

Figure 5. The ratios of waterlogged fields in the study region.
Sources: 1. Questionnaire for 2017-2018 agricultural season.
2. Fayoum Governorate Agricultural Administration 2019.

Economic Indicators Related to Irrigation Water Requirements and Crop Productivity in the Study Sample

Table (2) shows average agricultural productivity per feddan for both winter and summer seasons of 2017/2018 in the study area. From Table (2), average feddan productivity for winter crops (Wheat, Clover, Sugar Beets, and Vegetables) were 2.08, 14.62, 16.84, and 11.27 ton/feddan, respectively. Meanwhile, average unit-water productivity for winter crops was 0.96, 5.30, 6.79, and 5.99 Kg/m^3, respectively. On the other hand, average feddan productivity for summer crops (Maize, Fodor Maize, Sesame, and Vegetables) were 1.92, 6.01, 0.43, 8.86 ton/feddan, respectively. Average unit-water productivity for summer crops was 0.63, 2.19, 0.13, and 3.4 Kg/m^3, respectively.

Economic Impact Assessment of Waterlogging Effects on the Study Sample

Questionnaire data for the study sample in the area of Ezbet Khalaf and Monsha'at Tantawy – Markaz Senorss, Fayoum Governorate, showed that Feddan productivity in the study area was affected by waterlogging at different ratios. This was reflected on the percent areas of cultivated crops, percent areas of non-cultivated lands, and percent areas converted to fishponds. Table (3) and Figure (5) show feddan productivity, and percent change in average feddan crop productivity for the seasons 2011/2012 and 2017/2018. comparing with the average crop productivity per feddan for the same crops in Fayoum Governorate during 2017/2018.

Table 2. Average agricultural productivity per feddan for both winter and summer seasons of 2017/2018 in the study area (Ezbet Khalaf and Monshaat Tantawy) [1,2].

Season	Crop	Area Served (Fedan)	Feddan Producticity (ton)	Water Requirements (m^3/feddan/ season)	Unit Water Productivity (Kg/m^3)
Winter	Wheat	76	2.08	2176	0.96
	Clover	17	14.62	2758	5.30
	Sugar Beets	23	16.84	2481	6.79
	Vegetables	11	11.27	1883	5.99
Summer	Maize	35	1.92	3050	0.63
	Fodor Maize	41	6.01	2745	2.19
	Sesame	15	0.43	3189	0.13
	Vegetables	14	8.86	2605	3.40

Sources: 1. Collected field questionnaire for the study area for the season 2017/2018.
2. Directorate of Agriculture, Department of Agricultural Holdings, Fayoum Governorate, 2019.

Table (3) shows reduction in Average Feddan Productivity for winter crops (Wheat, Clover, and Sugar Beets) in the study sample during 2017/2018 as compared to that of the study area during 2011/2012 at ratios of 22.10, 11.39, and 8.23%, respectively. However, the same comparison showed increase in Average Feddan Productivity of vegetables at 3.58%. This is attributed to flexible selection of vegetable areas and to its shorter growth season. When compared to Fayoum Governorate Average Feddan Productivity, the study area Average Feddan Productivity during the winter was less at ratios of 5.88, 4.94, 1.81, and 4.25% respectively (as shown in Figure 6).

During the summer season, Average Feddan Crop Productivity (Maize, Fodor Maize, Sesame, and Vegetables) were less at rates of 22.58, 5.65, 12.24, and 8.19%, respectively, for the study area data for summer 2017/2018 as compared to the study area for summer 2011/2012 The comparison between the results of the study area with the the data of Fayoum Governorate for the same season (summer 2017/2018), showed that it was less at the ratios of 6.80, 2.75, 8.51, and 3.17%, respectively (Figure 6).

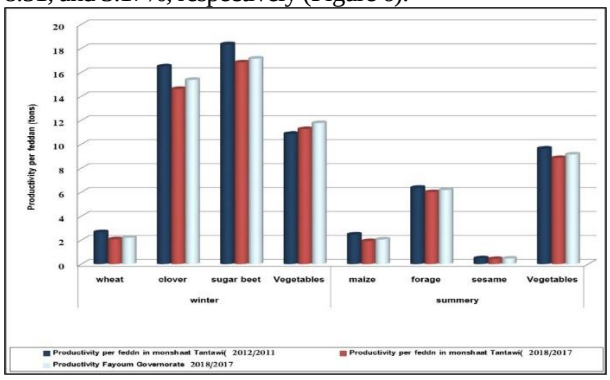

Figure 6. Comparison between Average Feddan Crop Productivity for the study area sample during 2011/2012 and 2017/2018, and compared to Fayoum Governorate during 2017/2018.

T-test was conducted to compare the study sample average to Fayoum Governorate general average for the season 2017/2018. The t-test showed that all the results are significant at 1% level, which is a strong indication that there are significant differences between Average Feddan Crop productivity in the study area sample and the corresponding values for Fayoum Governorate. JOHN, (1979); Dixon and Massey (1983). (as shown in Table 4).

Table 3. Average Feddan Productivity for the study area crops during the seasons 2011/2012 and 2017/2018, and comparing them to those of Fayoum Governorate [1,2,3].

Season	Crop	Feddan Productivity (ton)		% Change in Prod.	Fayoum Gov. Feddan Prod. (ton)	% Change in Prod.
		2011/2012	2017/2018		2017/2018	
Winter	Wheat	2.67	2.08	-22.10	2.21	-5.88
	Clover	16.5	14.62	-11.39	15.38	-4.94
	Sugar Beets	18.35	16.84	-8.23	17.15	-1.81
	Vegetables	10.88	11.27	3.58	11.77	-4.25
Summer	Maize	2.48	1.92	-22.58	2.06	-6.80
	Fodor Maize	6.37	6.01	-5.65	6.18	-2.75
	Sesame	0.49	0.43	-12.24	0.47	-8.51
	Vegetables	9.65	8.86	-8.19	9.15	-3.17

Sources: 1. Questionnaire for the study area for 2017/2018. 2. Central Authority for Public Mobilization and Statistics, Statistical yearbook, various years. 3. Directorate of Agriculture, Department of Agricultural Holdings, Fayoum Governorate, 2019.

Table 4. Results of t-test for comparison between the study area Average Crop Productivity against those of Fayoum Governorate for the agricultural season 2017/2018[1,2]

Season	Crop	No. Obs.	Fayoum Avg.	Study Sample Avg.	St. dev.	t-test value	Diff Avg.	Prob. P	Eval.
Winter	Wheat	42	2.21	2.077	0.056	-15.53	-0.133	0.00	Sig.
	Clover	34	15.38	14.623	0.105	-42.28	-0.757	0.00	Sig.
	Sugar Beets	37	17.15	16.842	0.053	-35.43	-0.308	0.00	Sig.
	Vegetables	29	11.77	11.270	0.031	-87.03	-0.500	0.00	Sig.
Summer	Maize	31	2.06	1.923	0.028	-27.43	-0.137	0.00	Sig.
	Fodor Maize	38	6.18	6.005	0.028	-39.05	-0.175	0.00	Sig.
	Sesame	23	0.47	0.431	0.017	-9.63	-0.039	0.00	Sig.
	Vegetables	25	9.15	8.864	0.023	-62.91	-0.286	0.00	Sig.

Sources: 1. Questionnaire for the study area for 2017/2018.
2. Directorate of Agriculture, Department of Agricultural Holdings, Fayoum Governorate, 2019. (Diff. Avg. = Difference Average, Sig. = Significant)

Estimation of Crop Yield Losses in the Study Area Based on Our Results

The questionnaire data were collected, together with Fayoum Governorate data, to estimate crop yield losses in the study area sample relative to Fayoum Governorate averages for the agricultural season 2017/2018. Winter season crop losses (wheat, Clover, Sugar Beets, and Vegetables) were estimated as 10.11, 12.87, 7.08, 5.50 tons/fed., respectively. Meanwhile, summer season crop losses (Maize, Fodor Maize, Sesame, and Vegetables) were estimated as 2.80, 7.18, 0.59, and 4.0 tons/fed., respectively (as shown in Table 5).

Table 5. Crop Yield Losses in the collected samples from the study area (Ezbet Khalaf and Monsha'at Tantawy) according to study sample results for the agricultural season (2017/2018). (Yield in tons) [1,2].

Season	Crop	Study Area Sample				Ezbet Khalaf & Monsha'at Tantawy	
		% area	Area (feddans)	Diff. Avg.	Yield Reduction	Area (feddans)	Yield Reduction
Winter	Wheat	59.8	76	0.133	10.11	1197	159.18
	Clover	13.4	17	0.757	12.87	268	202.66
	Sugar Beets	18.1	23	0.308	7.08	362	111.56
	Vegetables	8.7	11	0.500	5.50	173	86.61
Summer	Maize	33.3	35	0.137	4.80	667	91.33
	Fodor Maize	39.0	41	0.175	7.18	781	136.67
	Sesame	14.3	15	0.039	0.59	286	11.14
	Vegetables	13.3	14	0.286	4.00	267	76.27

Sources: 1. Questionnaire for the study area for 2017/2018. 2. Directorate of Agriculture, Department of Agricultural Holdings, Fayoum Governorate, 2019.

Estimation of Crop Yield Losses in the Area Served of Ezbet Khalaf and Monsha'at Tantawy Based on the study Results

The collected questionnaire data for the study area sample were used to estimate crop yield losses in the area served of 2000 feddans of Ezbet Khalaf and Monsha'at Tantawy that is affected by waterlogging, as compared to the average yields in Fayoum Governorate (2017/2018 season). It is assumed that the distribution of area cultivated with crops samples in the study area and in Fayoum Governorate are at the same proportions. Thus, winter crops' losses (Wheat, Clover, Sugar Beet, and Vegetables) were estimated at 159.18, 202.66, 111.56, 86.61 tons/fed., respectively for the entire study area. Meanwhile, summer crops' losses (Maize, Fodor Maize, Sesame, and Vegetables) were estimated at 91.33, 136.67, 11.14, and 76.27 tons/fed., respectively (as shown in Table 5).

CONCLUSION AND RECOMMENDATIONS

In the results, of the study revealed that.

- All parts of the study area suffer from waterlogging and lateral seepage, and the ratio of waterlogged portion varies from 5% to 100%.
- The main reason for waterlogging in the study area is poor agricultural drainage and lack of tile drainage system, and the increase in Lake Qaroun water surface level. In addition, El-Bats and Abo-Harawa drains carry significant loads of pollutants and participate in increasing Lake Qaroun surface water level.

- Average Feddan Productivity in the study area for winter crops (Wheat, Clover, Sugar Beet) in the season 2017/2018 was less than that in the season 2011/2012 at rates of 22.10, 11.39, and 8.23%, respectively. Meanwhile, Vegetables' Feddan Productivity increased at 3.58%. Compared to Fayoum Governorate Average Feddan Productivity for winter crops in the study area (Wheat, Clover, Sugar Beet, and Vegetables) was reduced at 5.88, 4.94, 1.81, and 4.25%, respectively.
- Average Feddan Productivity in the study area for summer crops (Maize, Fodor Maize, Sesame, and Vegetables) in the season 2017/2018 was less than that in the season 2011/2012 at rates of 22.58, 5.65, 12.24, 8.19%, respectively. Compared to Fayoum Governorate Average Feddan Productivity for summer crops in the study area (Maize, Fodor Maize, Sesame, and Vegetables) was reduced at 6.80, 2.75, 8.51, and 3.17%, respectively.
- T-test Comparison results between study area sample average and Fayoum Governorate Average for the agricultural season 2017/2018 for the study crops showed significant changes at 1% significance level.
- Crop yield losses for the study area (2000 Feddans of Ezbet Khalaf and Monsha'at Tantawy) were estimated assuming that crops are cultivated in areas of the same percent proportions in the study area sample, as in the study area, as in all Fayoum Governorate. Winter crop yield losses/Feddan for the study area (based on comparison to Fayoum Governorate Productivity) were 159.18, 202.66, 111.56, and 86.61 tons/Feddan for Wheat, Clover, Sugar Beet, and Vegetables; respectively. Summer crop yield losses/Feddan for the study area (based on comparison to Fayoum Governorate Productivity) were estimated at 91.33, 136.67, 11.14, and 76.72 tons/Feddan for Maize, Fodor Maize, Sesame, and Vegetables; respectively.

Based on the above conclusions, this study recommends:

In the short-term:

1. The necessity of rehabilitation and maintenance of agricultural drains' cross sections and beds in the study area in order to raise the hydraulic efficiency to carry the design discharges of drainage waters coming from upstream agricultural fields. This is expected to significantly reduce waterlogging in the study area.
2. Increase the number of pumping (lifting) units at drain ends to raise their capacity for dumping drainage waters to Lake Qaroun. This is also expected to participate in lowering water table levels in the study area to levels lower than surface water level in Lake Qaroun.
3. Train the engineers and technicians in the agricultural extension service departments in order to improve their capacities to train farmers in the study area to accept and use modern irrigation systems (sprinkler/drip). This will raise productivity per Feddan and productivity per unit water used.

In the medium- and long-term:

4. Plan to develop and improve the irrigation system in the study area in order to replace surface flood irrigation with sprinkler/drip irrigation systems, with adaptation to the area's soils. This will raise productivity per Feddan and productivity per unit water used.
5. Complete the planned construction of the protection dike between the study area and Lake Qaroun.
6. Install subsurface pipe drainage network in the study area.
7. Install sewage network in the study area, with appropriate sewage treatment plants.

REFERENCES

CAIEF (Central Administration for Irrigation in East Fayoum), (2019). Unpublished data.

CAPMAS (Central Agency for Public Mobilization and Statistics), (2019). Statistical yearbook, various years.

DAHFG (Directorate of Agriculture, Department of Agricultural Holdings, Fayoum Governorate), (2019).

DRI (Drainage Research Institute), (2015). "Providing the necessary solutions to the problem of rising ground water levels under the control of the farms of the Tantawi facility - Senouras Center, Fayoum Governorate," Unpublished study report.

IDSCF (Information and Decision Support Center, Fayoum Governorate), monthly information bulletin, different issues, different years.

JOHN, E. Freund, (1979). Modern Elementary Statistics. Arizona State University 5th Edition, Prentice-Hall INC, Englewood Cliffs, New Jersey.

Maxwell, L. B., (1979). Farm Budgets from Farm Income Analysis to Agricultural Project Analysis. Published for the World Bank, The John Hopkins University Press, Baltimore and London.

W. J. Dixon, F. J. Massey (1983). Introduction to Statistical Analysis, McGraw – Hill, Fourth Edition.

تقييم الآثار البيئية والاقتصادية لارتفاع منسوب الماء الأرضي ببعض الأراضي عزبة خلف ومنشأة طنطاوي بمركز سنورس – محافظة الفيوم (دراسة حالة)

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ينخفض منسوب الأراضي الزراعية بمحافظة الفيوم بالاتجاه شمالا تجاه بحيرة قارون حيث يصل منسوب الأراضي المتاخمة للبحيرة إلى حوالى -40م، وهذا يجعلها عرضة لارتفاع الماء الأرضي بها في الكثير من الأحيان إما نتيجة لحركة رشح الماء الأرضي من المناطق المرتفعة بتأثير الجاذبية الأرضية، أو نتيجة لارتفاع منسوب المياه في البحيرة. ومن خلال دراسة تذبذب الماء الارضى على مساحة حوالى 2000 فدان ببعض أراضى عزبة خلف ومنشأة طنطاوى بمركز سنورس بالفيوم، تبين أن جميع زمامات منطقة الدراسة تعاني من ارتفاع منسوب الماء الأرضي نتيجة استخدام نظام الرى بالغمر بالزراعة. وأظهرت نتائج تحليل بيانات البحث أن متوسط إنتاجية الفدان من محاصيل الموسم الشتوي انخفضت خلال موسم 2018/2017 عن مثيلها على مستوى محافظة الفيوم بنسب تتراوح بين 1.81% إلى 5.88% حسب ارتفاع منسوب الماء الأرضي، كما انخفض متوسط إنتاجية الفدان من محاصيل الموسم الصيفي عن مثيلها على مستوى محافظة الفيوم بنفس الموسم بنسب تتراوح بين 2.75% إلى 8.51%. وأظهرت نتائج اختبار (ت) للمقارنة بين متوسط عينة الدراسة والمتوسط العام لمحافظة الفيوم للمحاصيل محل الدراسة وجود فرق معنوي عند مستوى معنوية 1%. لذا فقد أوصى البحث بضرورة العمل على تطوير نظام الري بمنطقة الدراسة بهدف تقليل كمية الماء الزائد المنصرف نحو الأراضي المنخفضة ونحو بحيرة قارون، وهذا من شأنه تحسين الميزان المائي لعمل توازن بين المياه الداخلة إلى البحيرة وفواقد البخر، وذلك لخفض منسوب الماء في بحيرة قارون، والذي سوف ينعكس على تحسين حالة الأراضي المنخفضة. كما أوصى البحث بإعادة تأهيل وتطهير القطاع المائي للمصارف الزراعية ومحاولة تخفيض منسوب قاعها، وإنشاء وتطوير شبكة الصرف المغطى بمنطقة الدراسة.