Kafr El-Sheikh University
Faculty of Agriculture
Soil Department.

# EVALUATION OF SOILS IN THE NORTH NILE DELTA UNDER DIFFERENT AGRICULTURAL PRACTICES

By
Bahgat Abd El-Kawy Abd El-Hamid Zamil

A Thesis Submitted in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY
In
Agricultural Sciences
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# APPROVAL SHEET

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**Bahgat Abd El-Kawy Abd El-Hamid Zamil**

*B.Sc. Agric. Soil Science, Kafr El-Sheikh, Tanta University 1980*

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**THESIS**

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**IN**

**AGRICULTURE SCIENCE**

**(SOILS)**

***Approved by:***

**Prof. Dr. Saber A. Gaheen** ............

*Prof. of Soil Science, Fac. of Agric.,*
*Kafrelsheikh University*

**Prof. Dr. Raafat A. Ali** ............

*Prof. and Head of Soil Sci. Dept. Fac. of Agric.*
*Kafrelsheikh* University

**Prof. Dr. Hassan A. Ismail** ............

*Prof. of Soil Science, Fac. of Agric. (El-Shatby),*
*Alexandria University*

**Prof. Dr. Mohamed E. Abowaly** ............

*Prof. of Soil Science, Fac. of Agric.,*
*Kafrelsheikh* University

Date:20/8/2007

## ADVISORS COMMITTEE

**Prof. Dr. Saber A. Gaheen**

*Prof. of Soil Science, Fac. of Agric.,*
*Kafrelsheikh University*

**Prof. Dr. Mohamed E. Abowaly**

*Prof. of Soil Science, Fac. of Agric.,*
*Kafrelsheikh University*

**Dr. Ekhlas M. Al Wkeil**

*Assoc. Prof. of Soil Science, Fac. of Agric.,*
*Kafrelsheikh University*

**Prof. Dr. Mohamed I. El-Shahawy**

Head of Research, Soils, Water & Env.
Res. Ins., Agric. Res. Center

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# EVALUATION OF SOILS IN THE NORTH NILE DELTA UNDER DIFFERENT AGRICULTURAL PRACTICES

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ABSTRACT

The current study was carried out to evaluate the reclaimed soils under different agricultural practices i.e. land use periods, irrigation water sources, drainage systems and fish farming. To achieve such aim, two regions in North Delta area (namely) Al-Zawea region and Gharb Al-Mansoure region were chosen.

- Twenty one profiles were selected in these regions, to represent variations in agricultural practices.
- Sources of irrigation water were fresh water and blended water.
- Drainage systems in both regions were tile drainage and open drainage.
- Land cultivation periods were, (virgin soil), 5, 15, 30 and 50 years. All profiles were described according to macro-morphological features of different layers, soil samples were collected from the subsequent layers, for physical and chemical analysis and fertility status.
- Five water samples from the different irrigation sources (Al-Ghabat, Al-Halafi and Al-Daramally canals) in Al-Zawea region, and (Kom Al-Teen Canal and Al-Mansour canal) in Gharb Al-Mansoure region, were collected for chemical analysis.
- Land evaluation of the studied area was assessed, using applied system of land evaluation (ASLE program), which suits the different environmental conditions of Egypt. Four main factors were used for land evaluation; soil properties, fertility status, irrigation water quality and environmental conditions. The final index of land evaluation (F.I.L.E.) was calculated.

The main obtained results could be summarized as follow:

**Effect of agricultural practices on the different soil properties:**

**Soil physical properties:** The studied soil physical properties were improved as results of increasing cultivation period, using fresh water for irrigation and tile drainage system, hence the values of bulk density were decreased, and the values of aggregation parameters and hydraulic conductivity were increased.

**Soil chemical properties:** The soil chemical properties of the studied samples were improved, as a result of increasing cultivation period, using fresh water for irrigation and tile drainage system. Values of soil salinity (ECe), soil sodicity (ESP), soil adsorption ratio (SAR) and total calcium carbonate were decreased.

**The effect of agricultural practices on soil fertility status:**

1. **Organic matter:**

- The soil organic matter was increased with increasing cultivation periods, especially in the surface layers.
- Organic matter content was higher in cultivated soils than virgin soils.
- The OM content of soil increased under tile drainage system and fresh irrigation water source, than open drainage and blended water.

2. **Available N, P and K:** The NPK content of soil irrigated by blended water and served by open drainage, was higher than those irrigated with fresh water and served by tile drainage.
3. **Available micronutrients (Fe, Mn, Zn and Cu):** The available micronutrients (Fe, Mn, Zn and Cu) content were increased with increasing cultivation periods, for the soil under open drainage. While it were decreased with soil under tile drainage. On the other hand, there was no clear effect on micronutrients due to irrigation water quality.

**The effect of using fish farming on soil properties:**

1. **Soil physical properties:** The fish farming caused deterioration of soil physical properties, comparing with the soil that directly cultivated, the soil bulk density values were increased, while aggregation parameters and hydraulic conductivity values, were decreased in the soil used as a fish farm.
2. **Soil chemical properties:** The fish farming resulted in leaching of salts out of soil profile, comparing with virgin soil, values of ECe were decreased by about (67.68 and 72.18%), for soil that used as fish farm, for about 15 and 10 years respectively. ESP was decreased by about (32.14 and 44.09%) for soil used as fish farm, for the same periods. These values were still higher than those obtained for cultivated soils.

**Land capability of the studied area using ASEL program:**

Final index of land evaluation were calculated, to evaluate the influence of different agricultural practices on soil productivity. The obtained data could be summarized as follows:

1. Soils under tile drainage had the higher values of F.I.L.E. compared to the soil under open drainage at the same period of cultivation.
2. The soil irrigated with fresh water had F.I.L.E. values higher than those irrigated with blended water, at the same cultivation periods.
3. The F.I.L.E. values were increased with increasing cultivation period.
4. Virgin soil in the different locations had the capability class of $C_5$ (very poor), the limitations of such soil were, the hydraulic conductivity, soil aggregation, soil salinity, alkalinity, ground water salinity, organic matter content and available nitrogen and phosphorus.
5. The soil irrigated with fresh water under tile drainage, classified as $C_3$ (fair), for soil cultivated for 5 years and was $C_2$ (good), for soil cultivated about 15, 30 and 50 years. The most limiting factors for these soils were, ground water salinity, organic matter, available nitrogen and phosphorous.
6. The soils irrigated by fresh water with open drainage were classified as $C_3$ (fair), in the soil cultivated for 5 and 15 years and to $C_2$ (good), in the soil cultivated for 30 years. The most limiting factors were, ground water depth, ground water salinity, soil salinity, organic matter, available nitrogen and phosphorus.
7. The soils that irrigated by blended water under tile drainage were classified as $C_3$ (fair)s for the soil cultivated for 5 and 15 years, and to $C_2$ (good), for soil cultivated for 30 and 50 years. The most limiting factors were, ground water depth, the hydraulic conductivity, ground water salinity, organic matter content and available nitrogen and phosphorus.
8. The soil that irrigated by blended water and served by open drainage, was classified into $C_3$ (fair), with different cultivation periods. The most limiting factors were, ground water depth, ground water salinity, soil salinity, organic matter content and available nitrogen and phosphorus.
9. Soils that used as fish farming for about 15 years was classified as $C_3$ (fair). Also, the soil that cultivated about 15 years, then converted to fish farming, for 10 years was classified as $C_3$ (fair). The most limiting factors were, ground water depth, hydraulic conductivity, ground water salinity, soil salinities organic matter content and available nitrogen and phosphorus.

Thus, the most limiting factors prevailed in the soil located at the North Nile delta were high water table depth and salinity (due to inefficient drainage system), sea water intrusion, salinity and sodicity, insufficient content of organic matter and available macronutrients, as well as fresh water shortage, (since these soils located at the tail-end of irrigation canals).

**Land suitability for crops:** The study area is highly suitable for sugar beet, barley, wheat, berseem and cabbage, as winter crops and sunflower, rice and cotton, as summer crops.

From the current study, the following recommendations could be recommended:

1. The most high salt tolerant crops (barley-sugar beet, cotton) and tolerant crops (wheat - rice - sunflower) must be grown.
2. Follow-up the drainage condition and increasing its efficiency through periodical maintenance of tile drainage system and using some drainage accessories such as mole drain and subsoiling.
3. When fresh water is available, it must be used in irrigation during the most sensitive physiological plant stage especially in germination and seedling stage.
4. Establish fish farm in salt-affected soils during the leaching stage to increase the farmers income.
5. Forbidden using the productive agricultural land as fish farming to maintain its quality and prevent degradation of its properties.

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# INTRODUCTION

In the last years, the Egyptian population increased rapidly, if this increase continues at the present rate (2.7%) (FAO, 1992), the land resources will not overcome the needs of such population. So, there is an urgent need to match land types and uses, in the most practicable and logical ways, to continue sustainable production, and to meet the needs of society conserving ecosystems.

Most countries in arid and semi-arid regions are facing water shortage because, limitation of availability of fresh water, and degradation of water supplies. The growing demands on existing water to maximize the agricultural production, horizontally and vertically, to cope the progressive demand on food and agricultural crops, compels the countries to use all water sources. Use of low quality water, for long-term, especially in salt affected soils, restricts the growth of most crops, and makes the productivity of such soil much lower than what their fertility would allow.

Farmers at the tail-end of irrigation canals, unofficially reuse about 2 billion $m^3/y$ of drainage water, directly for irrigation (**El-Hessy and El-Kady, 1997**). Use of low quality water for long time led to several adverse effects for soils and plants.

In the North Nile delta, there are different agricultural practices, which may affect the soil characteristics, and there productivity, these practices comprise:

1. Drainage system (open or tile).
2. Sources of water (blended or fresh).
3. Subjecting soils under fishering.
4. Different land use periods.

Land evaluation is an essential tool in land use planning. It deals with two major aspects: physical resources, such as soil and climate, and socioeconomic resources, like availability of manpower and market position, which affect the choice of the different alternatives, for the most beneficial land use (**Rossiter, 1990, Rossiter and van Wambek, 1995**).

The objective of the present work is to evaluate the soil under different agricultural practices to define:

1. the most reasons of land degradation in North Delta, and to find out the most proper techniques to combat it.
2. land capability and suitability for different crops, under different agricultural practices, and to find the most constrains that affect land productivity.
3. the proper agricultural practices, that maximize house hold income, land and water resources efficiency.

# 2. REVIEW OF LITERATURE

## 2.1. Effect of management practices on soil properties:

Several agricultural practices were conducted in North Nile Delta region, in leaching processes to removal the excess salts. Also, application of some soil amendments, such as gypsum, farmyard manure and farm waste, to improve soil physical and chemical properties and nutrient status, with different cultivated periods. As well as, their different drainage system (tile and open drainage) to improve soil hydro-physical properties. On the other hand, farmers at this region, used different water qualities for irrigation i.e. fresh water (Nile water), blended water and sometimes drainage water. All these agricultural practices affect directly or indirectly on physical and chemical soil properties.

### 2.1.1. Soil physical properties:

Several investigators revealed that water table depth plays an important role in soil conservation, through its effects on soil properties and crop productivity. Artificial drainage becomes necessary to control the water table, and maintain suitable aerated zone. The shallow water table reduces growth, due to the decrease of rooting volume and insufficient oxygen. Drainage technology has developed around two basic needs (i) to ensure aeration and trafficability for agricultural soils, and (ii) to provide for salinity control (**Moukhtar *et al.*, 2003**).

The bulk density value was increased with increasing drain spacing. While the infiltration rate (IR), hydraulic conductivity (Ks), penetration and total porosity values, were decreased with increasing drain spacing in heavy clay soil (**Naguib, 1987; El-Gohary *et al.*, 1989; Wahdan *et al.* (1985, 1992); El-Sabry *et al.*, 1992 and Ramadan *et al.* (1994)**.

**Salem (2003)** reported that, application of soil amendments (farmyard manure, gypsum and their combinations) caused reduction in the bulk density of the cultivated clayey soil, where the total porosity, as well as, water field capacity, wilting point and available water increased in the soil.

The drainage improve poor permeability, and enhance water movement, which is considered an important factor for salt leaching, and preventing water logging in the root zone (**Armstrong *et al.*, 1990**).

**El-Sabry (1986)** showed that, deep ploughing in the presence of gypsum, has a largest effect on down-ward movement of salts comparing with surface ploughing.

**Shams El-Din (2001)** pointed out, that the mole drains (unlined circular soil channels which function like pipe drains), improved the infiltration rate of the soil, compared to that without mole drain treatment. The installation of tile drains is considered one of the important factors affecting soil aggregate formation directly and indirectly, the direct effect is due to wetting and drying cycles, which create better environmental conditions for aggregate formation, whereas, the indirect effect of tile drains on soil structure, may be due to the redistribution of chemical constituents in the soil profile (**Abdel-Mawgood 1987**).

**McConkey *et al.* (1997)** stated that, subsoiling 35 cm or deeper increased the amount and depth of infiltrated water. **Sojka *et al.* (1997)** stated that soil porosity, saturated and slightly unsaturated hydraulic conductivity ($K_5$ at $K_{40}$) and air permeability, were highly variable but, generally increased with subsoiling. Also, they reported that persistence of subsoiling effect, as measured by plant response, penetration resistance and bulk density was: one year for sandy soil and two years for silty or clayey soils. Subsoiling improved physical conditions to 45 cm depth, but was less effective at great depths.

**Anter (2005)** showed that, the hydraulic conductivity increased with decreasing the distance from the lateral drains. The hydraulic conductivity values, above drains were higher as compared to values obtained from midway between drains.

**Koriem *et al.* (1988)** found that stable aggregates > 2.0 mm in soils irrigated at 75% of available water, were lower than those in soils irrigated at 50% of available water. Also, they found that optimum size of aggregates (2.0-0.5 mm) increased with decreasing salinity in irrigation water and available moisture content at time of irrigation.

**Khalifa (1990)** evaluated the suitability of drainage water for irrigation purposes, and its effect on some soil properties. He compared some physical parameters of the soil when drainage and Nile water were used under cotton crop. He reported that in case of using El-Gharbia main drain for irrigation, the aggregation index (AI), total water stable aggregates (WSA) and mean weight diameter (MWD) of surface layer (0-15), decreased by 37.9%, 9.67% and

3.13%, respectively. But in case of Nile water, such parameters increased by 4.21%, 10.60% and 23.80% respectively.

**Kandil (1990)** reported that the use of drainage water for irrigation decreased structure stability. This effect was more pronounced in the clay loam soils. The mean weight diameter (MWD) of soil aggregates was not affected significantly, if a mixture of drain and canal water was used for irrigation.

**El-Samanoudi (1992)** showed that, total porosity, volume of drainable pores; and quick drainable pores and subsequently hydraulic conductivity, clearly decreased as a result of increasing salinity and sodicity of irrigation water. **El-Henawy (2000)** found that using drainage water, or drainage water mixed with waste water for irrigation, caused slightly decrease of soil bulk density. Hydraulic conductivity values of soil irrigated with fresh water, were lower than that irrigated with drainage water. Also, Ks values of soil increased with increasing salinity of irrigation water, and decreased with increasing ESP of soil and irrigation water.

**Abo Soliman *et al.* (2001)** reported that, use of drainage blended with treated swage water for irrigation, enhanced the formation of aggregates, and increased both the optimum size aggregates (OSA) and water stable aggregates (WSA), while the lowest values of aggregates parameters, were recorded with fresh water. Also, they added that, the highest value of basic infiltration rate was achieved with sewage water, under surface irrigation while the lowest value was recorded with fresh water. **Levy *et al.* (2002)** pointed out that the decrease in hydraulic conductivity relative to initial hydraulic conductivity, which depended on the both water quality, and soil sodicity, was greater with the decrease in water EC and an increase in ESP.

**Ghazy (2003)** studied the impact of different irrigation water sources on hydrophysical properties of some soil types. He found that the highest values of soil moisture content at different tensions, quickly, slowly and total drainable pores, water holding pores, soil hydraulic conductivity and total porosity, as well as, the lowest values of fine capillary pores and bulk density, were achieved with irrigation by treated swage water, in clay and loamy soils, while it was opposite with irrigation by fresh water.

**Chauchan and Tripathi (1983)** found that increasing rate of gypsum (5 to 20 tons/ha) progressively, improved hydraulic conductivity. The increase of the amount of irrigation water, as well as, the amounts of applied gypsum and organic manure, with deep ploughing, led to increase of soil hydraulic conductivity.

**Kaoud *et al.* (1989)** found that, the significant increase of porosity factor, voids ratio and organic carbon after rice cultivation, were related to the addition of both calcium super phosphate and gypsum, but the gypsum had highest effect.

**Chawla and Chhabra (1991)** found that application of gypsum amendments mixed with P and N fertilizers to sodic soil, increased infiltration rate (IR), saturated hydraulic conductivity and water stable aggregates. **Rany *et al.* (1995)** stated that under normal conditions, deep ploughing increased the pore space in soil.

**Hamoud (1992)** reported that total soil porosity increased with increasing ploughing depth.

**Awad (1998)** stated that, total porosity was increased with increasing farmyard manure, (FYM) alone or mixed with gypsum. **Zein *et al.* (1996)** stated that both gypsum and FYM increased water stable aggregates percentages (WSA%), aggregation index (AI), mean weight diameter (MWD) and optimum size aggregates (OSA) (1.0-0.5) and structure coefficient. **Abdul Wahid *et al.* (1998)** stated that farmyard manure (FYM) and clover hay, increased WSA and water holding capacity (WHC). **Zhang *et al.* (1997)** stated that the addition of organic matter significantly reduced soil compactness.

**El-Shanawany *et al.* (2000)** indicated that gypsum addition besides subsoiling operations, had general depressive effect on soil bulk density. On the other hand, it increased the values of structure factor (S.F) and hydraulic conductivity (Ks) after implementation.

**2.1.2. Soil chemical properties:**

Ground water salinity, soil salinity, soil reaction (pH), cation exchange capacity (CEC), exchangeable sodium percentage (ESP), total carbonate and gypsum content are the main chemical factors for land evaluation.

Several investigators studied the effect of different agricultural practices on soil chemical properties. The soil salinity (ECe) and sodicity (ESP) have been reduced by tile drainage system, hence, soil productivity increased as a result of the reduction of salinity.

**Madramootoo and Buckland (1990), Schellekens *et al.* (1990), Moustafa *et al.* (1990) and Wahdan *et al.* (1992). Abu-Sinna (1991)** indicated that soil desalinization is associated with the decrease in SAR and ESP values, due to the high leachability of $Na^+$ compared to that $Ca^+$ and $Mg^{++}$, as well as, under leaching conditions of saline sodic soils, effective solubility are much increase.

**Abou Hussien and Abou El-Khir (1999)** showed that the tile drainage system establishment plus gypsum application resulted in a decrease of EC, pH, SAR and ESP values. Such decrease increased with increasing the drainage period. **Hassanien *et al.* (1992)** stated that, EC values of organic materials treated-clayey soil increased from 2.44 to 3.08 and 3.87 dS/m by adding 20 and 40 ton/feddan organic materials, respectively.

**Youssef (1992)** studied the effect of gypsum addition, 25 and 50% of gypsum requirement (GR), under subsoil drainage system in the reclamation of alluvial saline sodic soil, in El-Sharkia governorate (clay loam). He showed that gypsum application decreased the Ece, ESP, and soil pH values, compared to the control (leaching without gypsum addition).

**El-Shanawany *et al.* (2000)** indicated that application of gypsum and subsoiling, under tile drainage of 25 m spacing, reduced the ECe value of soil surface, with the percentages of 20.00% and 55.36% of the initial state, during the studied two seasons, respectively. The corresponding values of the subsoil layers were 22.72 and 49.53%, respectively. Also, the ESP value was reduced from 16.9 to 12.2 and 11.3%, in the soil surface and from 19.6 to 15.63 and 14.23% in the subsoil ones, for the two studied seasons respectively.

**Anter (2005)** found that, tile drainage installation, somewhat reduced soils salinity especially, in the surface soil layers. In this respect **Ibrahim (1998)** reported that the effect of tile drainage on reducing soil salinity, is attributed to the increase of salts removal with drainage water, and its effect on reducing water table depth.

**El-Sabry (1986)** reported that, the addition of organic manure accompained with deep ploughing, and high application of irrigation water, pronounced decreased soluble cations and anions, incoporation of organic manure in addition to gypsum, in the presence of deep mechanical ploughing, and suitable amount of irrigation water, are the most effective practice in SAR reduction and consequently, improvement of chemical properties of saline sodic soil.

**Koriem (1993)** reported that, EC values of 1: 2.5 water extract in sewage sludge and farmyard manure treated soil, significantly increased above that found in the control. **Rehman *et al.* (1996)** achieved a substantially decreased ECe and SAR of saline sodic soils, with the addition of different organic amendments.

**Koriem *et al.* (1988)** found that significant increase of both electrical conductivity (EC), soluble sodium and chloride, was almost proportional to salt concentration of irrigation water, pH values significantly increased, with decreasing both concentration of salts in irrigation water and available water at irrigation time. **Abo-**

**Soliman *et al.* (1992)** reported that increasing salinity level in the drainage water used for irrigation, increased soil salinity level and individual soluble ions of the clay soil, while using fresh water showed the opposite trend.

**El-Samanoudi (1992)** reported that the increase in salinity of irrigation water causes increase of SAR and ESP.

**El-Gazzar (1996)** studied the use of low water quality in irrigation, and its effect on soil properties in the surface layer. He found that the cationic composition of soil solution followed the order $Na^+ > Ca^{++} > Mg^{++} > K^+$ in most cases; whereas, the anionic composition follow the descending order $SO^{=}_4 > Cl^- > HCO^-_3$.

**Sobh *et al.* (1997)** pointed out that, increasing salinity of applied water, caused an increase in Na-adsorption by soil complex. On the other hand, the increase in either salinity or SAR of water which used for irrigation, caused clearly increase of soil ECe and SAR.

**El-Henawy (2000)** pointed out that the soil salinity, soluble ions, SAR values and exchangeable Na and Mg, increased as a result of using drainage water, or drainage water mixed with wastewater, while exchangeable Ca decreased in comparison with using fresh water for irrigation purpose. **Omar *et al.* (2001)** found that soil salinity and alkalinity were increased as a result of using drainage water or blended water for sugar beet irrigation.

**Gazia (2001)** studied the use of different sources of water for sugar beet irrigation under soil moisture depletion. He found that the irrigation with fresh water gave the lowest value of soil salinity and sodium adsorption ratio (SAR). While the highest values (8.5 and 10.1) were obtained by using blended sewage water with well water, at the ratio of 2: 1 under the two methods of water application, respectively.

**Zein *et al.* (2002)** revealed that using poor water quality for irrigation, increased ECe, SAR, soluble $Na^+$, $Mg^{++}$, $SO^{=}_4$ and $Cl^-$ in soil paste extract than that of mixed or good water quality. **Hassan *et al.* (2003)** showed that the irrigation with low water quality, significantly increased the soil salinity and soil sodicity, and significantly increased exchangeable $Na^+$ and $K^+$, while exchangeable $Ca^{++}$ and $Mg^{++}$ significantly decreased.

**El-Morsi (1990)** stated that the values of $Ca^{++}$, $Mg^{++}$ and $Na^+$ ions were higher under shallow ploughing at 15 cm than its values under deep ploughing at 30 cm.

**Awad *et al.* (1996)** reported that the sulphur application with organic manure, decreased the soil pH by 4% on average during the wheat season in the highly calcareous soils. **Mostafa *et al.* (2001)** showed that the application of FYM and chicken-manure to soil alone, or in combination with Fe or Zn decreased soil pH values in the two studied soils in Ismaila and Nubaria soils.

**Gomaa (1998)** found that, gypsum application beside drainage and sub-soiling, decreased the content of most soluble ions, and in turn both ESP and soil pH were decreased.

**Mahmoud *et al.* (2001)** stated that application of gypsum and sulphur alone or in combination with FYM, improved some soil properties and fertility status (i.e., soil pH, ECe, ESP, CEC and OM content, and in turn the availability of N, P and K in saline sodic soil.

**2.1.3. Soil fertility status:**

Soil fertility is important element in determining the suitability of lands for agriculture, especially under arid and semi-arid climates.

**Abou-Hussien and Abou El-Khir (1999)** pointed out that the available and total N, P and K contents, decreased with the tile drainage system establishment and gypsum application. This decrease was clear after second year in the surface layers of these soil profiles above drains. Also, they added that the micronutrients (Fe, Mn, Cu and Zn) were clearly affected by the tile drainage and gypsum application, where the total and available content of these elements decreased after the first year. After the second year, the total content of these elements were decreased, but the available content increased.

**Shams El-Din *et al.* (2000)** pointed out that the highest nitrogen content of soil was achieved with gypsum application combined with sandy mole, especially in the surface layer. The highest phosphorus content was detected with gypsum application combined with subsoiling. The availability of micro-nutrients; Zn, Mn, Fe and Cu tend to be increased with all soil amelioration treatments.

**Mahmoud *et al.* (1996)** observed that the availability of Fe, Zn and Mn increased gradually with increasing the amounts of applied water and gypsum. **El-Fakharani (1997)** added that the uptake of NPK, was significantly increased as a result of increasing gypsum level to 2 tones $ha^{-1}$, at the rate of 10 tons $ha^{-1}$ of poultry manure, whereas at the rate of 1 ton $ha^{-1}$ of gypsum, significantly increased the uptake of NPK at the rate of 20 tons $ha^{-1}$ of poultry manure, moreover, NPK uptake was decreased at the higher levels of gypsum (4 and 8 tons $ha^{-1}$).

**Omar *et al.* (2001)** noticed that the soil elements content after sugar beet, was increased as a result of irrigation with drainage or blended water and sludge treatments. The highest values were 36.17, 6.16 and 394 ppm for N, P and K, respectively, as well as 2.21, 27.64, 17.00 and 11.4 ppm for Zn, Fe, Mn and Cu, respectively. The same trend was obtained after canola crop. **Mostafa *et al.* (1992)** reported that, irrigation with different saline water, slightly decreased total nitrogen in loamy soil, as well as, the use of saline solutions showed depressive effect on soil available-P, as compared with the control treatment.

**Ghazy (2002)** found that the contents of macro and micronutrients in maize grains, sugar beet roots and cotton seeds, were increased with irrigation by treated sewage water, followed by drainage water, while the lowest content was achieved by fresh water.

**Mahmoud (1994)** showed that the application of different organic manures increased both soil organic carbon and total nitrogen. The increment seems to be depended on the source and rate of applied manure, as well as, the concerned soils.

**El-Ghazoli (1998)** stated that the application of different organic manures, increased the availability of soil macronutrients. **Nadia *et al.* (2000)** stated that organic manures application as FYM, compost and biogas manure treatments, significantly increased available N, P and K. **El-Gala *et al.* (1998)** found that the application of organic manure and sulphur improved the fertility status and chemical properties of two calcareous soils (sandy and sandy loam), in addition to increase the total nitrogen and available contents of phosphorus and potassium in treated soils.

**2.1.4. Effect of agricultural practices on soil productivity:**

Many investigators stated that, soil productivity is directly and/or indirectly affected by different agricultural practices such as using different water quality (fresh water, blended and drainage water), surface or tile drainage and cultivation period.

Concerning the effect of irrigation water quality on soil productivity, **Ismial *et al.* (1994)** found that mean seed cotton decreased by irrigation with saline water at the seedling and flowering stage. **El-Mowelhi *et al.* (1995)** noticed that, using fresh water for irrigation rice, produced the best yield of grain and straw. While, reusing open drainage water, significantly dropped the yield of rice, as the reduction rates of both grain and straw yield were 17.5 and 4.5%, respectively.

**Amer *et al.* (1997)** studied the effect of water quality on soil salinity and some crop production. They found that, the continuous use of drainage water for five years irrigation, adversely affected the crop yield. The reduction in cotton yield in first season was 7.0% but, in the last season ($5^{th}$ years) were amounted to be 16.7%. Regarding the effect of drainage system on soil productivity, **Ramadan *et al.* (1994)** reported that, 10 m drain spacing recorded higher yield than 20 m and 40 m.

**Aly *et al.* (2002)** found that, yield obtained from tile drained soils (30 and 40 m spacings), were higher than that obtained from the undrained soil. The increase was 51-60%, for rice, cotton, wheat and maize, respectively and was 20% for sugar beet, only slight yield differences were observed between 30 and 40 m spacing treatments.

**Ramadan *et al.* (2006)** reported that, grain yield and straw yield for wheat crop, significantly increased as the distance from drain line decreased from L/2 to L/4 in both studied seasons. Also, they added that, N-uptake by wheat plants at booting stage increased as the distance from drain line decreased in both seasons.

**Abo-Soliman *et al.* (2002)** reported that, addition of gypsum in mole drains or subsurface application, achieved better properties of salt affected soil and produced higher yield of sugar beet.

## 2.2. Effect of land use on soil properties:

**Rabie *et al.* (1988)** studied the changes in sandy soil properties under cultivation for different periods. They reported that the changes included the distinction of weak surface horizons, with relatively high percentage of fine particles, particularly, in the soils cultivated for 30 years, under flood irrigation system. Also, OM contents and consequently CEC increased, but the soil salinity (ECe) decreased.

**Noaman and Sheta (1988)** found in their study on the irrigated dried lake soils, that the surface soil salinity decreased after two years of cultivation, no clear changes in either texture or the contents of amorphous Si and Al were observed.

**Gouda *et al.* (1990)** found that cultivation of sandy soils resulted in significant increases of field capacity, the wilting point and available moisture content. The effect is highly significant in the surface layer.

**Omar *et al.* (1990)** found that soil aggregation values of Tahrir province sandy soils, were significantly increased with the increase of cultivation period. Also, silt and clay fractions, as well as, the organic matter content were increased, while the amount of $CaCO_3$ content was decreased.

**Nagarajarao and Jayasree (1994) and Edwards *et al.* (1992)** demonstrated that long-term soil management practices decreased both pH and bulk density, while OM and nutrient availability of the soil increased.

**Kobkiet *et al.* (1993)** stated that the soil productivity and fertility degradation are mainly related to specific soil characteristics, and applied management practices. **Tiwari *et al.* (1995)** revealed that there was significant increase in the organic carbon content in the cultivated soils over the uncultivated soils. This may be attributed to the addition of crop residues and organic manures in the cultivated soils. There was a decrease in the organic carbon content down within profile depth.

Different cultivation periods were also found to affect the status of some nutrients. According to **Abou-Hussien (1999)**, the contents of both total and available N, P, K, Fe, Mn, Zn and Cu were increased, with increasing cultivation period in some Kalioubiya soils. He also found that these nutrients tend to concentrate at the surface layer. This behaviour was attributed to the addition of fertilizers and manures by farmers.

## 2.3. Effect of fish farming on soil properties:

When soil is flooded with water, as happens when a pond is filled with water, as in fish farms, some changes in the soil properties are usually occurred.

**Ghosh *et al.* (1976)** stated that the pH of a submerged acidic sandy loam soil (pH 6.4), increased to near neutrality, during the first 30 days of submergence, and there after remained nearly constant. **Ponnamperuma (1972)** suggested that the decrease in pH of sodic and calcareous soils upon submergence, are dependent on the changes in the levels of carbon dioxide.

**Chattopadhyay and Mandal (1980)** in a laboratory study on the effect of water salinity on decomposition of organic matter, found that, the rate of decomposition of added organic manure, was comparatively lower under high salinity levels of water, and indicated that, the use of well decomposed manures would be suitable with fish ponds using brackish water.

**Aboulroos *et al.* (1981)** studied the effect of flooding on pH of some alkaline soils. They found that pH was decreased upon flooding, until reaching slightly acidic values. They attributed this to the accumulation of $CO_2$ produced by respiration of anaerobic bacteria. The rate of pH decrease was more pronounced during the first and second week of submergence, with little changes then-after.

**Ramadan *et al.* (1994)** studied the effect of fish farming on changing the properties of salt affected soils, compared to that effect of normal agricultural practices. They found that fish farming may improve the salt affected soils, via decreased salts out of the soil profiles, and decreased ESP of deeper layers than in leached and cultivated soils. On the other hand, there was tendency to form an argillic horizon. which may be confirmed by accumulation of both total and fine clay particles in the lower layers of soils, under fish farming, which may cause filling of fine pores, and prevailing of anaerobic and gleying conditions. The soils used as a fish farm for 3 or 7 years, contained relatively lower amounts of heavy metals, compared to the other studied two soils.

## 2.4. Land evaluation:

### 2.4.1. Concept of land evaluation:

Land evaluation has been defined as the process of assessing or predicting the performance of land for specific purpose (**FAO, 1976**).

**Sys *et al.* (1991)** pointed out that land evaluation is a concept, which describes the interpretation process of the principal inventories, belonging to soil characteristics, vegetation cover, environmental conditions, climatic status and many other aspects related to the land, to identify the best land use among its alternatives.

**Bacic *et al.* (2003)** stated that, land evaluation is the prediction of land performance over time under specific uses, to guide strategic land use decisions. Modern land evaluation has a 50 years history, yet the results have often been disappointing, land users and planner have been reported to ignore land evaluation, perhaps reflecting poor quality, low relevance, or poor communication, and that due to the primary deficiencies were identified as:

1. No estimate of environmental degradation risk,
2. No financial analysis,
3. No social analysis of decision makers attitudes and preferences,
4. No risk assessment for climate, yields, profits and
5. Insufficiently specific alternative land uses.

**El-Sakka (2004)** pointed out that land evaluation is the first step for land use planning, and land scope conservation. He also added that, soil evaluation models can be used for direct flow up and comparison of soil fertility and productivity.

**2.4.2. Types of land evaluation:**

**a. Land capability:**

USDA capability classification (**Klingebiel and Montgomery, 1966**) was one of a number of interpretative groupings, made primarily for agricultural purpose. Therefore, the system was one of a general appraisal, and not related to a specific land utilization type and land use was reflected in the classes. As such the arable soils were grouped according to their potentialities and limitations for sustained production, of the common cultivated crops that did not require specialized site conditioning or site treatment, non-arable soils were grouped according to their potentialities and limitations for the production of permanent vegetation, and according to their risk of soil damage if mismanaged. The USDA capability classification provided three major categories of soil grouping: classes, subclasses and units.

**i. Capability classes:**

Capability classes are groups of land units that have the same degree of limitations became progressively greater from class 1 to class VIII.

**ii. Capability subclasses:**

Capability subclasses are defined on the basis of major conservation problems, such as:

- Erosion and runoff.
- Root-zone limitations.
- Excess water.
- Climatic limitations.

The capability subclass provides information as to the kind of conservation problem or limitation involved. Class and subclass together, provide the map user information about both the kind of problem involved, and the degree of this limitation.

**iii. Capability units:**

Capability unit is a subdivision of subclasses on the basis of potential productivity, belong to the same capability unit. This means that soils in a capability unit are sufficiently uniform to:

a. Produce a similar kind of cultivated crops and pasture plants with similar management practices.
b. Require similar conservation treatment and management.
c. Have comparable potential productivity.

**Mostafa *et al.* (1997)** studied land capability classification for soils in Behira Governorate, they found that the soil of the study area are classified into three capability classes. These classes were represented by excellent, good and fair and represent 9.19%, 63.33% and 27.48% of the area, respectively. The good and fair classes can be improved to better ranked classes by improving the drainage system, application of some soil amendments such as gypsum, and using relatively high quality irrigation water, with taking the leaching requirements into consideration. Also, enriching and maintenance organic matter content by application of manure, green manure, mulching and crop rotation. As well as application of nitrogen fertilizer.

**Ismail *et al.* (2001)** studied land capability for three areas selected from three different regions: Samoul (Nile Delta), Burg El-Arab (North West Coast) and El-Shahama (Western Desert). The obtained results showed that samoul area was classified into two land capability classes: Class 2 (good) and class 3 (moderate). These classes were further classified into sub-classes; units and subunits that reflected the limiting productivity factors in the area. Results indicated also that limitations for land capability were the relatively low soil permeability, shallow ground water table in some limited parts, the relative increment of soil salinity in some others, ground water salinity and low levels of soil organic matter and nutrients.

Concerning Burg El-Arab area: it was classified into two land capability classes: Class 3 (moderate) and class 4 (marginal). Results indicated that limitations for land capability were unstable soil structure, profile depth, low soil permeability, low percentage of clay in some limited parts, and the relative increment of soil salinity in some others, low level of soil organic matter and nutrients.

El-Shahama area was classified into two land capability classes: class 3 (moderate) and class 4 (marginal). Results revealed that limitation factors for land capability were, weak unstable soil structure in some limited parts and low percentage of clay, relatively high soil permeability, low percentage of soil available water in only one profile. A relatively increment of soil salinity, and general low levels of soil organic matter and nutrients were indicated.

**Naser El-Din (2001)** evaluated some different soils under different crop patterns at Kafr El-Sheikh Governorate. He found that land capability classes were excellent, good, fair and poor. The good, fair and poor classes can be improved to better ranked classes, by lowering the depth of ground water from the surface, through maximizing the potential of the drainage system, application of mineral fertilizers (macro-micro nutrients) as well as, biofertilizers.

**Fayed (2003)** evaluated the land capability of El-Bostan region, west Nile Delta. He found that some of the studied soils belong to land capability class IV (weak or marginal), while others belong to class III which reflect fair or moderate degree of land capability. He also added that, the main limiting soil factor in all the studied soils is soil texture (t). Also, sodium saturation, salinity, useful depth and carbonate content are found to be among the soil limiting factors.

**Higab (2005)** studied the evaluation of some soils of South El-Borolus lake area. He found that the capability index for these soils are grade (S2) good soils, grade (S3) fair soils and grade (N1) non-agriculture soil.

**b. Land suitability:**

Land suitability is the fitness of a given type of land for a specified kind of land use. Four categories namely orders, classes, subclasses and units are recognized as follow (**FAO, 1976**).

I. Land suitability orders: reflecting kinds of suitability i.e. suitable(s) or not suitable (N).

II. Land suitability classes: reflect degrees of suitability orders (i.e. $S_1$, $S_2$, $S_3$, $N_1$ and $N_2$).

**Where:**

$S_1$ High suitable

$S_2$ Moderately suitable

$S_3$ Marginally suitable

$N_1$ Marginally not suitable

$N_2$ Permanently not suitable.

III. Land suitability subclasses: reflect kinds of limitation or kinds of inputs and improvements required within classes.

IV. Land suitability units: reflect minor differences in the required management within subclasses.

**Ghabour *et al.* (1994)** studied land suitability classification of El-Katta farm at Giza Governorate. They found that land suitability was very suitable, moderately suitable and marginally suitable.

**Fayed (2003)** classified the soils of El-Bostan area to low suitability ($S_4$) for virgin soil, while most of the cultivated soils have moderate suitability ($S_3$).

**Abo-Zied and Abd El-All (2004)** studied soils of Armant area in Upper Egypt region, they found that these soils belong to both moderately suitable ($S_2$) and marginally suitable ($S_3$).

**El-Toukhy (2004)** indicated that soils of north western coast of Egypt were, moderate suitable $S_2$, marginal suitable ($S_3$) and permanently not suitable ($N_2$).

**Higab (2005)** studied some soils of south El-Borolus lake area. He reported that the studied soil profiles include all the suitable classes (S2, S3 and N). He added also that, the suitable crops are:

1. Field crops: beans, rice, cotton, alfalfa, barley, sunflowers, wheat and maize.
2. Vegetables: tomato, cabbage and watermelon.
3. Fruit trees: citrus and olive.

**2.4.3. Models of land evaluation:**

Land evaluation is an important topic, not only for soil survey but also used in agronomical planning extensions. Also evaluation systems are very similar in the concept, although there are differences between them in the factors, which they are based on. However, identifying some factors through an evaluation system to be evaluated, facilitate the comparison process of the advantages and disadvantages of various soils **(Ismail *et al.,* 2001)**.

**Rice (1936)** had chosen six factors which must be considered to evaluate the soil; geographic location, land form, climate, soil characteristics, vegetation cover and the socio-economic aspect.

**Storie (1937)** illustrated the important evaluation system that which modified in 1944, 1948, 1955 and 1964. This system concentrated on finding a category for the soil, described as percentage, that be calculated using four factors A, B, C and X. Factor A concerns the soil profile depth; factor B concerns texture of the soil surface, factor C concerns the slope, factor x concerns number of subfactors including drainage, alkalinity, acidity, fertility, erosion and micro relief. Storie classes could be identified by multiply the above factor values (as a percentage). He divided the soil into six classes as follows:

| Grades | Soil quality | Rating value | Suitability |
|---|---|---|---|
| I | Excellent soils | 80-100% | Suitable for a wide range of crops |
| II | Good soils | 60-79% | Suitable for most crops |
| III | Fair soils | 40-59% | Suitable for few crops |
| IV | Poor soils | 20-39% | Have limited agriculture use. |
| V | Very poor soils | 10-19% | Are very limited agriculture and may be used for pasture |
| VI | Non agricultural soils | < 10 % | |

**USBR (1953)** (United States Bureau of Reclamation) reported that, three main groups of factors must be considered into the land evaluation process; (1) physical factors, which included topography, drainage and soil factor, (2) water quality factors, which included water salinity, permeability problem and toxicity problem and (3) economic factors, which included costs of land, costs of production and production capacity.

**Fathi (1957)** (in Arabic) defined two groups of factors for land evaluation, the first is related to the soil fertility such as salinity, layering, texture and structure, while the second represents other factors such as, water table level, drainage status irrigation system and communication.

**Labib (1963)** considered that soil texture, salinity, exchangeable sodium percent, pH, $CaCO_3$ and organic matter are the important properties for land evaluation.

In 1970, a parametric method for land evaluation has been proposed by **Riquier *et al.* (1970)**. The system avoided economic and sociological considerations, which lie outside the province of the soil scientist, and proposed an index of soil productivity, nine factors were taken into account.

The formula for calculating such index is as follows:

Productivity index = H x D x P x T x (N or S) x O X A x M

Where, moisture (H), drainage (D), effective depth (P), Texture/structure (T), base saturation (N), soluble salt concentration(s), organic matter content (o), mineral exchange capacity/nature of clay (A), and mineral reserve (M).

The land capability classification for the humid tropics, is a parametric system for general evaluation developed by **Sys and Frankart (1971)** and can be considered as an adapted application of the parametric system of **Riquier *et al.* (1970)** an index of soil capability for calculating this index were taken into account.

The formula for calculating such index is as follows:

$$CI = A \times \frac{B}{100} \times \frac{C}{100} \times \frac{D}{100} \times \frac{E}{100} \times \frac{F}{100}$$

**Where:**

CI = Capability index
A = Rating for profile development
B = Rating for texture
C = Rating for soil depth
D = Rating for color/drainage conditions
E = Rating for pH/base saturation
F = Rating for the development of the A horizon.

The capability or soil index was an expression of the natural fertility, and can therefore be correlated with crop production under natural conditions, without use of fertilizers or soil improvement works.

**Nairooz (1967); Omar and El-Kholie (1970)** reported that the factors which limited the productivity of El-Fayoum soils were, profile depth, topsoil texture, water table level and soil salinity.

**El-Nahal *et al.* (1977)** stated that productivity classes of the Nile Delta soils, as compiled from soil survey work, could be grouped as the following:

1. The first class soil covers only a small portion of the Nile Delta, about 4% mainly in Menufiya and Qualubia Governorates in the southern part, those soils are suitable for all crops, and give the highest yield at the lowest cost. They have deep profiles of medium texture, have efficient irrigation system, and are well drained; they are non-saline and free of alkalinity.
2. The second class soil represents nearly 5% of the Delta area. The soil of this class are different from those of the first class, only in having heavier texture and slightly saline. They are located in large areas in Menufiya, Qualubia and Gharbia Governorates.
3. The third class soil represents 33.5% of the Delta area. They are concentrated in large areas in Sharkia, Dakhlia, Kafr El-Sheikh and El-Behaira Governorates, which occupy most of the Northern part of the Delta.
4. The fourth class soil represents 7.8% of the delta. They are concentrated mainly in the newly reclaimed soil, along the desert fringes, south of the Northern lakes and the sea coast. The high salt content, high water table and the heavy or coarse texture, are the main factors that restrict the productivity of the third and the fourth soil class.
5. The fifth class (barren and flooded land) represents 22.5% of the Delta area.
6. The six class (public utilities and arable lands) represent 7.4% of the Delta area.

**Abdel-Motteleb and Hussein (1985)** (in Arabic) introduced a more complete system for land evaluation, which was based on both soil properties and environmental factors. They considered soil properties to be physical such as, texture, water table depth, permeability, available water and topography, as well as, chemical properties such as pH, $CaCO_3$ content, gypsum content, CEC and ground water salinity. Four environmental factors were also considered. They were, irrigation system, drainage conditions, communication status and agronomical processes of mechanization and crop rotation. **Marei *et al.* (1987)** designed a computer program for land evaluation based on the system of **Abdel-Motteleb and Hussein, 1985. El-Fayoumy (1989)** modified the system to include soil fertility and irrigation water factors. Land suitability to different crops based on land properties, as well as, climatic data. Each factor was described as an index value, to give its status in the percentage form. These indicators were calculated using some empirical equations. The final index of land evaluation (F.I.L.E.) was calculated as;

$$\text{F.I.L.E.} = \frac{4}{\frac{1}{\text{S.I.}} + \frac{1}{\text{E.I.}} + \frac{1}{\text{W.I.}} + \frac{1}{\text{F.I.}}}$$

**Where:**

S.I. The soil index.
E.I. Environmental index
W.I. Irrigation water index
F.I. The soil fertility index

**(Ismail *et al.*, 1994)**

**De La Rosa *et al.* (1992)** constructed an evaluation system, named Microcomputer-land evaluation information system (Micro LEIS). There are stages in the micro LEIS land evaluation system. These stages include general land capability, agricultural soil suitability and crop yield prediction.

**FAO (1993)** constructed an evaluation system named land evaluation and farming system analysis, abbreviated as LEFSA. **Rossiter and Van Wambek (1995)** suggested a simple economic land evaluation system, named Automated land evaluation system (ALES).

**Ismail *et al.* (2001)** suggested the applied system for land evaluation (ASLE) in arid and semi-arid regions, they listed four major factors to define the land capability classification, which were soil chemical and physical properties; environmental status; irrigation system and water qualities, and soil fertility. This approach also included land suitability classification for several crops.

**Bahnassy *et al.* (2001)** applied land suitability, using micro LEIS software, and coupled it with SALTMOD, to predict the effect of water table and salinity on the productivity of wheat in Sugar Beet area. They found that the productivity of wheat would decrease due to increasing salinity and water table depth, as a result of mismanagement practices.

**Abdel-Kawy (2004)** constructed an evaluation system named Agriculture Land Evaluation System for arid region (ALES. Arid), which is a new approach for land capability and suitability evaluation, based on the minimum data set. He listed three main groups of parameters included:

1. Soil physical parameters such as (texture, available water, soil depth, and soil permeability), and chemical parameters such as (salinity and alkalinity limitations, calcium carbonate and gypsum status, cation exchange capacity and soil pH).
2. Soil fertility parameters such as (organic matter, available (N, P, K).
3. Water irrigation parameters such as (salinity and infiltration problems, and toxicity problems).

# 3. THE STUDY AREA

## 3.1. Location:

The Nile delta extends between 30° 10' N and 30° N latitudes North of Cairo, the delta fans out to form a triangular shape, which is about 250 km from east to west and 200 km from South to North. The delta is separated into three zones: The eastern delta, the middle delta and the western delta. Seven branches of the Nile river originally flowed through the delta, but these have now been controlled and diverted into two main branches, the Rosetta and Damietta.

The study area is located in the northern part of Kafr El-Sheikh Governorate between (30° 57,100)-(31° 08.100) E and (31° 15.500)- (31° 25.800) N. It is located in two regions Al-Zawea region and Al-Mansur West region Fig. (1).

## 3.2. Physiography:

The Nile delta soils are formed as a result of the deposition of silt brought down by the Nile river. These silts are the result of physical and chemical weathering of the igneous and metamorphic rocks, which form the Ethiopian plateau. The average thickness of the Nile delta soils deposits is about 9.2 meters. Below the clay soils of the delta are deep coarse sands. As is expected, the Nile delta is relatively flat, with a slight slope (1: 10.000) towards the northwest. The majority of the soil in the delta is classified as alluvial, varying in texture from light (30% clay content) to heavy (80% clay content) clay (**Amer and Abou-Zeid, 1989**). The clay content in the soil profile tends to increase in the delta from South to North.

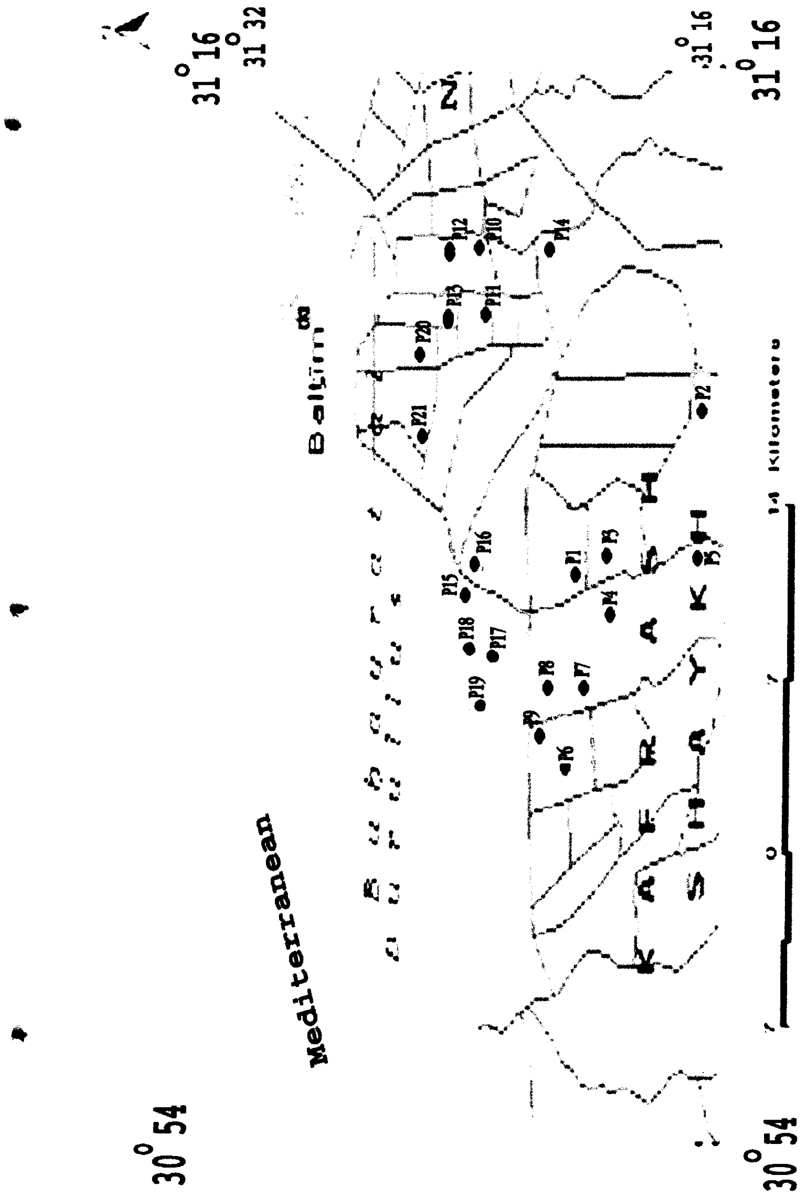


Fig. (1): Locations of the studied profiles

In the northern part of the delta from a physiographic point of view, two main land forms may be distinguished:

- The fluvio-marine flats.
- The coastal barrier plain and beaches.

The fluvio-marine flats form the natural extension of the delta's clayey top-set peds, but because they are low lying and consequently badly drained, they are very saline.

## 3.3. Climate:

The climatic conditions of the study area are typically arid Mediterranean climate, characterized by aridity with long hot rainless summer, mild winter with low amounts of rainfall; the other seasons are characterized by unstable climate. Climatological data were recorded from the nearest main station which is located in Sakha town, during 16 years extending from 1990 to 2006 and shown in Table (1). For convenience, the elements of its climate are presented as follows:

### 3.3.1. Air temperature:

The highest air temperature was recorded during summer season (May-October), with maximum 33.07°C. While the lowest air temperature was recorded in winter season, the minimum value recorded in January was 6.52°C. In spring, temperature varies between 15.60°C and 30.17°C, while the temperature ranges between 18.69 and 31.45°C in autumn.

**Table (1):** Climatological data of Sakha Station (Average of 16 years, 1990-2006).

| Months | Temperature, °C | | | Rain fall, mm/month | Evaporation, mm/month | Relative Humidity, % | Wind speed, m/sec |
|---|---|---|---|---|---|---|---|
| | Max. | Min. | Mean | | | | |
| January | 18.62 | 6.52 | 12.57 | 13.70 | 60.61 | 80.00 | 1.31 |
| February | 19.99 | 7.17 | 13.58 | 12.90 | 65.51 | 79.00 | 1.39 |
| March | 22.69 | 8.55 | 15.60 | 5.90 | 74.78 | 77.00 | 1.69 |
| April | 26.83 | 10.82 | 18.83 | 2.80 | 90.38 | 69.00 | 1.42 |
| May | 30.17 | 14.46 | 22.32 | 0.00 | 107.10 | 65.00 | 1.49 |
| June | 32.00 | 17.73 | 24.87 | 0.00 | 119.35 | 65.00 | 1.50 |
| July | 33.07 | 19.85 | 26.46 | 0.00 | 127.14 | 74.00 | 1.31 |
| August | 32.77 | 19.61 | 26.19 | 0.10 | 125.72 | 76.00 | 1.21 |
| September | 31.48 | 18.46 | 25.15 | 1.60 | 120.14 | 75.00 | 1.02 |
| October | 29.01 | 15.76 | 22.39 | 3.60 | 107.46 | 75.00 | 0.92 |
| November | 24.92 | 12.46 | 18.69 | 6.20 | 89.61 | 78.00 | 1.01 |
| December | 20.65 | 8.43 | 14.54 | 12.90 | 69.83 | 82.00 | 1.09 |
| Annual | | | | 59.70 | 1157.63 | | |
| Mean | 26.88 | 13.32 | 20.01 | 4.98 | 96.47 | 74.58 | 1.28 |

### 3.3.2. Rainfall:

The amounts of rainfall were observed in winter season and averaged 4.98 mm/month. The rainy season usually being in the second half of October, and ends in the first half of March. The maximum rainfall is recorded in January (13.7 mm), while in summer no rain or very low is recorded, while occasional rainfall may exist in autumn months.

### 3.3.3. Evaporation:

The evaporation data show that the mean value of evaporation of the studied area was 96.47 mm/month. The lowest value was recorded in January when the temperature was comparatively low 12.57°C, while the highest value 127.14 mm/month was recorded in July. The annual mean evaporation was 1157.63 mm.

### 3.3.4. Relative humidity:

The monthly variations in relative humidity varied only within narrow range with mean 74.58%. The mean percent relative humidity ranges between 65.0% in May and 82.00% in December. The data show that relative humidity increases in the winter months.

### 3.3.5. Wind speed:

The wind velocity ranges from 0.92 to 1.69 m/Sec. Wind speed varies in the different months. The maximum monthly mean (1.69 m/Sec) was recorded in March, while the minimum monthly mean (0.92 m/Sec) was recorded in October.

## 3.4. Hydrogeology and ground water:

Prior to construction of the High Dam, Groundwater in the delta and Nile valley was recharged once a year, during the flooding of the Nile River (August to October). A dynamic balance in the ground water table was achieved through extraction by farmers for irrigation, and by discharge back to the Nile River during low flow periods. The introduction of perennial irrigation, since the construction of the High Dam, resulted in a more continuous recharges to the groundwater aquifer, as a result of seepage from canals and percolation from fields. The natural drainage system was no longer able to prevent the rise of the water table into the crop root zone, and water logging and salinity problems began to occur throughout the Delta. It is estimated that within the Nile Delta and Nile valley, up to 500 billion $m^3$ of groundwater exists. This is 3 to 4 times the amount of storage which exists in Lake Nasser (**Attia and**

**Tuinhor, 1989)**. Current groundwater is estimated at 2.3 billion $m^3$/year for domestic industry and irrigation needs for the southern part of the delta. There is a general downward flow of the groundwater closer to the Northern coast, the influence of the Mediterranean sea causes an upward flux to occur.

There are two interconnected underground water bodies in the region. The upper one is the subsoil water of the upper semi-pervious clay cap aquitard. The lower water body is the groundwater in the aquifer forming the reservoir.

The groundwater pressure of the reservoir is referred to the piezometric head, while the subsoil phreatic surface of the clay cap is called the shallow water table.

The shallow water table fluctuates in response to the irrigation water and seepage from intensive irrigation from the canals. This affects in turn the peizometric head. The difference between the levels between the piezometric head in the aquifer and the water table, causes vertical movement through the clay cap. Water table depth in the Kafr El-Sheikh governorate, depends on the distance between the tested location and the Burulus lake, Rosetta Branch and the main drains, especially the El-Moheat Main Drain. The soil North of Kafr El-Sheikh adjacent to Burulus lake are submerged with a water table, in the area between the Mediterranean and the lake in a depth less than 20 cm. The area closer to the River Nile Branches, suffer from the seepage of water, and consequently the depth of water table ranges between 80 and 150 cm. On the other hand, the depth of the water table becomes deeper to the South and

Middle of Kafr El-Sheikh governorate, as well as, the area adjacent to the El-Moheat main drain.

### 3.5. Irrigation and drainage systems:

The Nile River is the main source of irrigation water throughout Egypt. The water is delivered through a complex system of Principal canals; main canals; branch canals and distributary canals. The principal canals take water directly from the Nile River, and is distributed from these canals to each successive canal. The principal, main and branch canals flow continuously. While the distributary canals are usually on a rotation system. The time interval when water flow in the canal depends on the cropping patterns and seasonal weather (**Abdel Dayem and Oosterban, 1995**).

The hydrology of the Nile delta has changed significantly over time, particularly since the construction of Aswan High Dam. The Natural surface drainage of the delta is supplemented with complex system of open drains, totaling approximately 16.000 km in length, and serves 4.7 million feddans of land (**Abdel-Dayem and Oosterban, 1995**). These drains have little effect on controlling the water table in surrounding fields, but serve as outlets for the subsurface field drainage system. The lack of sufficient slope requires that pumps must be used to remove much of the drainage water, or discharge the drainage water back into irrigation canals for reuse. The surface drainage system is extensive and very complex.

The total area provided with tile drainage amounts to about 6.5 million feddan. The rest of the area is to be covered up to year 2010 (**Amer, 2004**).

### 3.6. Water supply:

Approximately 2.55 billion $m^3$ of drainage water is pumped back into the irrigation canals and reused for irrigation. At present there are 20 reuse pumping stations for blending drainage water with canal water. Drainage water officially reused through blending is now estimated to be around 3.6 billion $m^3/y$ and is planned to increase to 7.4 billion $m^{-3}/y$ by the year 2017 (**MWRI, 2005**).

Farmers at the tail-end of the irrigation canals unofficially reuse about 2 billion $m^3/y$ of drainage water, directly for irrigation, whenever they suffer from limited canal water supply (**El-Hessy and El-Kady, 1997**). The better quality canal water is used at all other times depending on its availability, in other words, the tail-end farmers unofficially adopt the cycling strategy, but they can not limit saline water use to the salt-tolerant crops, or growth-stages as recommended by **Rhoads *et al.* (1992)**. Average salinity of reused drainage water increased from around 855 mg/L in 1984 to 1000 mg/L in 1994 (**Amer, 1996**). Total water demand in Egypt is expected to increase to about 61.5 billion $m^3$ by the year 2025 (**MWRI, 2005**).

# 4. MATERIALS AND METHODS

## 4.1. Field work:

Twenty one profiles were selected in the clayey soils of Al-Zawea and Al-Mansur West Regions, as newly reclaimed soil, to represent the different agricultural practices in the northern part of the Nile delta, which can be summarized as follows:

1) Using different sources of irrigation: (i) fresh water and (ii) blended water.
2) Application of different systems of drainage: (i) open drains and (ii) tile drains.
3) The type of land use: (i) crop farming and (ii) fish farming.
4) The period of land use.

Table (2) shows the location of different profiles under the selected land use types and periods.

- All profiles were described morphologically according to the system of **FAO (1990)** (Appendix 2).
- Soil samples were collected from different layers according to morphological variations, or at equal distances (0-30. 30-60. 60-90. 90-120 cm), for homogenous profiles, and were subjected to different physical and chemical analyses.
- Three water samples from the Al-Ghabat, Al-Halafi and Al-Daramaly irrigation canals, in Al-Zawea region, and two water samples from Kom Al-Teen irrigation canal, and Al-Mansur canal, in Al-Mansur West region, were collected for chemical analyses. Ground water samples were collected from all profiles for chemical analyses.

**Table (2):** Location of profiles under different agricultural practices.

| Prof. No. | Land use period | Type of irrigation water | Drainage system | Coordination: Longitude E | | Coordination: Latitude N | |
|---|---|---|---|---|---|---|---|
| **A. Al-Zawea Region** | | | | | | | |
| 1 | Virgin | Fresh water | Tile drainage | 31° | 01.587 | 31° | 19.340 |
| 2 | 5 | | | 31° | 03.358 | 31° | 15.891 |
| 3 | 15 | | | 31° | 01.914 | 31° | 18.498 |
| 4 | 30 | | | 31° | 00.210 | 31° | 18.420 |
| 5 | 50 | | | 31° | 01.829 | 31° | 15.579 |
| 6 | Virgin | | Open drainage | 30° | 58.975 | 31° | 21.527 |
| 7 | 5 | | | 30° | 59.946 | 31° | 19.575 |
| 8 | 15 | | | 30° | 59.987 | 31° | 21.827 |
| 9 | 30 | | | 30° | 59.924 | 31° | 20.154 |
| **B. Al-Mansur West region** | | | | | | | |
| 10 | Virgin | Blended water | Tile drainage | 31° | 07.610 | 31° | 24.620 |
| 11 | 5 | | | 31° | 06.608 | 31° | 06.608 |
| 12 | 15 | | | 31° | 07.222 | 31° | 25.040 |
| 13 | 30 | | | 31° | 07.234 | 31° | 25.125 |
| 14 | 50 | | | 31° | 08.069 | 31° | 18.950 |
| 15 | Virgin | | Open drainage | 30° | 58.128 | 31° | 23.444 |
| 16 | 5 | | | 36° | 58.187 | 31° | 23.444 |
| 17 | 15 | | | 30° | 57.720 | 31° | 23.720 |
| 18 | 30 | | | 30° | 58.183 | 31° | 23.059 |
| 19 | 50 | | | 30° | 58.180 | 31° | 23.464 |
| **C. Fish farms** | | | | | | | |
| 20 | 15 | Blended water | Tile drainage | 31° | 06.610 | 31° | 25.480 |
| 21 | 10 | | | 30° | 58.186 | 31° | 23.725 |

## 4.2. Laboratory work:

### 4.2.1. Soil analyses:

Disturbed and undisturbed soil samples were taken from the layers of the different profiles. The disturbed soil samples were air-dried, ground and passed through a 2 mm sieve to get fine earth (< 2 mm) and stored for analyses.

#### 4.2.1.a. Physical analyses:

Physical properties were determined in the soil samples as follows:

1. Soil bulk density (g/cm$^3$) using the core method according to (**Black, 1965**).
2. Mechanical analysis was carried out by the pipette method, using sodium hexametaphosphate as a dispersing agent according to **Piper (1950)**.
3. Soil hydraulic conductivity was determined by auger hole method in the field according to **Van Beers (1970)**.
4. Aggregate stability parameters: In undisturbed soil samples, using sieving technique which described by **Baver *et al.* (1972)** was carried out, using set of sieves having 2.00, 1.00, 0.5 and 0.25 mm screen openings, to determine the aggregate size distribution. Water stable aggregates (WSA), optimum size of aggregates (OSA), mean weight diameter (MWD), aggregation index (AI) and structure coefficient (SC) were calculated and recorded according to **Baver *et al.* (1972)**.

5. Structure factor (SF) was calculated according to the following formula: S.F. = $(1-\frac{\%\ \text{clay in aggregation analysis}}{\%\ \text{clay in mechanical analysis}})x100$, (**Marei *et al.*, 1987**).

**4.2.1.b. Chemical analyses:**

The chemical analyses were carried out as follow:

1. Soil reaction (pH) in 1: 2.5 soil: water suspension by combined electrode pH meter type jenway 4320, according to (**Jackson, 1973**).
2. Salt content expressed as (ECe dS/m) of the saturated soil extract using a conductometer , Model Jenway 4320, (**Jakson, 1973**).
3. Soluble cations: $Na^+$ and $K^+$ were determined with flame photometer and ($Ca^{++}$, $Mg^{++}$) were determined by titration with versenate (Na-EDTA) method according to **Jakson (1973)**.
4. Soluble anions: $Cl^-$ was determined by titration with silver nitrate, $CO_3^=$ and $HCO_3^-$ were determined by titration with $KHSO_4$ and $SO_4^=$ was calculated by difference between cations and anions, **Jakson (1973)**.
5. Sodium adsorption ratio (SAR) was calculated according to the following formula:

$$SAR = Na^+/\sqrt{(Ca^{++} + Mg^{++})/2}$$

Where: $Na^+$, $Ca^{++}$ and $Mg^{++}$ refer to their concentrations in milliequivalents per liter, **Richards (1954)**.

6. Total carbonate content as $CaCO_3\%$ was determined using collin's calcimeter.
7. Gypsum content was determined using acetone as a precipitating agent according to **Richards (1954)**.

8. Organic matter content (%) was determined according to Walkely and Black method (**Jakson, 1973**).
9. Cation exchange capacity (CEC) by sodium acetate (NaOAC) pH 8.2 as described by, **Klute (1986)**.
10. Available nitrogen was extracted using 2M KCl, and determined by the automatic micro-kjeldahl/method (Model Kejetic auto sampler system 1035 analyzer) according to **Cottenie *et al.* (1982)**.
11. Available phosphorus: by sodium bicarbonate, as an extracting agent, according to **Olsen *et al.* (1954)**, and determined by spectrophotometer.
12. Available potassium: was carried out by flame photometer using the in $NH_4$-OAC pH7 as extracting agent according to **Page (1982)**.
13. The micronutrients Fe, Mn, Zn and Cu: were extracted using DTPA as recommended by **Lindsay and Norvell (1978)** and determined using atomic absorption spectrophotometer.

#### 4.2.2. Water samples analyses:

Total soluble salts, pH, soluble cations and anions using the above mentioned methods in soil analyses, were carried out for irrigation and ground waters as well.

### 4.3. Land evaluation:

The land capability of the studied soil profiles, under different agricultural practices, were calculated using ASLE software programme (Ismail et al., 2001). Also, the suitability of the studied soils for the most common crops, prevailed in the studied area were also determined using the above mentioned ASLE software, Fig. (2).

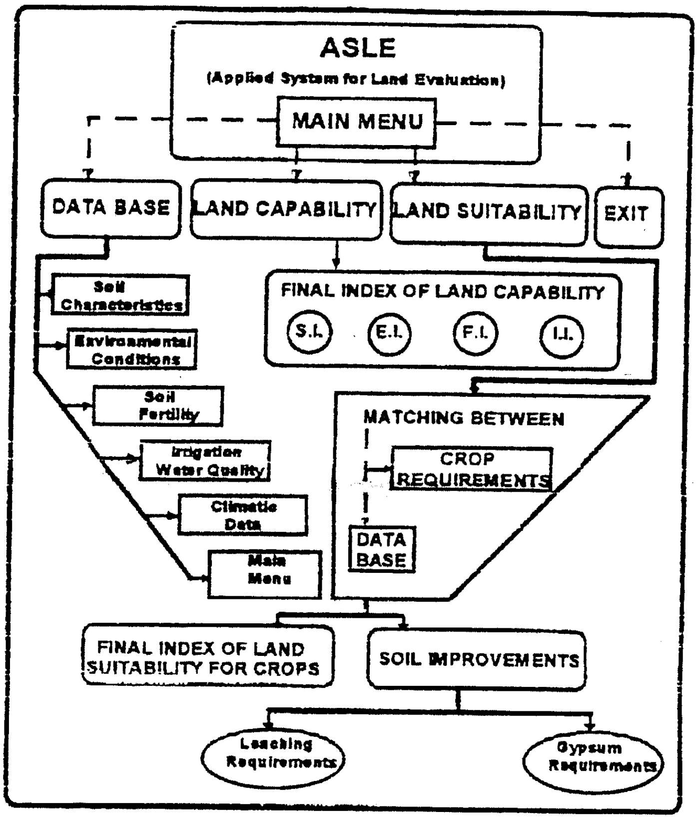


**Fig. (2):** Illustrated procedure for applied system for land evaluation (ASLE) model.

# 5. RESULTS AND DISCUSSION

## 5.1. Effect of agricultural practices on some soil properties:

### 5.1.1. Morphological properties:

The field observations and the macromorphological description of the investigated profiles, were given in the appendix (2). The morphological description, in general, reflects the following observations:

1. Soil color varies in narrow range among the studied soil profiles, and within each profile. It varies from light brownish gray (10 YR 6/2) to very dark brown (10 YR 2/2) in moist state, and from brown (10 YR 5/3) to very dark grayish brown (10 YR 3/2), in dry condition. Color value refers to the relative lightness of color and it increase from dark to light colors (**Foth, 1990**). Generally, the morphological investigation reveals the variations of soil color compared with virgin soil are increased as the land use period increases.
2. The most of studied profiles have massive structure throughout the layers of profiles. Some of the studied profiles have a blocky structure in the surface layer, and massive structure in the rest of layers, as found in profiles 4, 5, 8, 9, 12, 13 and 14. Also, the blocky structure was found in surface and subsurface layers in some profiles. This may be attributed to the different agricultural practices with long-time cultivation.
3. There are plant roots in surface and subsurface layers, while decayed organic residues was detected in subsurface layers.

4. Hard and soft carbonate nodules were found in different depths in the studied profiles. On the other hand, the surface layers of studied virgin soil is characteristics by salt florescence.

**5.1.2. Physical properties:**

The soil texture, bulk density, aggregation parameters and hydraulic conductivity, were the main studied physical properties in this study.

**5.1.2.1. Texture:**

Most of the studied soil profiles were clayey, except for profile NO. (3) (silty clay), which represents a soil irrigated by fresh water under tile drainage, and cultivated for 15 years. The texture of the studied soils mainly reflects the conditions of soil formation, more than the influence of the prevealed agricultural practices, or land use period. The subsurface layer (30-60 cm) of the profile No. 13, exhibited clay loam texture, which confirms the stratification of layers in the soil profiles, where the time is not enough to reflect the soil horizons.

Data in Tables (3a and 3b) show that soils with clayey texture, revealed an increase of the clay content with depth, particularly in the subsurface layer. There was an increase of clay content ranged between 3-4% in the subsurface layer, in most of the studied soils that have a clayey texture. It could be attributed to the impact of $Na^+$, as a prevailing cation, either soluble or exchangeable, which enhanced the deflocculation process of the aggregates, and movement of single particles downwards.

Soils in Al-Mansur west region (Table 3b), exhibited little differences of the clay content, along the depth of the soil profiles. Except for profiles No. 10, 15 and 17, which revealed a noticeable increase of clay content in the subsurface layer. Some other profiles revealed decrease or constant percent of clay with depth.

**5.1.2.2. Bulk density ($\rho a$):**

Data in Tables (3 and 3 b) show that, soil bulk density ($\rho a$) in the studied profiles, decreased with increasing land use period. Where the highest mean value of soil bulk density was 1.47 g/cm$^3$ for the virgin soil (profile 1). While, the lowest one was 1.09 g/cm$^3$, for the soil cultivated for 50 years (profile 5). That decrease was attributed to agricultural practices, such as organic matter and gypsum addition to the soil, and crop residues which led to aggregate formation and consequently decreasing of bulk density. **Recheigl (1995)** reported that, the addition of organic C amendments to soil, is likely to increase soil aggregation and its stability, decrease bulk density and increase water-holding capacity.

With respect to drainage system effect, the soil under tile drainage system have lower mean values of bulk density, than those under open drainage system with different cultivated periods, where the mean values of $\rho a$ under tile drainage system were 1.18, 1.13, 1.10 and 1.08 g/cm$^3$, for profiles (11, 12, 13 and 14) respectively, after 5, 15, 30 and 50 years cultivation period respectively. While they were 1.20, 1.15, 1.14 and 1.11 g/cm$^3$ for profiles 16, 17, 18 and 19, respectively at the previous cultivation periods, Tables (3a and 3b) and Fig. (3). These results were in agreement with those

**Table (3a):** Effect of agricultural practices, on some physical properties of studied profiles in Al-Zawea region. (a) Fresh irrigation water under tile drainage system.

| Profile No. | Depth, cm | $\rho a$, g/cm$^3$ | SP, % | Particle size distrib. Sand % | Silt % | Clay % | Texture | W.T. Depth, cm | S.F | K.S, cm/h | Aggregation parameters WSA % | OSA % | MWD, mm | AI | SC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Virgin soil** | | | | | | | | | | | | | | | |
| 1 | 0-30 | 1.46 | 120.63 | 16.88 | 35.09 | 48.03 | Clay | 110 | 21.26 | 0.35 | 19.53 | 6.20 | 0.20 | 0.10 | 0.46 |
| | 30-60 | 1.45 | 118.43 | 12.95 | 35.07 | 51.98 | Clay | | 24.78 | | 25.39 | 8.33 | 0.18 | 0.09 | 0.24 |
| | 60-90 | 1.47 | 123.67 | 17.41 | 31.78 | 50.81 | Clay | | 26.27 | | 22.60 | 12.52 | 0.22 | 0.11 | 0.26 |
| | 90-120 | 1.48 | 130.74 | 16.06 | 30.39 | 53.55 | Clay | | 29.38 | | 17.27 | 8.26 | 0.13 | 0.07 | 0.29 |
| | Mean | 1.47 | 123.37 | 15.83 | 33.08 | 51.09 | | | 25.42 | 0.35 | 21.20 | 8.83 | 0.18 | 0.09 | 0.31 |
| **Cultivation period for five years** | | | | | | | | | | | | | | | |
| 2 | 0-30 | 1.16 | 98.43 | 6.42 | 37.19 | 56.39 | Clay | 96 | 24.61 | 0.43 | 42.38 | 28.60 | 0.57 | 0.29 | 0.74 |
| | 30-60 | 1.16 | 96.35 | 1.77 | 39.10 | 59.13 | Clay | | 25.30 | | 38.75 | 24.80 | 0.47 | 0.24 | 0.63 |
| | 60-90 | 1.19 | 101.37 | 10.05 | 36.50 | 53.45 | Clay | | 28.60 | | 30.41 | 19.70 | 0.34 | 0.17 | 0.44 |
| | 90-120 | 1.22 | 105.30 | 7.91 | 40.50 | 51.59 | Clay | | 28.40 | | 25.30 | 15.40 | 0.27 | 0.14 | 0.34 |
| | Mean | 1.18 | 100.36 | 6.54 | 38.32 | 55.14 | | | 26.73 | 0.43 | 34.21 | 22.13 | 0.41 | 0.21 | 0.54 |
| **Cultivation period for fifteen years** | | | | | | | | | | | | | | | |
| 3 | 0-30 | 1.08 | 93.33 | 3.58 | 58.45 | 37.97 | Silt clay | 92 | 28.58 | 0.52 | 47.40 | 30.10 | 0.57 | 0.29 | 0.90 |
| | 30-60 | 1.13 | 96.80 | 3.15 | 59.40 | 37.45 | Silt clay | | 30.01 | | 41.21 | 25.31 | 0.47 | 0.24 | 0.70 |
| | 60-90 | 1.16 | 96.80 | 5.13 | 49.27 | 45.60 | Silt clay | | 35.77 | | 31.02 | 20.60 | 0.34 | 0.17 | 0.45 |
| | 90-120 | 1.20 | 97.27 | 2.80 | 40.30 | 56.90 | Clay | | 40.55 | | 25.65 | 13.59 | 0.25 | 0.13 | 0.34 |
| | Mean | 1.14 | 96.05 | 3.66 | 51.86 | 44.48 | | | 33.73 | 0.52 | 36.32 | 22.40 | 0.41 | 0.21 | 0.67 |

**Table (3a):** Continue.

| Profile No. | Depth, cm | $\rho a$, g/cm$^3$ | SP % | Particle size distrib. Sand % | Silt % | Clay % | Texture | W.T. Depth, cm | S.F | K.S, cm/h | Aggregation parameters WSA, % | OSA, % | MWD mm | AI | SC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cultivation period for thirty years** | | | | | | | | | | | | | | | |
| 4 | 0-30 | 1.03 | 82.40 | 18.91 | 32.96 | 48.13 | Clay | 106 | 36.23 | 0.75 | 48.10 | 32.40 | 0.52 | 0.26 | 0.93 |
| | 30-60 | 1.13 | 84.30 | 13.88 | 33.57 | 52.55 | Clay | | 37.65 | | 39.60 | 26.90 | 0.41 | 0.21 | 0.66 |
| | 60-90 | 1.21 | 86.80 | 17.27 | 32.60 | 50.16 | Clay | | 40.76 | | 36.56 | 21.30 | 0.37 | 0.19 | 0.58 |
| | 90-120 | 1.15 | 87.16 | 10.83 | 36.44 | 52.73 | Clay | | 42.43 | | 27.62 | 16.30 | 0.27 | 0.1 | 0.38 |
| | Mean | 1.13 | 85.17 | 15.22 | 33.89 | 50.89 | | | 39.27 | 0.75 | 37.97 | 24.23 | 0.39 | 0.20 | 0.64 |
| **Cultivation period for fifty years** | | | | | | | | | | | | | | | |
| 5 | 0-30 | 1.01 | 75.51 | 18.33 | 34.61 | 47.06 | Clay | 113 | 45.47 | 0.78 | 52.60 | 36.60 | 0.58 | 0.29 | 1.11 |
| | 30-60 | 1.04 | 79.60 | 15.14 | 33.10 | 51.76 | Clay | | 54.80 | | 48.23 | 30.43 | 0.51 | 0.26 | 0.93 |
| | 60-90 | 1.20 | 80.39 | 15.78 | 34.50 | 49.72 | Clay | | 50.60 | | 35.26 | 21.11 | 0.37 | 0.19 | 0.54 |
| | 90-120 | 1.11 | 82.38 | 9.31 | 35.43 | 55.26 | Clay | | 54.69 | | 24.83 | 15.80 | 0.29 | 0.15 | 0.33 |
| | Mean | 1.09 | 79.47 | 14.64 | 34.41 | 50.95 | | | 51.39 | 0.78 | 40.20 | 25.99 | 0.44 | 0.22 | 0.73 |

WSA: water stable aggregates
AI: Aggregation index
S.F: Structure factor
OSA: Optimum size aggregates
SC: Structure coefficient
MWD: Mean weight diameter
K.S: Hydraulic conductivity

**Table (3a):** Continue. (b): Fresh irrigation water under open drainage system.

| Profile No. | Depth, cm | ρa, g/cm³ | SP % | Particle size distrib. Sand % | Silt % | Clay % | Texture | W.T. Depth, cm | S.F | K.S, cm/h | Aggregation parameters WSA % | OSA % | MWD, mm | AI | SC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Virgin soil** | | | | | | | | | | | | | | | |
| 6 | 0-30 | 1.35 | 77.58 | 16.96 | 27.94 | 55.10 | Clay | 82 | 31.98 | 0.30 | 26.40 | 13.90 | 0.37 | 0.19 | 0.36 |
| | 30-60 | 1.32 | 106.72 | 11.29 | 30.53 | 58.18 | Clay | | 40.48 | | 24.80 | 11.30 | 0.36 | 0.18 | 0.33 |
| | 60-90 | 1.37 | 103.02 | 13.13 | 33.69 | 53.18 | Clay | | 20.36 | | 21.20 | 10.70 | 0.28 | 0.14 | 0.27 |
| | 90-120 | 1.39 | 103.34 | 10.47 | 37.72 | 51.81 | Clay | | 21.31 | | 18.00 | 9.80 | 0.20 | 0.10 | 0.22 |
| | Mean | 1.36 | 97.67 | 12.96 | 32.47 | 54.57 | | | 28.53 | 0.30 | 22.60 | 11.43 | 0.30 | 0.15 | 0.30 |
| **Cultivation period for five years** | | | | | | | | | | | | | | | |
| 7 | 0-25 | 1.16 | 109.35 | 16.99 | 37.20 | 45.81 | Clay | 86 | 36.72 | 0.45 | 34.60 | 17.10 | 0.38 | 0.19 | 0.53 |
| | 25-60 | 1.20 | 105.61 | 19.44 | 32.39 | 48.17 | Clay | | 42.56 | | 30.40 | 15.20 | 0.34 | 0.17 | 0.44 |
| | 60-90 | 1.22 | 105.90 | 21.82 | 32.30 | 45.88 | Clay | | 33.54 | | 26.50 | 14.40 | 0.28 | 0.14 | 0.36 |
| | 90-120 | 1.23 | 131.41 | 15.80 | 30.35 | 53.85 | Clay | | 58.85 | | 22.10 | 10.00 | 0.22 | 0.11 | 0.28 |
| | Mean | 1.20 | 113.07 | 18.51 | 33.06 | 48.45 | | | 42.92 | 0.45 | 28.40 | 14.18 | 0.31 | 0.15 | 0.40 |
| **Cultivation period for fifteen years** | | | | | | | | | | | | | | | |
| 8 | 0-40 | 1.13 | 105.47 | 16.97 | 35.21 | 47.82 | Clay | 81 | 26.22 | 0.47 | 36.40 | 18.20 | 0.47 | 0.24 | 0.57 |
| | 40-80 | 1.16 | 118.88 | 14.81 | 34.68 | 50.51 | Clay | | 28.59 | | 32.60 | 16.50 | 0.38 | 0.19 | 0.48 |
| | 80-110 | 1.23 | 161.57 | 14.99 | 37.12 | 47.89 | Clay | | 9.12 | | 25.50 | 14.30 | 0.33 | 0.17 | 0.34 |
| | Mean | 1.17 | 128.64 | 15.59 | 35.67 | 48.74 | | | 21.31 | 0.47 | 31.50 | 16.30 | 0.39 | 0.20 | 0.46 |
| **Cultivation period for thirty years** | | | | | | | | | | | | | | | |
| 9 | 0-30 | 1.10 | 92.47 | 16.86 | 35.55 | 47.59 | Clay | 82 | 51.57 | 0.52 | 35.80 | 17.20 | 0.50 | 0.25 | 0.56 |
| | 30-80 | 1.15 | 90.48 | 14.58 | 34.68 | 50.74 | Clay | | 55.42 | | 33.10 | 16.10 | 0.43 | 0.22 | 0.44 |
| | 80-105 | 1.17 | 116.25 | 12.45 | 37.21 | 50.34 | Clay | | 46.78 | | 28.60 | 15.00 | 0.38 | 0.19 | 0.40 |
| | Mean | 1.14 | 99.73 | 14.63 | 35.81 | 49.56 | | | 51.25 | 0.52 | 32.60 | 16.10 | 0.44 | 0.22 | 0.48 |

**Table (3b):** Effect of agricultural practices, on some physical properties of studied profiles in Al-Mansur west region. (a) Blended irrigation water under tile drainage system.

| Profile No. | Depth, cm | $\rho a$, g/cm$^3$ | SP % | Particle size distrib. Sand % | Silt % | Clay % | Texture | W.T. Depth, cm | S.F | K.S, cm/h | Aggregation parameters WSA % | OSA % | MWD, mm | AI | SC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Virgin soil** | | | | | | | | | | | | | | | |
| 10 | 0-30 | 1.32 | 94.04 | 20.44 | 36.57 | 42.99 | Clay | 90 | 16.19 | 0.35 | 23.30 | 12.90 | 0.24 | 0.12 | 0.31 |
| | 30-60 | 1.30 | 101.54 | 19.89 | 33.89 | 46.22 | Clay | | 7.25 | | 23.38 | 11.80 | 0.22 | 0.11 | 0.30 |
| | 60-90 | 1.42 | 94.49 | 23.24 | 29.36 | 47.40 | Clay | | 22.13 | | 22.70 | 10.40 | 0.20 | 0.10 | 0.29 |
| | 90-120 | 1.44 | 73.16 | 14.02 | 37.96 | 48.02 | Clay | | 32.59 | | 20.22 | 9.50 | 0.18 | 0.09 | 0.25 |
| | Mean | 1.37 | 90.81 | 19.40 | 34.45 | 46.15 | Clay | | 19.54 | 0.35 | 22.40 | 11.15 | 0.21 | 0.11 | 0.29 |
| **Cultivation period for five years** | | | | | | | | | | | | | | | |
| 11 | 0-30 | 1.17 | 72.31 | 16.45 | 36.88 | 46.67 | Clay | 89 | 35.57 | 0.4 | 36.20 | 21.20 | 0.34 | 0.17 | 0.57 |
| | 30-60 | 1.18 | 99.34 | 18.11 | 36.82 | 45.07 | Clay | | 30.15 | | 32.61 | 20.62 | 0.31 | 0.16 | 0.48 |
| | 60-90 | 1.19 | 121.43 | 25.33 | 31.34 | 43.33 | Clay | | 30.12 | | 31.23 | 18.52 | 0.35 | 0.18 | 0.45 |
| | 90-120 | 1.19 | 110.07 | 25.83 | 31.18 | 42.99 | Clay | | 26.12 | | 29.51 | 18.20 | 0.41 | 0.21 | 0.42 |
| | Mean | 1.18 | 100.79 | 21.43 | 34.06 | 44.51 | Clay | | 30.49 | 0.4 | 32.39 | 19.64 | 0.35 | 0.18 | 0.48 |
| **Cultivation period for fifteen years** | | | | | | | | | | | | | | | |
| 12 | 0-30 | 1.10 | 83.91 | 16.06 | 34.39 | 49.55 | Clay | 85 | 26.68 | 0.50 | 39.20 | 17.15 | 0.39 | 0.20 | 0.64 |
| | 30-60 | 1.13 | 93.13 | 18.27 | 31.80 | 49.93 | Clay | | 24.37 | | 34.80 | 15.96 | 0.32 | 0.16 | 0.53 |
| | 60-90 | 1.16 | 109.06 | 17.73 | 30.36 | 51.91 | Clay | | 39.84 | | 30.40 | 13.35 | 0.29 | 0.15 | 0.44 |
| | 90-120 | 1.13 | 120.29 | 19.83 | 29.66 | 50.51 | Clay | | 36.49 | | 28.00 | 12.00 | 0.28 | 0.14 | 0.39 |
| | Mean | 1.13 | 101.60 | 17.97 | 31.55 | 50.48 | Clay | | 31.85 | 0.50 | 33.10 | 14.62 | 0.32 | 0.16 | 0.50 |

**Table (3b):** Continue.

| Profile No. | Depth, cm | ρa, g/cm³ | SP % | Particle size distrib. | | | Texture | W.T. Depth, cm | S.F | K.S, cm/h | Aggregation parameters | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Sand % | Silt % | Clay % | | | | | WSA % | OSA % | MWD, mm | AI | SC |
| **Cultivation period for thirty years** | | | | | | | | | | | | | | | |
| 13 | 0-30 | 1.08 | 72.31 | 23.59 | 32.16 | 44.25 | Clay | | 37.40 | | 41.03 | 19.19 | 0.54 | 0.27 | 0.70 |
| | 30-60 | 1.09 | 98.49 | 23.83 | 36.35 | 39.82 | Clay loam | | 47.69 | 0.53 | 34.52 | 20.18 | 0.42 | 0.21 | 0.53 |
| | 60-90 | 1.10 | 98.55 | 19.47 | 33.60 | 46.93 | Clay | 89 | 49.14 | | 33.38 | 20.17 | 0.43 | 0.21 | 0.50 |
| | 90-120 | 1.11 | 130.00 | 13.86 | 35.43 | 50.71 | Clay | | 55.79 | | 29.06 | 16.66 | 0.34 | 0.17 | 0.41 |
| | Mean | 1.10 | 99.84 | 20.19 | 34.38 | 45.43 | Clay | | 47.51 | 0.53 | 34.50 | 19.05 | 0.43 | 0.22 | 0.54 |
| **Cultivation period for fifty years** | | | | | | | | | | | | | | | |
| 14 | 0-30 | 1.02 | 75.10 | 15.88 | 32.53 | 51.59 | Clay | | 42.14 | | 42.75 | 26.00 | 0.49 | 0.25 | 0.75 |
| | 30-60 | 1.05 | 96.40 | 15.81 | 33.00 | 51.19 | Clay | | 36.63 | 0.61 | 35.63 | 21.27 | 0.39 | 0.20 | 0.55 |
| | 60-90 | 1.13 | 78.37 | 13.70 | 33.50 | 52.80 | Clay | 105 | 38.20 | | 33.77 | 20.40 | 0.31 | 0.16 | 0.51 |
| | 90-120 | 1.10 | 77.01 | 11.78 | 38.87 | 49.35 | Clay | | 30.90 | | 31.72 | 20.93 | 0.35 | 0.18 | 0.46 |
| | Mean | 1.08 | 81.72 | 14.29 | 34.48 | 51.23 | Clay | | 36.97 | 0.61 | 35.97 | 22.15 | 0.39 | 0.20 | 0.57 |

**Table (3b):** Continue. (b) Blended irrigation water under open drainage system.

| Profile No. | Depth, cm | ρa, g/cm$^3$ | SP % | Particle size distrib. Sand % | Silt % | Clay % | Texture | W.T. Depth, cm | S.F | K.S, cm/h | Aggregation parameters WSA % | OSA % | MWD, mm | AI | SC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Virgin soil** | | | | | | | | | | | | | | | |
| 15 | 0-30 | 1.37 | 97.89 | 27.13 | 32.77 | 40.10 | Clay | 79 | 3.04 | 0.44 | 27.07 | 13.06 | 0.25 | 0.12 | 0.37 |
| | 30-75 | 1.39 | 129.69 | 24.01 | 29.95 | 46.04 | Clay | | 17.69 | | 24.51 | 11.20 | 0.25 | 0.12 | 0.32 |
| | 75-110 | 1.40 | 129.36 | 23.22 | 33.49 | 43.29 | Clay | | 12.17 | | 20.93 | 8.70 | 0.18 | 0.09 | 0.26 |
| | Mean | 1.39 | 118.98 | 24.79 | 32.07 | 43.14 | Clay | | 10.97 | 0.44 | 24.17 | 10.99 | 0.23 | 0.11 | 0.32 |
| **Cultivation period for five years** | | | | | | | | | | | | | | | |
| 16 | 0-30 | 1.19 | 107.38 | 14.18 | 34.72 | 51.10 | Clay | 78 | 39.78 | 0.36 | 29.10 | 18.27 | 0.27 | 0.14 | 0.41 |
| | 30-70 | 1.21 | 114.62 | 16.84 | 32.55 | 50.61 | Clay | | 37.17 | | 27.70 | 16.07 | 0..26 | 0.13 | 0.38 |
| | 70-95 | 1.21 | 122.78 | 14.94 | 33.45 | 51.61 | Clay | | 42.61 | | 24.00 | 12.00 | 0.21 | 0.11 | 0.32 |
| | 95-120 | 1.18 | 124.14 | 9.80 | 34.64 | 55.56 | Clay | | 42.75 | | 22.40 | 11.12 | 0.19 | 0.10 | 0.29 |
| | Mean | 1.20 | 117.23 | 13.94 | 33.84 | 52.22 | Clay | | 40.58 | 0.36 | 25.80 | 14.37 | 0.23 | 0.12 | 0.35 |
| **Cultivation period for fifteen years** | | | | | | | | | | | | | | | |
| 17 | 0-30 | 1.13 | 89.065 | 13.57 | 39.11 | 47.32 | Clay | 73 | 36.88 | 0.40 | 30.15 | 19.70 | 0.28 | 0.14 | 0.43 |
| | 30-60 | 1.16 | 95.44 | 10.42 | 39.46 | 50.12 | Clay | | 44.53 | | 28.45 | 18.30 | 0.25 | 0.13 | 0.40 |
| | 60-90 | 1.15 | 93.10 | 5.44 | 42.20 | 52.36 | Silt clay | | 43.16 | | 27.47 | 16.70 | 0.22 | 0.11 | 0.39 |
| | 90-120 | 1.17 | 110.34 | 8.47 | 42.03 | 49.50 | Silt clay | | 34.28 | | 23.80 | 16.70 | 0.19 | 0.10 | 0.31 |
| | Mean | 1.15 | 96.99 | 9.48 | 40.70 | 49.82 | | | 39.71 | 0.40 | 27.47 | 17.63 | 0.24 | 0.12 | 0.38 |
| **Cultivation period for thirty years** | | | | | | | | | | | | | | | |
| 18 | 0-20 | 1.12 | 98.38 | 14.24 | 37.98 | 47.78 | Clay | 76 | 40.62 | 0.47 | 35.02 | 22.10 | 0.35 | 0.18 | 0.54 |
| | 20-50 | 1.13 | 101.95 | 23.06 | 32.57 | 44.37 | Clay | | 32.27 | | 31.15 | 22.60 | 0.35 | 0.18 | 0.45 |
| | 50-90 | 1.15 | 125.50 | 16.00 | 35.83 | 48.17 | Clay | | 39.90 | | 29.76 | 19.80 | 0.26 | 0.13 | 0.42 |
| | 90-120 | 1.14 | 137.36 | 18.02 | 36.25 | 45.73 | Clay | | 28.20 | | 22.80 | 13.30 | 0.21 | 0.11 | 0.30 |
| | Mean | 1.14 | 115.80 | 17.83 | 35.66 | 46.51 | | | 35.25 | 0.47 | 29.68 | 19.45 | 0.29 | 0.15 | 0.43 |
| **Cultivation period for fifty years** | | | | | | | | | | | | | | | |
| 19 | 0-30 | 1.09 | 98.26 | 16.19 | 35.59 | 48.22 | Clay | 83 | 53.14 | 0.56 | 37.10 | 19.60 | 0.39 | 0.20 | 0.59 |
| | 30-60 | 1.12 | 95.82 | 13.03 | 39.94 | 47.03 | Clay | | 50.74 | | 35.50 | 17.80 | 0.35 | 0.18 | 0.55 |
| | 60-90 | 1.09 | 95.54 | 14.19 | 37.16 | 48.65 | Clay | | 52.37 | | 30.40 | 15.80 | 0.33 | 0.17 | 0.44 |
| | 90-120 | 1.13 | 140.62 | 7.65 | 41.20 | 51.15 | Silt clay | | 42.97 | | 27.40 | 1430 | 0.32 | 0.16 | 0.38 |
| | Mean | 1.11 | 107.56 | 12.77 | 38.47 | 48.76 | | | 49.81 | 0.56 | 32.60 | 16.88 | 0.35 | 0.18 | 0.49 |

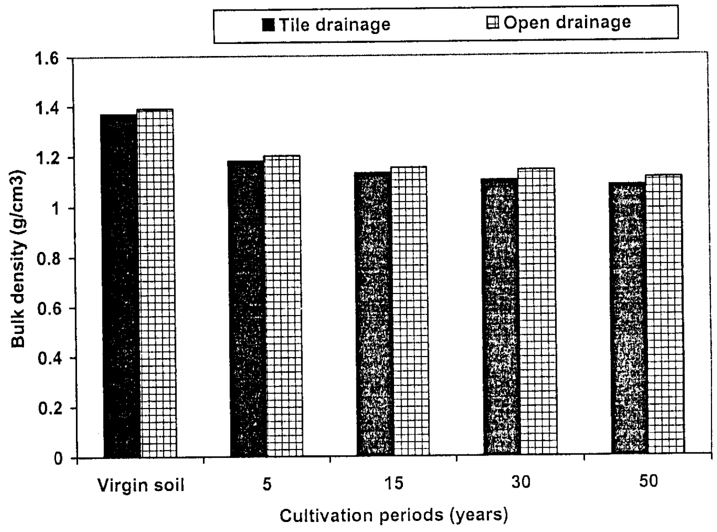


Fig. (3): Effect of drainage systems on soil bulk density (g/cm$^3$)

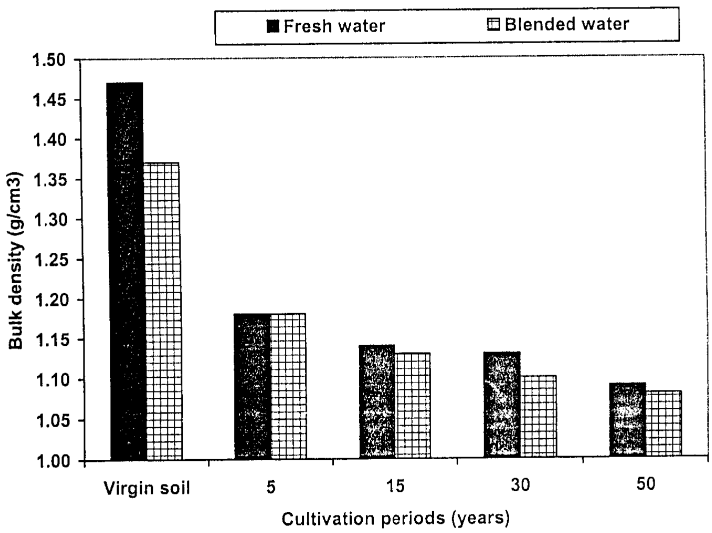


Fig. (4): Effect of irrigation water types on soil bulk density.

obtained by **Ramadan *et al.* (1994) and Moukhtar *et al.* (2003)**, who reported that, the 10 m drain spacing had lower values of $\rho a$ and penetrability, and the higher one of porosity and infiltration rate before planting, after harvesting than 20 and 40 m, respectively.

Data in Tables (3a and 3b) and Fig. (4) showed that there is no clear trend for bulk density values, due to irrigation water types **Fayed (2003)**. There was little decrease of $\rho a$ after 50 years of cultivation, where it reached 1.09 g/cm$^3$ (profile No. 5), compared to the soil after 5 years of cultivation (profile No. 2), where its $\rho a$ was 1.18 g/cm$^3$, in the case of fresh water. There was no clear difference in $\rho a$ due to irrigation with blended water, compared to fresh water after the same land use period. It could be attributed to close values of SAR for both fresh and blended waters.

**5.1.2.3. Aggregation parameters:**

Data in Tables (3 a and 3 b) and Figs. (5 and 6), revealed that aggregation parameters, such as water stable aggregates (WSA%), optimum size aggregates (OSA), mean weight diameter (MWD), aggregation index (AI) and structure coefficient (SC) of the studied soils, increased with increasing cultivation period. The highest mean values of WSA%, OSA%, MWD, AI and SC, were recorded in profile (No. 5), which represent the soil cultivated for 50 years, under fresh water and tile drainage. Whereas, the lowest values of aggregation parameters, were recorded in profile No. (1), which represent the virgin soil. These results are in agreement with those obtained by **Zien *et al.* (1996) and Awad (1998)**. In this respect **Omar *et al.* (1990)** reported that, soil aggregation values are significantly

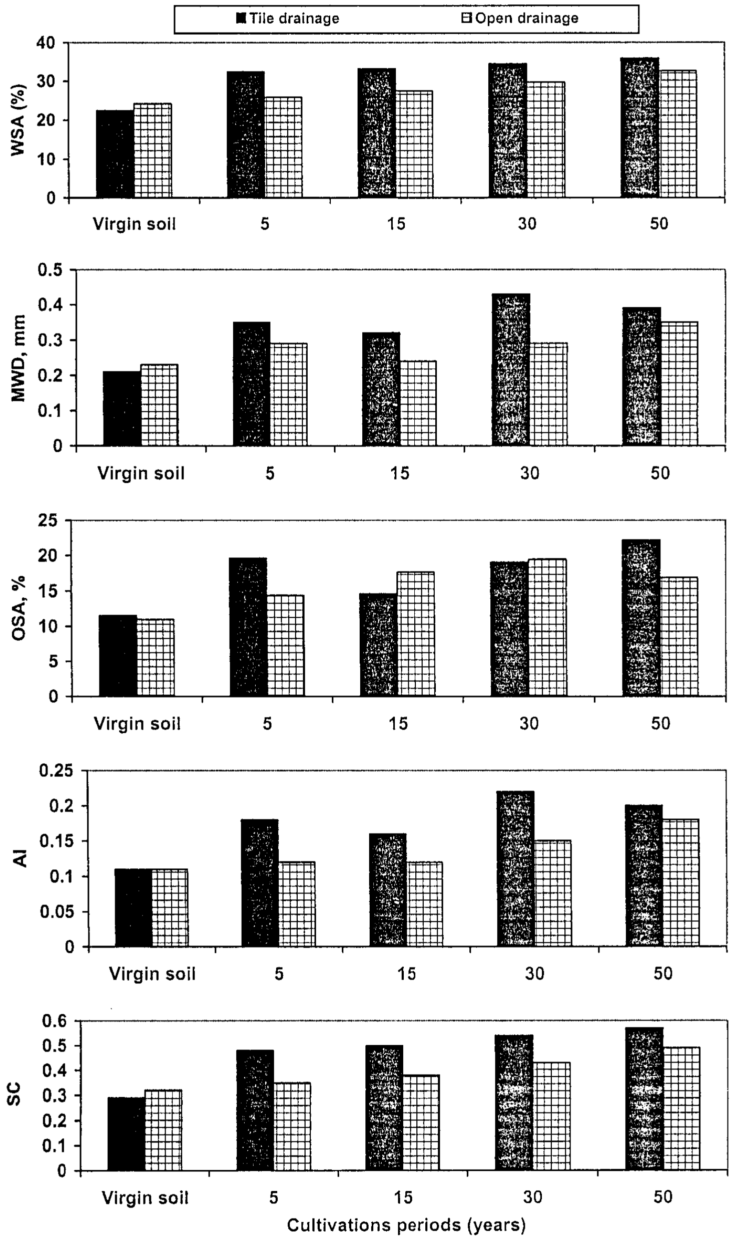


Fig. (5): Effect of drainage system on soil aggregation parameters.

increased with increasing of cultivation period, which may be due to the increase of organic matter. They added that, this behaviour may be attributed to the fact that, the increase of the aggregation with cultivation period is due to the cementing agents of clay and organic matter. Similar results were obtained by **Abo-Waly *et al.* (1996)**.

Data in Tables (3a and 3b) and Fig. (5), show the drainage system effect on aggregation parameters. The mean values of WSA% for soil under tile drainage, were higher than those obtained under open drainage system. Where the mean values of WSA% increased from 22.40% in profile No. 10 (virgin soil), to 35.97% after 50 years of cultivation (profile No. 14), under tile drainage. Values of WSA% were lower in profiles represent the soils served by open drainage, compared to soils under tile drainage at the same periods of cultivation.

Results in Tables (3a and 3b) and Fig. (5) revealed also that, the soils that served by tile drainage system, have the mean values of OSA, MWD, AI and SC higher than those obtained for soils that served by open drainage system, at different cultivation period, as shown in profiles (10, 11, 12, 13 and 14), which represent soils under tile drainage, as well as, in profiles (15, 16, 17, 18 and 19) which represent the soils under open drainage system. These results were in accordance with those obtained by **Wahdan *et al.* (1992) and Moukhtar *et al.* (2003)**. In this respect, **Abd El-Mawgood (1987)** reported that, the installation of tile drainage is considered one of the important factors affecting soil aggregate formation, directly and indirectly, the direct effect is due to wetting and drying cycles,

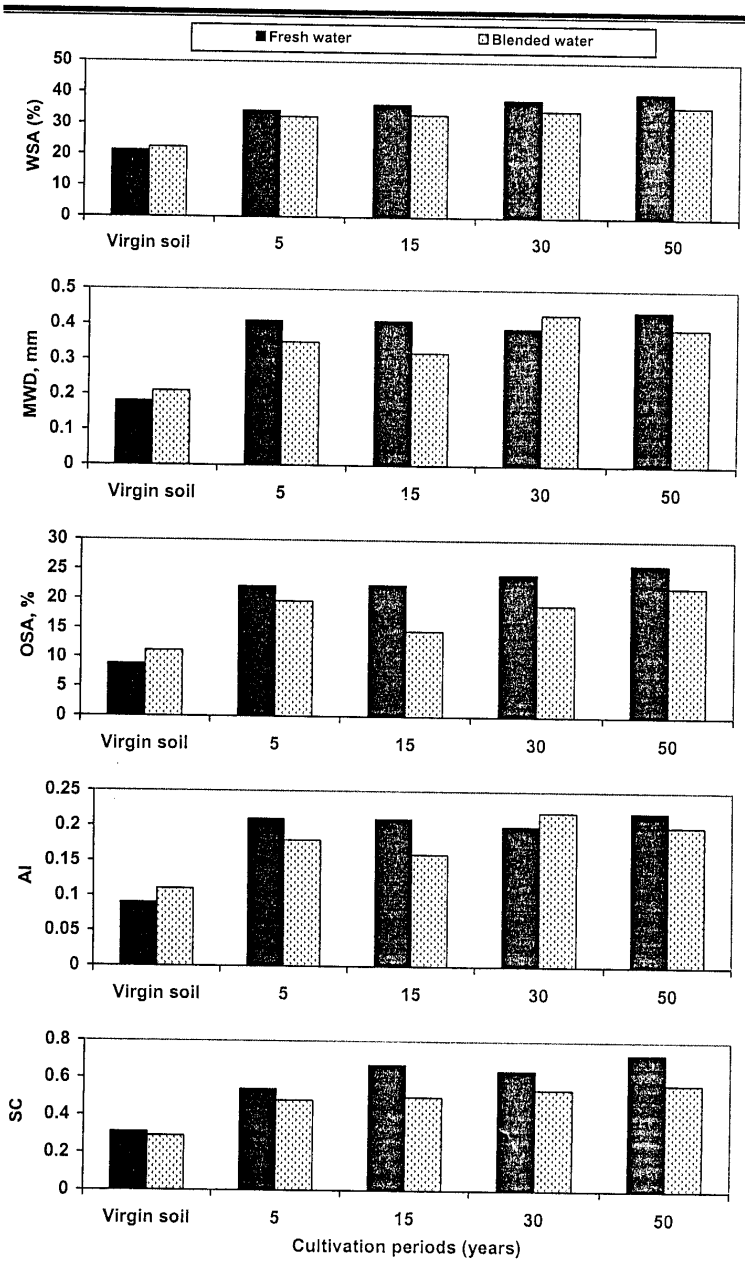


Fig. (6): Effect of irrigation water types on soil aggregation parameters.

which create better environmental condition for aggregate structure, the indirectly effect may be due to the redistribution of chemical constituents in the soil profiles.

Concerning the effect of irrigation water types on soil aggregation parameters, the mean values of aggregation parameters for soils irrigated with fresh water, were higher than those obtained for the soils that irrigated by blended water, at different cultivation periods. Where, the mean values of WSA% for the soils irrigated by fresh water, increased from 21.20 (profile No. 1) to 40.20% (profile No. 5), within 50 years of cultivation. While, the lowest values of WSA% were recorded for profiles No. 10, 11, 12, 13 and 14, which represent soils irrigated with blended waters, for the same corresponding periods of cultivation, as shown in Tables (3a and 3b) and Fig. (6).

Data show also that, other aggregation parameters (OSA, MWD, AI and SC) had taken the same trend, where their mean values for the soil irrigated by fresh water, were higher than those obtained for the soil that irrigated by blended water, as shown in Tables (3a and 3b) and Fig. (6).

**Khalifa (1990)** pointed-out that, using drainage water for irrigation purpose, led to increase of exchangeable $Na^{+}$ and $Mg^{+}$, ESP and EMgP. On the other hand, exchangeable $Ca^{++}$ and ECaP decreased Table (5). This effect led to deteriorate the clay soil structure, and other relevant properties, in comparison with using canal water in irrigation. These results were in agreement with **Elwan and Kandil (1992); Koriem (1994) and Tayel *et al.* (2003).**

**5.1.2.4. Hydraulic conductivity (Ks):**

Data in Tables (3a and 3 b) and Figs. (7 and 8) showed that, the hydraulic conductivity (Ks) for the studied soils, were increased gradually with increasing the cultivation periods. The values of Ks increased from 0.43 cm/h after 5 years of cultivation (profile No. 2), to 0.78 cm/h after 50 years of cultivation (profile No. 5). While, it was 0.35 cm/h in virgin soil (profile No. 1). The same trend of increasing Ks with time had been achieved under the different agricultural practices.

The results in Tables (3a and 3b) and Fig. (7) showed that, soils under tile drainage system, have higher values of (Ks) than those obtained for the soils under open drainage system. The values of the soils that served by tile drainage system, were generally higher than those for soils subjected under open drainage along the different cultivation periods, as shown in Fig. (7). This could be attributed to the relatively higher values of ESP and SAR of soils under open drainage, than that under tile drainage. These findings were in harmony with those obtained by **Naguib (1987) and Aly *et al.* (2002).**

Data in Tables (3a and 3 b) and Fig. (8) indicated that, values of hydraulic conductivity were increased in soils irrigated by fresh water, more than those irrigated by blended water. Where the hydraulic conductivity values for soils that irrigated by fresh water were 0.35, 0.43, 0.52, 0.75 and 0.78 cm/h, as recorded in profiles (1, 2, 3, 4 and 5), respectively at 0, 5, 15, 30 and 50 years of cultivation periods respectively. While they were 0.35, 40, 0.50, 0.53 and 0.61

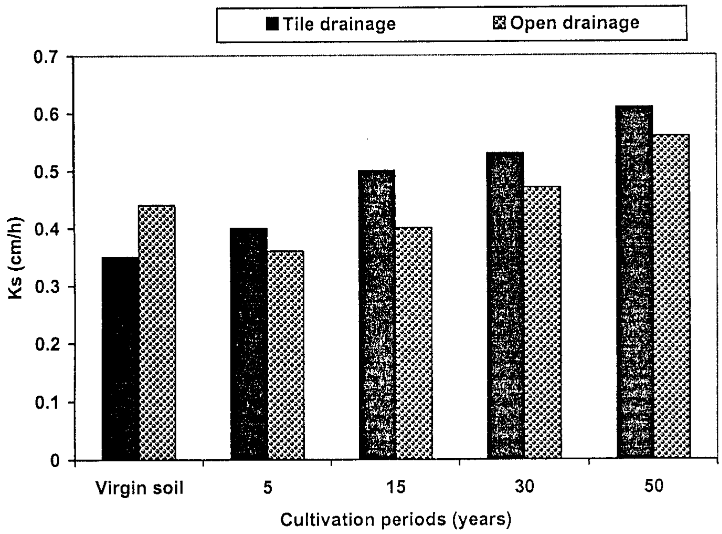


Fig. (7): Effect of drainage systems on soil hydraulic conductivity (Ks cm/h).

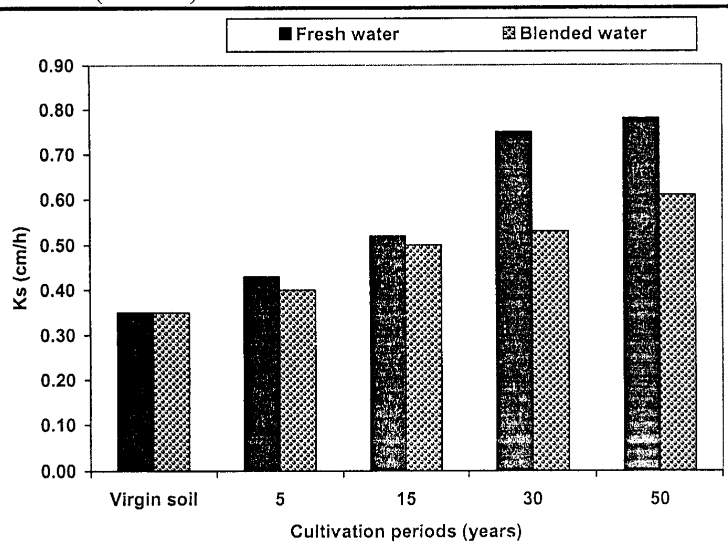


Fig. (8): Effect of irrigation water types on soil hydraulic conductivity (Ks cm/h).

cm/h, for profiles (10, 11, 12, 13 and 14), respectively at the same different cultivation period. These results were in agreement with those obtained by **El-Samanoudi (1992) and Madkour *et al.* (1999)**, who reported that, total porosity, volume of drainable pores and quick drainable pores, and subsequently hydraulic conductivity clearly decreased as results of increasing salinity and sodicity of irrigation water, , where the $EC_{iw}$ of fresh irrigation water ranged between 0.7 to 0.8 dS/m, while it ranged between 1.5 to 3.2 for blended water. The SAR for fresh irrigation water, ranged between 2.21 to 2.37 while, it ranged between 3.95 to 7.85 for blended water as shown in Table (5). In this respect **Khater (1988)** stated that soil dispersion and movement of clay particles, were increased as exchangeable sodium or sodium adsorption ratio increased, especially in saline clayey soils, and hence blocking the conducting pores.

### 5.1.3. Chemical properties:

#### 5.1.3.1. Soil pH:

The obtained results indicated that increasing the cultivation periods led to decrease in soil pH mean values (Tables 4a and 4b). The lowest mean value of soil pH 7.89, had bean obtained after 50 years of cultivation period (Prof. 5), while the highest one was 8.16 in virgin soil (Prof. 1). The values of soil pH in surface layers ranged from 7.66 (profile 5) to 8.18 (profile 16), of the cultivated soils and from 8.07 (profile 1) to 8.30 (profiles 10 and 15) in the virgin soils. The increase of cultivation periods resulted in a decrease of pH values. This decrease was more clear in the two upper layers in all

**Table (4a):** Effect of agricultural practices on some chemical properties of studied profiles in Al-Zawea region. (a) Fresh irrigation water under tile drainage system

| Prof. No. | Depth, cm | pH 1:2.5 | EC, dS/m | Salinity decrease % | Soluble anions, meq/L |  |  |  | Soluble cations, meq/L |  |  |  | SAR | CEC cmol/kg | $CaCO_3$ % | ESP % | Gyp. % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  | $HCO^-_3$ | $CO^=_3$ | $Cl^-$ | $SO^=_4$ | $Ca^{++}$ | $Mg^{++}$ | $Na^+$ | $K^+$ |  |  |  |  |  |
| **Virgin soil** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 0-30 | 8.07 | 50.30 |  | 6.25 | 0.00 | 523.00 | 115.40 | 86.80 | 105.60 | 450.00 | 2.25 | 45.88 | 31.40 | 1.76 | 43.69 | 0.2 |
|  | 30-60 | 8.10 | 46.30 |  | 5.75 | 0.00 | 480.70 | 106.12 | 79.10 | 96.60 | 414.80 | 2.07 | 44.26 | 23.80 | 2.44 | 54.11 | 0.2 |
|  | 60-90 | 8.16 | 54.60 |  | 6.75 | 0.00 | 564.30 | 122.98 | 103.40 | 103.40 | 485.20 | 2.43 | 47.76 | 22.20 | 2.44 | 67.56 | 0.2 |
|  | 90-120 | 8.29 | 60.00 |  | 7.50 | 0.00 | 615.00 | 140.58 | 112.30 | 123.00 | 525.00 | 2.70 | 48.40 | 23.80 | 2.66 | 60.33 | 0.2 |
|  | Mean | 8.16 | 52.80 | 0 | 6.56 | 0.00 | 545.75 | 121.27 | 95.40 | 107.15 | 468.75 | 2.36 | 46.58 | 25.30 | 2.33 | 56.42 | 0.2 |
| **Cultivation period for five years** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | 0-30 | 7.90 | 7.10 |  | 1.0 | 0.00 | 62.20 | 19.80 | 13.20 | 13.60 | 46.12 | 1.60 | 12.60 | 29.20 | 1.33 | 23.86 | 0.2 |
|  | 30-60 | 8.11 | 7.90 |  | 1.5 | 0.00 | 66.10 | 16.50 | 12.80 | 14.60 | 55.90 | 0.80 | 15.10 | 27.60 | 1.44 | 34.56 | 0.3 |
|  | 60-90 | 8.20 | 8.20 |  | 1.5 | 0.00 | 63.30 | 29.20 | 14.10 | 15.50 | 62.30 | 2.10 | 16.19 | 32.00 | 1.89 | 23.81 | 0.3 |
|  | 90-120 | 8.17 | 8.60 |  | 2.0 | 0.00 | 72.80 | 25.20 | 16.20 | 14.40 | 67.20 | 2.20 | 17.18 | 26.80 | 1.89 | 48.20 | 0.4 |
|  | Mean | 8.10 | 7.95 | 84.94 | 1.5 | 0.00 | 66.10 | 22.68 | 14.07 | 14.53 | 57.88 | 1.68 | 15.27 | 28.90 | 1.64 | 32.61 | 0.3 |
| **Cultivation period for fifteen years** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | 0-30 | 7.98 | 6.15 |  | 1.00 | 0.00 | 51.96 | 23.04 | 14.60 | 14.60 | 46.30 | 1.00 | 12.12 | 33.60 | 0.98 | 21.51 | 0.4 |
|  | 30-60 | 8.10 | 6.80 |  | 1.00 | 0.00 | 50.44 | 34.06 | 19.60 | 13.60 | 51.00 | 1.30 | 12.52 | 35.20 | 1.88 | 25.48 | 0.1 |
|  | 60-90 | 7.99 | 7.20 |  | 1.70 | 0.00 | 46.32 | 39.98 | 15.70 | 13.50 | 57.70 | 1.10 | 15.10 | 28.40 | 1.88 | 38.13 | 0.2 |
|  | 90-120 | 8.13 | 7.90 |  | 1.80 | 0.00 | 55.00 | 38.50 | 16.50 | 12.80 | 63.80 | 1.40 | 16.70 | 34.40 | 1.66 | 36.16 | 0.5 |
|  | Mean | 8.05 | 7.01 | 86.72 | 1.38 | 0.00 | 50.93 | 33.89 | 16.60 | 13.63 | 54.70 | 1.20 | 14.11 | 32.90 | 1.60 | 30.32 | 0.3 |

**Table (4a):** Continue.

| Prof. No. | Depth, cm | pH 1:2.5 | EC, dS/m | Salinity decrease % | Soluble anions, meq/L | | | | Soluble cations, meq/L | | | | SAR | CEC cmol/kg | $CaCO_3$ % | ESP, % | Gyp. % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $HCO^-_3$ | $CO^=_3$ | $Cl^-$ | $SO^=_4$ | $Ca^{++}$ | $Mg^{++}$ | $Na^+$ | $K^+$ | | | | | |
| **Cultivation period for thirty years** | | | | | | | | | | | | | | | | | |
| 4 | 0-30 | 7.99 | 6.00 | | 1.20 | 0.00 | 44.10 | 19.80 | 12.50 | 12.30 | 39.40 | 0.90 | 11.19 | 37.00 | 0.88 | 13.73 | 0.4 |
| | 30-60 | 8.13 | 6.40 | | 1.00 | 0.00 | 44.20 | 29.60 | 17.20 | 11.90 | 44.70 | 1.00 | 11.72 | 35.20 | 1.32 | 16.42 | 0.2 |
| | 60-90 | 8.01 | 7.10 | | 1.00 | 0.00 | 46.32 | 29.68 | 15.70 | 13.50 | 46.70 | 1.10 | 12.22 | 32.80 | 1.90 | 20.33 | 0.2 |
| | 90-120 | 7.95 | 7.80 | | 1.00 | 0.00 | 48.31 | 33.69 | 16.50 | 12.80 | 52.50 | 1.20 | 13.72 | 28.40 | 1.10 | 24.60 | 0.4 |
| | Mean | 8.02 | 6.83 | 87.06 | 1.05 | 0.00 | 45.73 | 28.20 | 15.48 | 12.63 | 45.82 | 1.05 | 12.21 | 33.35 | 1.30 | 18.77 | 0.3 |
| **Cultivation period for fifty years** | | | | | | | | | | | | | | | | | |
| 5 | 0-30 | 7.66 | 3.10 | | 1.00 | 0.00 | 25.50 | 5.50 | 5.00 | 4.20 | 22.20 | 0.60 | 10.35 | 38.00 | 0.33 | 12.10 | 0.6 |
| | 30-60 | 7.81 | 5.30 | | 1.50 | 0.00 | 37.00 | 15.50 | 10.00 | 7.20 | 35.60 | 1.20 | 12.14 | 36.20 | 1.44 | 14.50 | 0.4 |
| | 60-90 | 7.98 | 7.50 | | 2.00 | 0.00 | 54.00 | 21.00 | 13.70 | 12.00 | 50.10 | 1.20 | 13.98 | 32.00 | 1.89 | 16.00 | 0.1 |
| | 90-120 | 8.10 | 7.60 | | 2.00 | 0.00 | 56.00 | 20.00 | 12.50 | 12.00 | 52.00 | 1.50 | 14.86 | 28.40 | 1.94 | 25.47 | 0.5 |
| | Mean | 7.89 | 5.88 | 88.86 | 1.63 | 0.00 | 43.13 | 15.50 | 10.30 | 8.85 | 39.98 | 1.13 | 12.83 | 33.65 | 1.40 | 17.02 | 0.4 |

**Table (4a):** Continue. (b) Fresh irrigation water under open drainage system.

| Prof. No. | Depth cm | pH 1:2.5 | EC, dS/m | Salinity decrease % | Soluble anions, meq/L $HCO^-_3$ | $CO^-_3$ | $Cl^-$ | $SO^-_4$ | Soluble cations, meq/L $Ca^{++}$ | $Mg^{++}$ | $Na^+$ | $K^+$ | SAR | CEC cmol/kg | $CaCO_3$ % | ESP | Gyp. % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Virgin soil** | | | | | | | | | | | | | | | | | |
| 6 | 0-30 | 8.20 | 46.20 | | 3.38 | 0.00 | 281.80 | 188.29 | 81.57 | 55.70 | 334.10 | 2.10 | 40.33 | 22.00 | 1.64 | 50.70 | 0.3 |
| | 30-60 | 8.23 | 42.75 | | 3.04 | 0.00 | 265.03 | 168.74 | 62.50 | 47.35 | 325.20 | 1.76 | 43.88 | 23.00 | 2.32 | 62.28 | 0.3 |
| | 60-90 | 8.25 | 40.31 | | 304 | 0.00 | 249.93 | 159.62 | 59.05 | 49.17 | 302.61 | 1.76 | 41.14 | 22.40 | 2.21 | 48.35 | 0.3 |
| | 90-120 | 8.30 | 37.94 | | 2.03 | 0.00 | 235.26 | 148.24 | 55.46 | 47.99 | 280.46 | 1.62 | 39.00 | 21.60 | 3.21 | 65.51 | 0.3 |
| | Mean | 8.24 | 41.80 | 0 | 2.87 | 0.00 | 258.01 | 166.23 | 64.65 | 50.05 | 310.60 | 1.81 | 41.09 | 22.00 | 2.35 | 56.71 | 0.3 |
| **Cultivation period for five years** | | | | | | | | | | | | | | | | | |
| 7 | 0-25 | 8.10 | 8.30 | | 2.00 | 0.00 | 59.00 | 36.20 | 16.70 | 16.90 | 61.80 | 1.80 | 15.08 | 25.20 | 1.08 | 28.17 | 0.4 |
| | 25-60 | 8.15 | 8.80 | | 2.00 | 0.00 | 62.40 | 35.74 | 16.20 | 16.50 | 65.34 | 1.60 | 16.16 | 22.40 | 1.70 | 37.72 | 0.4 |
| | 60-90 | 8.20 | 9.50 | | 1.50 | 0.00 | 69.40 | 39.90 | 20.30 | 16.20 | 72.70 | 1.60 | 17.02 | 20.00 | 1.32 | 49.60 | 0.4 |
| | 90-120 | 8.30 | 11.80 | | 1.50 | 0.00 | 94.50 | 36.50 | 24.40 | 19.80 | 87.10 | 1.20 | 18.53 | 21.00 | 3.90 | 32.95 | 0.4 |
| | Mean | 8.19 | 9.60 | 77.03 | 1.75 | 0.00 | 71.33 | 37.09 | 19.40 | 17.35 | 71.74 | 1.55 | 16.70 | 22.15 | 2.00 | 37.11 | 0.4 |
| **cultivation period for fifteen years** | | | | | | | | | | | | | | | | | |
| 8 | 0-40 | 8.12 | 7.80 | | 1.50 | 0.00 | 59.60 | 24.20 | 15.70 | 14.20 | 54.10 | 1.30 | 13.99 | 30.20 | 2.42 | 22.12 | 0.4 |
| | 40-80 | 8.15 | 8.70 | | 1.00 | 0.00 | 64.90 | 26.07 | 16.27 | 14.00 | 60.70 | 1.00 | 15.60 | 23.60 | 1.98 | 35.88 | 0.4 |
| | 80-110 | 8.25 | 10.20 | | 1.50 | 0.00 | 76.30 | 35.00 | 20.30 | 18.00 | 73.50 | 1.00 | 16.80 | 19.10 | 0.44 | 39.58 | 0.4 |
| | Mean | 8.17 | 8.90 | 78.71 | 1.33 | 0.00 | 66.93 | 28.42 | 17.42 | 15.40 | 62.76 | 1.10 | 15.46 | 24.30 | 1.61 | 32.53 | 0.4 |
| **cultivation period for thirty years** | | | | | | | | | | | | | | | | | |
| 9 | 0-30 | 7.82 | 7.20 | | 1.50 | 0.00 | 43.50 | 29.50 | 11.10 | 12.60 | 49.20 | 1.60 | 14.29 | 22.40 | 2.55 | 18.86 | 0.3 |
| | 30-80 | 8.11 | 8.40 | | 1.50 | 0.00 | 55.60 | 28.51 | 11.96 | 15.95 | 56.40 | 1.30 | 15.10 | 26.00 | 0.88 | 22.42 | 0.3 |
| | 80-105 | 8.15 | 9.30 | | 1.00 | 0.00 | 63.40 | 33.61 | 14.90 | 16.94 | 64.87 | 1.30 | 16.26 | 29.20 | 0.55 | 27.50 | 0.3 |
| | Mean | 8.03 | 8.30 | 80.14 | 1.33 | 0.00 | 54.16 | 30.54 | 12.65 | 15.16 | 56.82 | 1.40 | 15.22 | 25.87 | 1.33 | 22.92 | 0.3 |

**Table (4b):** Effect of agricultural practices on some chemical properties of studied profiles in Al-Mansur west region.

(a) Blended irrigation water under tile drainage system.

| Prof. No. | Depth, cm | pH 1:2.5 | EC, dS/m | Salinity decrease, % | Soluble anions, meq/L | | | | Soluble cations, meq/L | | | | SAR | CEC cmol/kg | $CaCO_3$ % | ESP % | Gyp. % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $HCO^-_3$ | $CO^{--}_3$ | $Cl^-$ | $SO^{--}_4$ | $Ca^{++}$ | $Mg^{++}$ | $Na^+$ | $K^+$ | | | | | |
| **Virgin soil** | | | | | | | | | | | | | | | | | |
| 10 | 0-30 | 8.30 | 63.30 | | 7.87 | 0.00 | 593.06 | 155.88 | 115.58 | 133.09 | 505.14 | 2.80 | 44.37 | 27.00 | 1.54 | 70.96 | 0.30 |
| | 30-60 | 8.30 | 47.74 | | 6.00 | 0.00 | 500.83 | 110.38 | 86.35 | 101.15 | 427.52 | 2.14 | 44.15 | 26.00 | 1.32 | 54.11 | 0.40 |
| | 60-90 | 8.20 | 45.29 | | 5.67 | 0.00 | 473.94 | 84.40 | 84.15 | 92.97 | 385.50 | 1.39 | 40.96 | 19.20 | 3.30 | 58.80 | 0.40 |
| | 90-120 | 8.30 | 47.86 | | 6.01 | 0.00 | 503.16 | 111.06 | 93.08 | 101.64 | 423.37 | 2.14 | 42.91 | 17.00 | 3.08 | 54.07 | 0.10 |
| | Mean | 8.28 | 51.05 | 0 | 6.39 | 0.00 | 517.74 | 115.37 | 94.79 | 107.21 | 435.38 | 2.12 | 43.10 | 22.30 | 2.31 | 59.49 | 0.30 |
| **Cultivation period for five years** | | | | | | | | | | | | | | | | | |
| 11 | 0-30 | 7.98 | 8.10 | | 2.00 | 0.00 | 77.00 | 20.10 | 17.60 | 16.20 | 64.50 | 0.80 | 15.69 | 26.80 | 1.44 | 23.50 | 0.20 |
| | 30-60 | 8.19 | 8.40 | | 2.50 | 0.00 | 75.00 | 18.50 | 15.20 | 11.80 | 68.00 | 1.00 | 18.51 | 25.00 | 1.44 | 19.78 | 0.20 |
| | 60-90 | 8.17 | 9.10 | | 3.00 | 0.00 | 82.00 | 35.00 | 25.00 | 21.70 | 72.00 | 1.30 | 14.90 | 23.80 | 2.44 | 45.79 | 0.60 |
| | 90-120 | 8.25 | 8.60 | | 3.00 | 0.00 | 78.00 | 29.00 | 20.00 | 18.40 | 70.00 | 1.630 | 15.98 | 22.00 | 1.76 | 52.22 | 0.30 |
| | Mean | 8.15 | 8.60 | 83.15 | 2.63 | 0.00 | 78.00 | 25.65 | 19.45 | 17.02 | 68.63 | 1.18 | 16.27 | 24.4 | 1.77 | 35.22 | 0.35 |
| **Cultivation period for fifteen years** | | | | | | | | | | | | | | | | | |
| 12 | 0-30 | 8.10 | 7.40 | | 1.50 | 0.00 | 77.20 | 6.30 | 11.20 | 9.0 | 63.80 | 1.00 | 20.08 | 28.00 | 1.64 | 18.71 | 0.50 |
| | 30-60 | 8.13 | 8.10 | | 1.50 | 0.00 | 78.00 | 12.50 | 12.40 | 11.40 | 67.00 | 1.20 | 19.42 | 25.20 | 1.32 | 25.27 | 0.30 |
| | 60-90 | 8.15 | 8.70 | | 1.50 | 0.00 | 80.00 | 18.50 | 14.00 | 12.40 | 72.00 | 1.60 | 10.17 | 24.40 | 1.77 | 39.68 | 0.10 |
| | 90-120 | 8.19 | 9.20 | | 200 | 0.00 | 85.00 | 23.00 | 18.20 | 14.00 | 76.00 | 1.80 | 18.94 | 24.80 | 2.31 | 43.56 | 1.10 |
| | Mean | 8.14 | 8.35 | 83.64 | 1.62 | 0.00 | 80.05 | 15.08 | 13.95 | 11.70 | 69.70 | 1.40 | 17.15 | 25.6 | 1.76 | 31.81 | 0.50 |

**Table (4b):** Continue.

| Prof. No. | Depth, cm | pH 1:2.5 | EC, dS/m | Salinity decrease, % | Soluble anions, meq/L | | | | Soluble cations, meq/L | | | | SAR | CEC cmol/kg | $CaCO_3$, % | ESP, % | Gyp., % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $HCO^-_3$ | $CO^=_3$ | $Cl^-$ | $SO^=_4$ | $Ca^{++}$ | $Mg^{++}$ | $Na^+$ | $K^+$ | | | | | |
| **Cultivation period for thirty years** | | | | | | | | | | | | | | | | | |
| 13 | 0-25 | 8.04 | 7.20 | | 1.20 | 0.00 | 63.00 | 9.80 | 13.20 | 15.90 | 44.30 | 0.60 | 11.61 | 33.00 | 0.42 | 31.54 | 0.40 |
| | 25-55 | 8.06 | 7.40 | | 1.00 | 0.00 | 66.00 | 25.00 | 14.20 | 16.00 | 61.0 | 0.80 | 15.70 | 30.00 | 1.32 | 24.33 | 0.40 |
| | 55-85 | 8.10 | 8.20 | | 1.20 | 0.00 | 67.80 | 24.00 | 13.80 | 14.00 | 64.00 | 1.20 | 17.17 | 24.00 | 1.14 | 19.29 | 0.40 |
| | 85-120 | 8.15 | 9.00 | | 1.10 | 0.00 | 73.00 | 28.90 | 15.30 | 15.30 | 71.00 | 1.40 | 18.15 | 25.20 | 2.66 | 46.06 | 0.40 |
| | Mean | 8.09 | 7.95 | 84.43 | 1.13 | 0.00 | 67.45 | 21.92 | 14.12 | 15.30 | 60.08 | 1.00 | 15.66 | 27.80 | 1.39 | 30.31 | 0.40 |
| **Cultivation period for fifty years** | | | | | | | | | | | | | | | | | |
| 14 | 0-30 | 7.74 | 7.10 | | 1.50 | 0.00 | 60.00 | 15.10 | 12.30 | 13.70 | 50.00 | 0.60 | 13.87 | 30.00 | 0.30 | 26.23 | 0.40 |
| | 30-60 | 7.97 | 7.30 | | 1.00 | 0.00 | 66.00 | 12.49 | 12.00 | 11.49 | 55.00 | 1.00 | 16.05 | 24.00 | 0.98 | 18.50 | 0.40 |
| | 60-90 | 8.00 | 8.40 | | 1.50 | 0.00 | 74.50 | 12.00 | 13.80 | 11.00 | 62.00 | 1.20 | 17.61 | 28.40 | 1.32 | 20.67 | 0.50 |
| | 90-120 | 8.01 | 8.80 | | 1.50 | 0.00 | 70.00 | 27.50 | 20.30 | 17.30 | 60.00 | 1.40 | 13.84 | 31.40 | 0.99 | 39.93 | 0.50 |
| | Mean | 7.93 | 7.90 | 84.52 | 1.38 | 0.00 | 67.62 | 16.77 | 14.60 | 13.37 | 56.75 | 1.05 | 15.34 | 27.45 | 1.20 | 26.33 | 0.45 |

**Table (4b):** Continue. (b) Blended irrigation water under open drainage system.

| Prof. No. | Depth, cm | pH 1:2.5 | EC, dS/m | Salinity decrease, % | Soluble anions, meq/L | | | | Soluble cations, meq/L | | | | SAR | CEC cmol/kg | $CaCO_3$, % | ESP, % | Gyp., % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $HCO^-_3$ | $CO^=_3$ | $Cl^-$ | $SO^=_4$ | $Ca^{++}$ | $Mg^{++}$ | $Na^+$ | $K^+$ | | | | | |
| **Virgin soil** | | | | | | | | | | | | | | | | | |
| 15 | 0-30 | 8.30 | 53.14 | | 4.54 | 0.00 | 504.20 | 144.05 | 53.49 | 71.98 | 521.70 | 562 | 65.87 | 23.80 | 2.10 | 49.17 | 0.60 |
| | 30-75 | 8.42 | 40.94 | | 5.61 | 0.00 | 394.41 | 114.33 | 35.33 | 90.14 | 382.20 | 6.68 | 48.25 | 22.00 | 2.66 | 30.76 | 0.60 |
| | 75-110 | 8.40 | 47.30 | | 4.95 | 0.00 | 462.27 | 82.55 | 49.12 | 57.37 | 437.50 | 5.78 | 59.96 | 19.60 | 2.44 | 54.44 | 0.80 |
| | Mean | 8.37 | 47.30 | 0 | 5.03 | 0.00 | 453.62 | 113.64 | 45.98 | 73.16 | 447.13 | 6.03 | 58.03 | 21.80 | 2.40 | 44.79 | 0.66 |
| **Cultivation period for five years** | | | | | | | | | | | | | | | | | |
| 16 | 0-30 | 8.18 | 9.00 | | 2.50 | 0.00 | 72.00 | 23.70 | 14.70 | 21.80 | 60.30 | 1.40 | 14.12 | 24.40 | 1.10 | 32.60 | 0.30 |
| | 30-70 | 8.15 | 9.30 | | 2.00 | 0.00 | 80.80 | 26.30 | 14.30 | 21.50 | 72.30 | 1.00 | 17.09 | 24.00 | 2.10 | 28.97 | 0.30 |
| | 70-95 | 8.80 | 9.60 | | 1.50 | 0.00 | 80.80 | 33.30 | 18.60 | 20.60 | 75.60 | 0.80 | 17.08 | 21.40 | 2.70 | 38.96 | 0.40 |
| | 95-120 | 8.20 | 12.80 | | 2.00 | 0.00 | 118.20 | 36.10 | 23.10 | 26.90 | 105.50 | 0.80 | 18.83 | 18.60 | 2.22 | 50.29 | 0.40 |
| | Mean | 8.19 | 10.8 | 77.17 | 2.00 | 0.00 | 87.95 | 29.85 | 17.67 | 22.70 | 78.43 | 1.00 | 16.78 | 22.10 | 2.03 | 37.21 | 0.35 |
| **Cultivation period for fifteen years** | | | | | | | | | | | | | | | | | |
| 17 | 0-30 | 8.00 | 8.10 | | 2.25 | 0.00 | 75.30 | 24.85 | 13.20 | 21.00 | 66.70 | 1.50 | 16.13 | 28.60 | 1.20 | 23.72 | 0.50 |
| | 30-60 | 8.12 | 8.60 | | 2.50 | 0.00 | 78.40 | 24.90 | 16.20 | 19.50 | 69.10 | 1.00 | 16.36 | 22.80 | 2.20 | 24.32 | 0.40 |
| | 60-90 | 8.20 | 9.10 | | 1.50 | 0.00 | 80.50 | 34.60 | 17.00 | 19.20 | 79.70 | 0.70 | 18.73 | 21.00 | 1.88 | 38.66 | 0.40 |
| | 90-120 | 8.28 | 10.90 | | 1.50 | 0.00 | 107.75 | 29.99 | 19.43 | 19.64 | 99.58 | 0.60 | 21.15 | 19.60 | 1.88 | 40.79 | 0.40 |
| | Mean | 8.15 | 9.18 | 80.59 | 1.94 | 0.00 | 85.49 | 28.59 | 16.46 | 19.84 | 78.77 | 0.95 | 18.09 | 23.00 | 1.79 | 31.87 | 0.43 |
| **Cultivation period for thirty years** | | | | | | | | | | | | | | | | | |
| 18 | 0-20 | 8.10 | 7.30 | | 3.00 | 0.00 | 68.90 | 20.10 | 18.10 | 20.10 | 52.10 | 1.70 | 11.92 | 26.80 | 1.24 | 23.39 | 0.40 |
| | 20-50 | 8.11 | 7.90 | | 4.00 | 0.00 | 70.30 | 27.50 | 19.40 | 19.40 | 61.20 | 1.80 | 13.89 | 24.60 | 1.31 | 20.77 | 0.40 |
| | 50-90 | 8.12 | 9.50 | | 2.50 | 0.00 | 90.50 | 35.20 | 22.80 | 24.40 | 80.10 | 0.90 | 16.49 | 23.60 | 1.42 | 30.32 | 0.30 |
| | 90-120 | 8.15 | 10.90 | | 2.50 | 0.00 | 94.10 | 34.30 | 24.00 | 23.10 | 82.90 | 0.90 | 17.08 | 83.40 | 1.76 | 54.62 | 0.20 |
| | Mean | 8.12 | 8.90 | 81.18 | 3.00 | 0.00 | 80.95 | 29.28 | 21.08 | 21.75 | 69.08 | 1.32 | 14.85 | 24.60 | 1.43 | 32.28 | 0.32 |
| **Cultivation period for fifty years** | | | | | | | | | | | | | | | | | |
| 19 | 0-30 | 8.00 | 7.10 | | 3.00 | 0.00 | 52.80 | 25.70 | 13.80 | 13.20 | 52.80 | 1.70 | 14.37 | 32.00 | 0.29 | 19.48 | 0.50 |
| | 30-60 | 8.10 | 7.70 | | 2.50 | 0.00 | 58.40 | 29.01 | 18.40 | 15.11 | 55.10 | 1.30 | 13.46 | 27.20 | 1.95 | 23.32 | 0.30 |
| | 60-90 | 8.15 | 9.10 | | 2.50 | 0.00 | 80.20 | 28.52 | 21.68 | 15.74 | 72.80 | 1.00 | 16.83 | 24.80 | 1.52 | 31.34 | 0.30 |
| | 90-120 | 8.15 | 10.30 | | 2.00 | 0.00 | 98.00 | 25.84 | 22.04 | 24.24 | 78.56 | 1.00 | 16.33 | 21.60 | 1.79 | 51.91 | 0.30 |
| | Mean | 8.10 | 8.98 | 81.01 | 2.50 | 0.00 | 72.35 | 27.27 | 18.98 | 17.07 | 64.82 | 1.25 | 15.25 | 26.40 | 1.39 | 31.51 | 0.35 |

**Table (5):** Chemical analyses of irrigation water samples collected from studied area.

| Irrigation water samples | pH | EC, dS/m | Soluble anions, meq/L | | | | Soluble cations, meq/L | | | | SAR | Irrigation water type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $HCO^-_3$ | $CO_3^{--}$ | $Cl^-$ | $SO_4^{--}$ | $Ca^{++}$ | $Mg^{++}$ | $Na^+$ | $K^+$ | | |
| Al-Halafy Canal | 7.3 | 0.8 | 2.5 | 00 | 2.9 | 2.0 | 2.4 | 1.2 | 3.2 | 0.6 | 2.39 | Fresh water |
| Al-Ghabat Canal | 7.4 | 0.7 | 2.0 | 00 | 2.4 | 1.0 | 1.8 | 0.8 | 2.7 | 0.1 | 2.37 | Fresh water |
| Al-Daramally Canal | 7.4 | 0.8 | 2.0 | 00 | 3.2 | 2.1 | 2.5 | 1.2 | 3.0 | 0.6 | 2.21 | Fresh water |
| Al-Mansour Canal | 7.7 | 1.5 | 4.4 | 00 | 7.4 | 1.8 | 2.9 | 2.2 | 6.3 | 2.2 | 3.95 | Blended water |
| Kom Al-Teen canal | 8.0 | 3.2 | 3.2 | 00 | 22.3 | 0.1 | 4.0 | 5.6 | 17.2 | 0.4 | 7.85 | Blended water |

locations. This trend can be attributed to that, both surface and subsurface layers received large amounts of plant residues and organic manure which decomposed by soil organisms resulted in release of several organic acids (**Abd El-Aal, 1994**). **Mahmoud *et al.* (2001)** reported that application of gypsum and sulphur alone or in combination with FYM improved some soil proprieties and fertility status (i.e. soil pH, ECe, ESP, CEC and OM content). These results are similar with those obtained by **Tripthi *et al.* (1994), Verma *et al.* (1994) and Tiwari *et al.* (1995)**. Also, data revealed that the pH values increased with the soil depth. This resulted from the relative high organic matter and gypsum addition to the surface layers compared with the lower layers. In this respect **Abou Husien (1999)** reported that the pH values increased with the soil depth, as well as, the decrease of the organic carbon content.

Concerning the effect of drainage system on soil pH values, data in Tables (4a and 4b) showed that, the pH mean values, of soils under tile drainage were lower than that under open drainage. Where the pH mean values were 8.10, 8.05, 8.02 and 7.89 for profiles (2, 3, 4 and 5), respectively, which represent 5, 15, 30 and 50 years of cultivation periods respectively, for soils under the tile drainage. On the other hand, it was 8.16 for virgin soil (profile 1). The mean values of soil pH were 8.19, 8.17 an 8.03 for, profiles 7, 8 and 9, respectively which represent soils after 5, 15 and 30 years of cultivation periods, respectively for soils served by open drainage. These results are in harmony with those obtained by **Abou Hussien and Abou El-Khir (1999)** who reported that, the decrease of pH values of soil under tile drainage, resulted from improving leaching of soluble sodium salts and calcium replacing exchangeable sodium.

With respect to irrigation water type effect, data in Tables (4a and 4b) showed that, there was slight effect on soil pH values, due to irrigation water sources. Where the pH mean values of soil irrigated by fresh water were 8.16, 8.10,8.05, 8.02 and 7.89 for profiles, 1, 2, 3, 4 and 5, respectively, at 0, 5, 15, 30 and 50 years of cultivation periods, respectively. While the pH values were 8.28, 8.15, 8.14, 8.09 and 7.93 in profiles No. 10, 11, 12, 13 and 14, respectively, at the forecited cultivation periods for the soils which irrigated with blended water.

**5.1.3.2. Soil salinity (ECe, dS/m):**

Data in Tables (4a and 4b), show the effect of different agricultural practices on salt content in the soil, expressed as electrical conductivity (EC, dS/m). The soil salinity decreased with increasing cultivation periods. Where EC mean values ranged from 41.80 to 52.80 dS/m, for virgin soils (Profiles 6 and 1), while they ranged from 5.88 to 8.98 after 50 years of cultivation periods, profiles (5 and 19).

Regarding the effect of drainage system on soil EC values, data in Tables (4a and 4b) and Fig. (9) revealed that, the mean values of ECe for soils under tile drainage, were lower than those obtained under open drainage, along the different cultivated periods. Where the mean values of ECe for soils, under tile drainage decreased by 83.15, 83.64, 84.43 and 84.52% of the initial state after 5, 15, 30 and

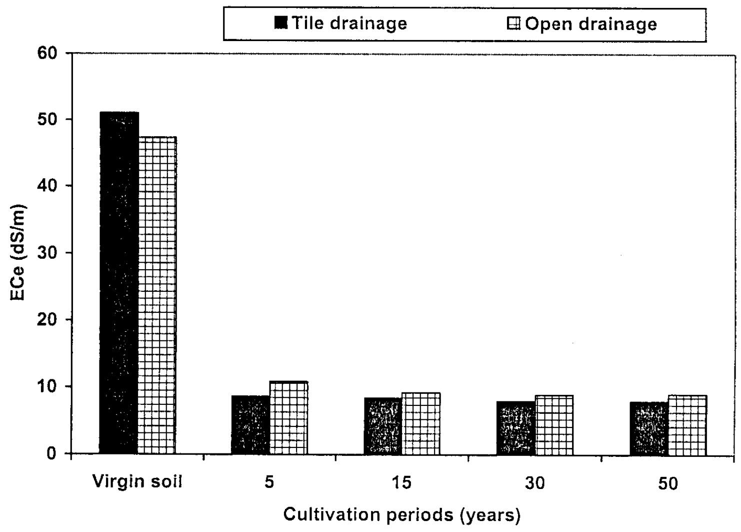


Fig. (9): Effect of drainage system on soil salinity (ECe).

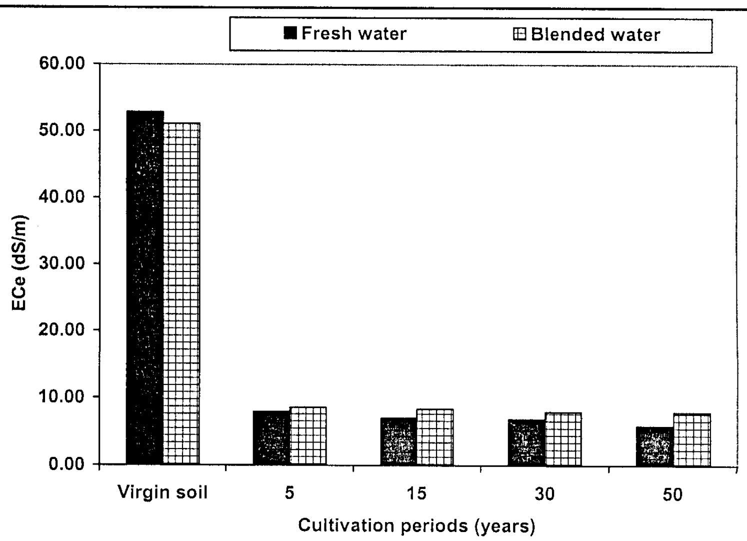


Fig. (10): Effect of irrigation water types on soil salinity (ECe).

50 years cultivation periods, as recorded in profiles 11, 12, 13 and 14, respectively. While it decreased by 77.17, 80.59, 81.18 and 81.01% of the initial state, for soils under open drainage, at the same cultivation period as achieved in profiles 16, 17, 18 and 19, respectively. This might be due to the high efficiency of leaching of salts out of soil profiles, in the presence of tile drainage system. These results were similar with that obtained by **Moustafa *et al.* (1990) and El-Shanawany *et al.* (2000)**. They indicated that application of gypsum and subsoiling under tile drainage of 25 m spacing, reduced the ECe values of soil surface, with the percentages of 20% and 53.36% of the initial state, during the studied two seasons, respectively.

Concerning the effect of irrigation water types on soil salinity, data in Tables (4a and 4b) and Fig. (10) showed that, the mean values of ECe of soils, irrigated by fresh water have lower values, than those irrigated by blended water. Where the mean values of soil salinity irrigated by fresh water, decreased by 84.94, 86.72, 87.06 and 88.86% of the initial state after 5, 15, 30 and 50 years cultivation period, as in profiles 2, 3, 4 and 5, respectively. While it decreased by 77.17, 80.59, 81.18 and 81.01% of the initial state for soils irrigated by blended water, at the same cultivation period, which achieved in profiles (16, 17, 18 and 19), respectively. It could be attributed to high salt content of blended water than fresh water, where ECe of fresh irrigation water, ranged between 0.7 and 0.8 dS/m, while it ranged between 1.5 and 3.2 dS/m for blended irrigation water (Table 5). These results were similar with those obtained by **Abo-Soliman *et al.* (1992), Sobh *et al.* (1997), El-Henawy (2000), Omar *et al.* (2001) and Gazia (2001)**.

**5.1.3.3. Soil alkalinity (ESP):**

Data in Tables (4a and 4b), show the effect of different agricultural practices on soil sodicity, expressed as (ESP). The ESP values generally decreased, with increasing cultivation periods. Where the mean values of ESP ranged between 44.79 and 59.49%, for virgin soils that in recorded profiles (1 and 10). While it ranged between 17.02 and 31.51% for soils cultivated for 50 years as recorded in profiles (5 and 19).

With respect to drainage system effect, the soil under tile drainage system have the mean values of ESP, lower than those obtained under open drainage, at different cultivation periods. Data in Tables (4a and 4b) and Fig. (11) showed that, the ESP mean values were 56.42, 32.61, 30.32 and 18.77%, for soil served by tile drainage for 0, 5, 15 and 30 years of cultivation period, as in profiles 1, 2, 3, and 4, respectively. While they were 56.71, 37.11, 32.53 and 22.92% for soil served by open drainage, for profiles (6, 7, 8 and 9), respectively at the same periods of cultivation.

This may be due to the higher efficiency of leaching of salts, especially, $Na^{+}$ and $Mg^{++}$ out of soil profiles in the case of tile drainage, than that under open drainage. These results are in harmony with those obtained by **Moustafa *et al.* (1990) and Faltas *et al.* (1991).** They reported that, the ESP values decreased during the first year after tile drainage installation, for all drain spacing and

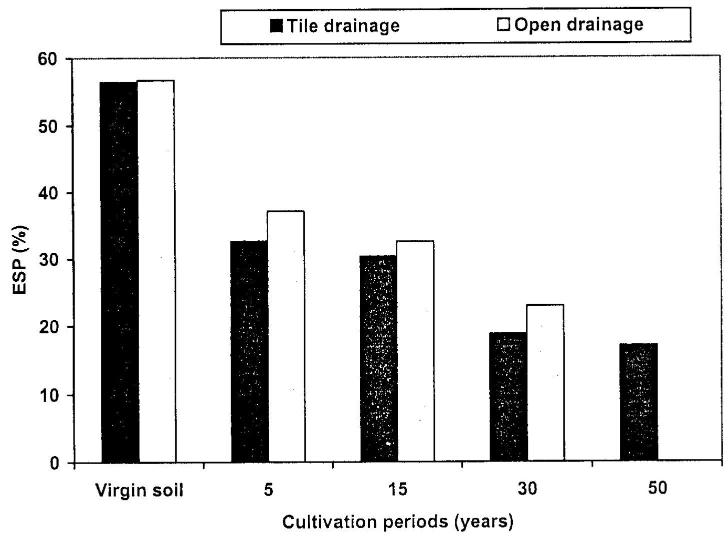


Fig. (11): Effect of drainage system on soil alkalinity (ESP).

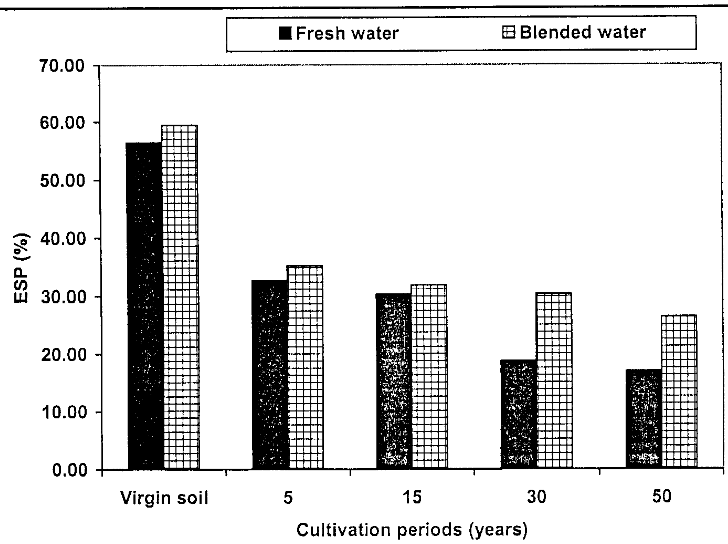


Fig. (12): Effect of irrigation water types on soil alkalinity (ESP).

soil depth. Concerning the effect of irrigation water sources on soil alkalinity (ESP), data revealed that ESP mean values had taken the same trend for ECe mean values. The magnitude of decrease of ESP values, with increasing the cultivation period had been highly pronounced in soils irrigated by fresh water, than those irrigated by blended water. This could be due to increase of soluble sodium content in blended water than fresh water, where the soluble sodium in fresh water ranged from 2.7 to 3.2 meq/L while it ranged from 6.3 to 17.2 meq/L for blended water, and SAR in fresh water ranged from 2.21 to 2.39 while it ranged from 3.95 to 7.85 for blended water Table (5). These results were in agreement with those obtained by **Omar *et al.* (2001), Gazia (2001), Zein *et al.* (2002) and Hassan *et al.* (2003)**. In this respect **Habib (1999)** reported that, soil irrigated with mixed water and/or drainage water, have significant increase of soil ESP as compared with that received canal water, especially, at surface soil layers. He attributed this effect to the equilibrium between the soluble and exchangeable cations, and the redistribution of cations on the colloidal complex.

**5.1.3.4. Sodium adsorption ratio (SAR):**

Values of sodium adsorption ratio (SAR), varied widely in the studied area, it ranged from 12.21 in profile (No. 4) to 58.03 in profile No. 15. Also the values of SAR in profiles representing cultivated soil ranged between (12.21-23.73), while those in the virgin soils ranged between (41.90-58.03), as shown in Tables (4a and 4b), indicating clearly that, cultivation practices cause decreasing of SAR values, which could be attributed to the leaching of sodium salts more rapidly, due to their higher solubility and mobility, than calcium and magnesium salts. Moreover, addition of manures and $Ca^{++}$ and $Mg^{++}$-bearing fertilizers, results in raising their concentration, and consequently lowering SAR value.

Data in Tables (4a and 4b) reveal the impact of cultivation periods on SAR, there are irregular decrease in SAR values with increasing cultivation period, where SAR values decreased from 46.58 (profile 1) to 12.83 (profile 5), from 41.90 (profile 6) to 15.2 (profile 9), from 43.10 (profile 10) to 15.34 (profile 14) and from 58.03 (profile 15) to 15.25 (profile 19) at different locations.

Concerning the effect of different drainage systems on SAR values, data in Tables (4a and 4 b) showed that the SAR values under tile drainage, ranged between 12.21 (profile 4) and 17.15 (profile 12) while, it ranged between 14.85 (profile 18) and 18.09 (profile 17), under open drainage system. This effect could be ascribed to the differential leaching of soluble cations, i.e. $Ca^{++}$, $Mg^{++}$ and $Na^{+}$. The continuous flow of drainage water under tile drainage, may cause an increase of the leaching rate of $Na^{+}$, over both $Ca^{++}$, $Mg^{++}$. These results were in harmony with those obtained by **Abou Hussien and Abou El-Khir (1999) and Shams El-Din (2001)**.

Data in Tables (4a and 4 b) showed that, soils irrigated by fresh water attained lower SAR values, it ranged from 12.21 (profile 4) to 16.70 (profile 7), while soil irrigated by blended water attained higher SAR values, and ranged from 14.85 (profile 18) to 18.09 (profile 17). These results were in agreement with **Sobh *et al.* (1997), El-Henawy (2000) and Hassan *et al.* (2003)** who decided that, the irrigation with waters of low quality, significantly increased the soluble $Na^+$ and $K^+$ but decreased the soil soluble $Ca^{++}$ and $Mg^{++}$.

**5.1.3.5. Re-distribution of soil soluble cations and anions:**

Reference to the data in Tables (4a and 4b), it could be stated that, sodium was the prevailed soluble cation in all studied areas. There was a great increase of Na content of both surface and subsurface soil layers, in areas irrigated with the mixed water which, resulted a significantly build up of soil soluble $Na^+$ as compared with the area irrigated by fresh water.

The other soluble cations of $Ca^{++}$, $Mg^{++}$ and $K^+$ contents, had the same trend for $Na^+$. The concentration of soluble cations in the studied areas were in the following descending order $Na^+ > Mg^{++} > Ca^{++} > K^+$. . In some soil profiles soluble $Ca^{++}$ exceeded the soluble $Mg^{++}$, particularly in the soils adjacent to the Burulus lake.

Regarding the content and distribution of anions, data show that, $Cl^-$ represent the dominant soluble anions, followed by $SO^{--}_4$ through the tested soil profiles. Bicarbonate ($HCO^-_3$) ions were relatively lower than $Cl^-$ and/or $SO^{--}_4$ ions (Tables 4a and 4 b). The concentration of both $Cl^-$ and $SO^{--}_4$ were relatively increased with depth of studied profiles.

Concerning the effect of cultivation periods on both soluble cations and anions, data showed a decrease of soluble cations and anions with increasing cultivation periods, parallel to ECe values, as shown in Tables (4a and 4b). For example the soluble $Na^+$ decreased from 468.75 meq/L in the virgin soil (profile No. 1), to 34.98 meq/L after 50 years of cultivation (profile No. 5). This may be due to leaching of $Na^+$ salts out of soil profiles, which highly induced with agricultural practices during the prolonged time.

Regarding the effect of drainage system on soil salts, data in Tables (4a and 4b) revealed that soils served by tile drainage have lower salt content, compared with soil served by open drainage. Comparison of profile No. 14 which represents soil cultivated for 50 years, in the presence of tile drainage with profile No. 19, represented soils under open drainage for the same period of cultivation, showed noticeable decreases of soluble cations and anions under tile drainage, compared to open drainage (Tables 4a and 4b).

Data also revealed that the soil irrigated by fresh water, have mean values of cations and anions lower than that irrigated by blended water, Tables (4a and 4b), as shown in comparison between profile No. 5 and profile No. 14. This may be attributed to the higher salts in blended irrigation water than those in fresh water (Table 5).

**5.1.3.6. Total calcium carbonate:**

The distribution of total carbonates in the studied soil profiles is presented in Tables (4a and 4b). The results indicated that the total carbonates varies widely from 0.29 to 2.55% in profiles No. 19 and 9 in the surface horizons, and from 0.44 to 3.90% (profiles 8 and 7) in most of the subsurface ones. Data showed that there was no general trend for total carbonate distribution with depth within tested profiles.

With respect to the influence of cultivation periods on calcium carbonate content, data in Tables (4a and 4b) revealed that total carbonate contents in virgin soils, was relatively higher than most the cultivated soils with different agricultural practices. This could be assigned to the presence of continuous supply of H-ions and organic acids in the cultivated soils, which originated from roots and/or organic manures decompositions, and consequently enhance the carbonate transformation into a more soluble form (**Soliman, 1982 and Abd El-Aal, 1994**).

The decrease in total $CaCO_3$ content was clear in the surface layers as OM content increased **Sangwan and Singh (1993), Tripathi *et al.* (1993) and El-Maaz (1997)**. Data also revealed the effect of drainage system on soil $CaCO_3$ content, where there were slight decrease in soil $CaCO_3$ % content values in soils under the tile drainage condition, compared to soils under open drainage. Where the mean values of $CaCO_3$ content in profiles 2, 3, 4, 5, 11, 12, 13 and 14, which represent the soils under tile drainage were little lower than that in profiles 7, 8, 9, 16, 17, 18 and 19. This may be due to the high leaching and drainage efficiency, which may slightly enhance the solubility of $CaCO_3$, due to dilution with continuos water flow (**Gendy, 2001**). Data in Tables (4a and 4b) showed also that, the mean values of $CaCO_3$ content in soils irrigated by fresh water, were lower than those obtained in soils irrigated by blended water. It could also be ascribed to the cultivation effect of fresh water, which contains lower content of salts compared to blended water. Fresh water also encourages vegetation to grow really and produces enough amounts of $CO_2$ that increases $CaCO_3$ solubility.

**5.1.3.7. Cations exchange capacity (CEC):**

The cation exchange capacity (CEC) of the soils is generally, considered to be related entirely to clay, fine silt fractions and organic matter contents. Data in Tables (4a and 4b) revealed that CEC values vary from profile to another, and from layer to another through the same profile, where the mean values of CEC ranged between 22.30 cmol $kg^{-1}$ (profile 10) to 33.65 cmol $kg^{-1}$ profile 5). With respect to the influence of cultivation periods, data showed that CEC values increased with increasing cultivation periods, where increased from 25.3 cmol $kg^{-1}$ (profile 1) for virgin soil, to 33.65 cmol $kg^{-1}$ (profile 5) for soil after 50 years of cultivation period. This effect is mainly due to the relative increase of organic matter and fine fraction (clay and silt) contents, under cultivation conditions. These results were in agreement with **Rabie *et al.* (1988)** who reported that, soil cultivated for 30 years led to increase in OM content, and consequently CEC, and a decrease in the soil salinity (ECe). Concerning the effect of drainage system on CEC, data showed that, the mean values of CEC for soils under tile drainage were higher than those obtained under open drainage as shown in Tables (4a and 4b).

Data also revealed that the soil irrigated by fresh water have a higher values of CEC than that irrigated by blended water, at the different cultivation periods. It could be attributed to the influence of fresh water on accumulation of organic matter for the healthy grown crops **El-Toukhy, 1987** reported that salinity of blended water may affect the activities of microorganisms responsible for decomposition of organic mater.

**5.1.3.8. Gypsum content:**

Gypsum is present in minor amount in all of the studied profiles, as shown in Tables (4a and 4b). The values of gypsum content in surface layers ranged from 0.2 to 0.6%, while it ranged from 0.2 to 1.10% in the subsurface layers. There is no evident relation between gypsum and the studied agricultural practices. In this respect, **Abdel-Mottelb and Hussein (1985)** stated that, gypsum concentration less than 5% has no negative effect on soil quality.

**5.1.4. Effect of the studied agricultural practices on the fertility status:**

**5.1.4.1. Organic matter (OM%):**

Data in Tables (6a and 6b) show that the organic matter contents (%) were generally low, and varies between 0.47% and 2.24% in the surface horizons of the studied profiles, while it varied from 0.36% to 1.79% at the subsurface. The results are expected in arid climatic condition, which encourage organic matter decomposition. However, it can be stated that, organic matter content was relatively higher in cultivated soils, where ranged from 0.60% in subsurface layer in profile 17, to 2.24% in surface layer in profile (4), compared to virgin soil that ranged from 0.36% in subsurface layer of profile (10), to 1.34% in surface layer of profile (6). This may be due to the continuous addition of manures and/or accumulation of plant residues in cultivated soils. Also, soil organic matter content increased with increasing the cultivation period. These results are in harmony with obtained by **Tiwari *et al.* (1995)**.

With respect to the influence of drainage system on the soil organic matter, data in Tables (6a and 6b) showed that, organic matter contents (OM) for soil served by tile drainage, were relatively little higher than that for soil served by open drainage along the consecutive periods. The improvement of either soil chemical or physical properties, which enhanced the plant growth and then residues to the soils subjected under tile drainage compared to open drainage.

Data revealed that soil irrigated by fresh water have relatively higher OM content than that irrigated by blended water (Tables 6a and 6b), where the mean values of OM% for soil irrigated by fresh water, mostly exceeded those in the case of using low quality of irrigation water (blended water), at the different periods of cultivation. It could be ascribed to the impact of saline water on the plant growth, due to the deterioration of both physical and chemical properties of soils, irrigated by blended water. These results were in harmony with those obtained by **Omar *et al.* (1990) and Tiwari *et al.* (1995)**, who reported that, the continuous addition of manure and/or accumulation of plant residues in the cultivated soils, led to increase of soil organic matter content.

**5.1.4.2. Available macro and micronutrients:**

**5.1.4.2.1. Macronutrients:**

Data in Tables (6a and 6b) show wide variations in the available macronutrients content, in the studied soil profiles in the surface layers, where it ranged from 15.16 ppm to 58.56 ppm for profiles No. 10 and 21 for N, from 5.25 ppm to 13.89 ppm for profiles No. 6 and 21 for P and from 360 ppm to 690 ppm for profiles No 14 and 6, respectively for K. According to **Hamissa *et al.* (1993)** Egyptian soils are considered to be deficient in macronutrients, when the available contents are less than 40 ppm for Nitrogen, 10 ppm for phosphorus and 200 ppm for potassium.

**Table (6a):** Soil fertility status in Al-Zawea region. (a) Fresh irrigation water under tile drainage system

| Prof. No. | Depth, cm | OM % | Available macronutrients (ppm) | | | DTPA extractable micronutrients (ppm) | | | | Exchangeable Ca & Mg (cmol/kg) | | Ca & Mg increase % | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | N | P | K | Fe | Mn | Cu | Zn | Ca | Mg | Ca | Mg |
| **Virgin soil** | | | | | | | | | | | | | |
| 1 | 0-30 | 0.59 | 19.16 | 6.27 | 630.00 | 7.25 | 5.08 | 3.62 | 1.08 | 9.28 | 4.17 | | |
| | 30-60 | 0.50 | 11.01 | 4.07 | 540.00 | 6.42 | 3.06 | 3.66 | 0.60 | 4.02 | 3.90 | | |
| | Mean | 0.55 | 15.09 | 5.17 | 585.00 | 6.84 | 4.07 | 3.64 | 0.84 | 6.65 | 4.04 | 0 | 0 |
| **Cultivation period for five years** | | | | | | | | | | | | | |
| 2 | 0-30 | 1.18 | 29.18 | 8.81 | 547.40 | 12.40 | 8.09 | 2.72 | 1.10 | 9.40 | 7.20 | | |
| | 30-60 | 1.07 | 24.06 | 6.10 | 531.80 | 9.40 | 4.52 | 2.40 | 0.42 | 8.32 | 8.04 | | |
| | Mean | 1.13 | 26.62 | 7.46 | 539.60 | 10.90 | 6.31 | 2.56 | 0.76 | 8.86 | 7.62 | 33.20 | 88.60 |
| **Cultivation period for fifteen years** | | | | | | | | | | | | | |
| 3 | 0-30 | 1.86 | 32.69 | 9.15 | 477.00 | 14.09 | 9.10 | 4.32 | 1.80 | 9.46 | 7.21 | | |
| | 30-60 | 0.70 | 21.71 | 7.12 | 406.60 | 8.13 | 5.10 | 2.38 | 0.44 | 8.32 | 8.04 | | |
| | Mean | 1.28 | 27.20 | 8.14 | 441.80 | 11.11 | 7.10 | 3.35 | 0.82 | 8.89 | 7.63 | 33.68 | 88.61 |
| **Cultivation period for thirty years** | | | | | | | | | | | | | |
| 4 | 0-30 | 2.24 | 36.78 | 11.19 | 371.50 | 13.14 | 10.30 | 4.42 | 1.10 | 16.03 | 13.00 | | |
| | 30-60 | 0.78 | 28.98 | 8.64 | 320.60 | 10.05 | 4.50 | 3.46 | 0.80 | 16.00 | 12.10 | | |
| | Mean | 1.51 | 32.88 | 9.92 | 346.05 | 11.60 | 7.40 | 3.94 | 0.95 | 16.01 | 12.55 | 140.00 | 211.00 |
| **Cultivation period for fifty years** | | | | | | | | | | | | | |
| 5 | 0-30 | 1.87 | 44.16 | 12.37 | 379.30 | 16.90 | 10.32 | 5.06 | 1.56 | 19.21 | 11.97 | | |
| | 30-60 | 1.62 | 37.45 | 10.15 | 281.50 | 7.25 | 8.78 | 3.92 | 1.18 | 18.94 | 9.07 | | |
| | Mean | 1.75 | 40.81 | 10.26 | 330.40 | 12.08 | 9.55 | 4.49 | 1.37 | 19.08 | 10.52 | 187.00 | 160.00 |

**Table (6a):** Continue. (b) Fresh irrigation water under open drainage system.

| Prof. No. | Depth cm | OM % | Available macronutrients (ppm) N | P | K | DTPA extractable micronutrients (ppm) Fe | Mn | Cu | Zn | Exchangeable Ca & Mg (cmol/kg) Ca | Mg | Ca & Mg increase % Ca | Mg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Virgin soil** | | | | | | | | | | | | | |
| 6 | 0-30 | 1.34 | 15.90 | 5.25 | 690.00 | 6.68 | 4.20 | 4.42 | 2.52 | 6.90 | 5.10 | | |
| | 30-60 | 0.88 | 15.40 | 4.58 | 580.00 | 7.20 | 3.94 | 3.56 | 0.86 | 5.11 | 3.50 | | |
| | Mean | 1.11 | 15.65 | 4.92 | 635.00 | 6.94 | 3.97 | 3.99 | 1.69 | 6.01 | 4.30 | 0 | 0 |
| **Cultivation period for five years** | | | | | | | | | | | | | |
| 7 | 0-25 | 1.48 | 21.94 | 7.46 | 531.76 | 12.80 | 9.14 | 5.06 | 0.58 | 8.16 | 8.12 | | |
| | 25-60 | 1.09 | 20.34 | 5.93 | 496.57 | 7.10 | 7.26 | 3.42 | 0.30 | 6.08 | 6.37 | | |
| | Mean | 1.29 | 21.14 | 6.70 | 514.17 | 9.95 | 8.20 | 4.24 | 0.44 | 7.12 | 7.24 | 18.00 | 68.40 |
| **Cultivation period for fifteen years** | | | | | | | | | | | | | |
| 8 | 0-40 | 1.83 | 36.33 | 9.66 | 490.00 | 17.90 | 12.70 | 5.50 | 0.58 | 12.73 | 8.77 | | |
| | 40-80 | 0.90 | 26.06 | 7.46 | 412.00 | 9.77 | 5.52 | 4.74 | 0.46 | 6.92 | 6.37 | | |
| | Mean | 1.37 | 31.20 | 8.56 | 451.00 | 13.84 | 9.11 | 5.12 | 0.52 | 9.83 | 7.57 | 64.00 | 76.00 |
| **Cultivation period for thirty years** | | | | | | | | | | | | | |
| 9 | 0-30 | 1.70 | 42.12 | 11.02 | 380.00 | 21.96 | 12.70 | 5.58 | 0.90 | 8.60 | 8.03 | | |
| | 30-60 | 1.10 | 29.74 | 8.14 | 346.00 | 11.97 | 6.40 | 5.22 | 0.58 | 9.00 | 8.49 | | |
| | Mean | 1.40 | 35.93 | 9.58 | 363.00 | 16.96 | 9.55 | 5.40 | 0.74 | 8.80 | 8.26 | 46.00 | 92.00 |

**Table (6b):** Soil fertility status in Al-Mansur west region.
a) Blended irrigation water under tile drainage system.

| Prof. No. | Depth, cm | OM % | Macronutrients (ppm) N | P | K | DTPA extractable micronutrients (ppm) Fe | Mn | Cu | Zn | Exchangeable Ca & Mg (mol/kg) Ca | Mg | Ca & Mg increase % Ca | Mg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Virgin soil** | | | | | | | | | | | | | |
| 10 | 0-30 | 0.47 | 15.16 | 6.60 | 650.00 | 10.58 | 8.84 | 3.66 | 0.96 | 3.34 | 2.40 | | |
| | 30-60 | 0.36 | 15.00 | 5.30 | 580.00 | 9.80 | 5.86 | 3.64 | 0.16 | 5.90 | 3.80 | | |
| | Mean | 0.42 | 15.08 | 5.95 | 615.00 | 10.19 | 7.35 | 3.65 | 0.56 | 4.62 | 3.10 | 0 | 0 |
| **Cultivation period for five years** | | | | | | | | | | | | | |
| 11 | 0-30 | 1.20 | 32.15 | 9.00 | 578.00 | 11.85 | 8.78 | 3.10 | 1.44 | 10.00 | 8.65 | | |
| | 30-65 | 0.90 | 21.45 | 5.80 | 547.00 | 5.49 | 3.74 | 2.76 | 0.32 | 8.56 | 9.09 | | |
| | Mean | 1.05 | 26.80 | 7.40 | 563.00 | 8.67 | 6.26 | 2.93 | 0.88 | 9.28 | 8.87 | 101.00 | 186.00 |
| **Cultivation period for fifteen years** | | | | | | | | | | | | | |
| 12 | 0-30 | 1.35 | 28.87 | 10.50 | 492.00 | 13.50 | 7.68 | 4.20 | 1.40 | 11.23 | 9.35 | | |
| | 30-60 | 1.05 | 21.03 | 7.50 | 484.00 | 10.04 | 7.64 | 3.54 | 0.42 | 9.15 | 7.29 | | |
| | Mean | 1.20 | 25.95 | 9.00 | 488.00 | 11.77 | 7.66 | 3.87 | 0.91 | 10.19 | 8.32 | 121.00 | 168.00 |
| **Cultivation period for thirty years** | | | | | | | | | | | | | |
| 13 | 0-25 | 1.85 | 51.76 | 12.90 | 383.00 | 13.93 | 10.40 | 4.64 | 1.46 | 8.44 | 6.27 | | |
| | 25-55 | 0.95 | 26.90 | 10.30 | 344.00 | 10.05 | 5.20 | 3.26 | 0.82 | 9.14 | 7.52 | | |
| | Mean | 1.40 | 39.33 | 11.60 | 364.00 | 11.99 | 7.60 | 3.95 | 1.14 | 8.79 | 6.89 | 90.26 | 122.00 |
| **Cultivation period for fifty years** | | | | | | | | | | | | | |
| 14 | 0-30 | 2.08 | 56.48 | 13.60 | 360.00 | 18.49 | 12.10 | 6.44 | 1.62 | 10.68 | 5.81 | | |
| | 30-60 | 1.20 | 33.90 | 11.00 | 325.00 | 10.49 | 9.54 | 5.84 | 1.34 | 10.88 | 6.86 | | |
| | Mean | 1.64 | 45.19 | 12.30 | 342.50 | 14.49 | 10.82 | 6.14 | 1.48 | 10.78 | 6.34 | 133.00 | 104.50 |

**Table (6b): Cont.** (b) Blended irrigation water under open drainage system.

| Prof. No. | Depth, cm | OM % | Macronutrients (ppm) | | | Micronutrients (ppm) | | | | Exchangeable cations (mol/kg) | | Ca & Mg increase % | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | N | P | K | Fe | Mn | Cu | Zn | Ca | Mg | Ca | Mg |
| **Virgin soil** | | | | | | | | | | | | | |
| 15 | 0-30 | 1.00 | 17.06 | 6.95 | 680.00 | 9.69 | 11.36 | 4.30 | 0.94 | 6.30 | 4.32 | | |
| | 30-75 | 0.88 | 16.14 | 5.08 | 540.00 | 9.18 | 4.66 | 3.56 | 0.50 | 8.20 | 6.21 | | |
| | Mean | 0.94 | 16.60 | 6.02 | 610.00 | 9.44 | 8.01 | 3.93 | 0.72 | 7.25 | 5.27 | 0 | 0 |
| **Cultivation period for five years** | | | | | | | | | | | | | |
| 16 | 0-30 | 1.56 | 32.70 | 8.31 | 586.60 | 11.44 | 10.98 | 5.50 | 0.90 | 8.11 | 7.93 | | |
| | 30-70 | 0.60 | 22.70 | 6.78 | 594.32 | 8.68 | 6.18 | 3.76 | 0.74 | 11.09 | 8.80 | | |
| | Mean | 1.08 | 27.70 | 7.55 | 590.46 | 10.06 | 8.58 | 4.63 | 0.82 | 9.60 | 8.37 | 32.41 | 58.80 |
| **Cultivation period for fifteen years** | | | | | | | | | | | | | |
| 17 | 0-30 | 1.60 | 29.50 | 10.51 | 508.30 | 12.83 | 10.62 | 5.00 | 092 | 11.20 | 8.22 | | |
| | 30-60 | 0.72 | 29.08 | 7.80 | 500.48 | 7.86 | 7.58 | 4.64 | 0.80 | 10.38 | 7.40 | | |
| | Mean | 1.16 | 29.29 | 9.16 | 504.34 | 10.34 | 9.10 | 4.82 | 0.86 | 10.79 | 7.81 | 48.83 | 48.20 |
| **Cultivation period for thirty years** | | | | | | | | | | | | | |
| 18 | 0-20 | 1.71 | 55.33 | 11.53 | 480.93 | 1439 | 11.36 | 5.34 | 0.96 | 9.20 | 8.23 | | |
| | 20-50 | 0.89 | 33.64 | 8.81 | 477.02 | 8.45 | 7.88 | 4.56 | 0.80 | 9.39 | 8.00 | | |
| | Mean | 1.30 | 44.49 | 10.17 | 478.98 | 11.42 | 9.62 | 4.95 | 0.88 | 9.29 | 8.12 | 28.13 | 54.00 |
| **Cultivation period for fifty years** | | | | | | | | | | | | | |
| 19 | 0-30 | 1.80 | 58.56 | 13.89 | 437.92 | 13.76 | 12.43 | 6.30 | 1.08 | 15.09 | 11.50 | | |
| | 30-60 | 1.20 | 39.47 | 10.17 | 445.74 | 9.56 | 7.29 | 3.90 | 0.84 | 10.39 | 9.30 | | |
| | Mean | 1.50 | 49.02 | 12.03 | 441.83 | 11.66 | 9.86 | 5.10 | 0.96 | 12.74 | 10.40 | 75.72 | 97.00 |

Regarding the effect of cultivation periods on soil macronutrients, data in Tables (6a and 6b) show that NPK contents were increased with increasing cultivation periods, under either tile drainage or open drainage (**Abou Hussien, 1999**). Where the mean values of soil N, P and K for virgin soil were 15.09, 5.17 and 585 ppm, respectively (profile 1), while they were 40.81, 10.26 and 330.40 ppm respectively, after 50 years of cultivation period (profile 5), under tile drainage system. There were the same trend for macronutrients for soils under open drainage system Tables (6a and 6b), in this respect **Beshay and Sallam (2001)** found that, the macronutrients increased as cultivation period increased and they attributed to farmyard manure and chemical fertilizer addition, as well as crops residues to the soils.

Data in Tables (6a and 6b) and Fig. (13) show that, available NPK exhibited a minor decrease in soil served by tile drainage, compared to open drainage. For example, the mean values of N, P and K for soil served by tile drainage were, 26.80, 7.40 and 563.0 ppm (Profile 11), at 5 years of cultivation, while they were 27.70, 7.55 and 590.46 ppm (profile 16), at the same period of cultivation under open drainage system. The available N, P and K values, under either tile and open drainage, had taken the same trend at different cultivation periods. This could be attributed to higher efficiency of leaching process, under tile drainage than open drainage. These results are in harmony with those obtained by **Abou-Hussien and Abou El-Khir (1999),** who reported that, the establishment of tile drainage system was accompanied by a loss of available NP and K.

With respect to the effect of irrigation water types on soil available macronutrients, data in Tables (6a and 6b) and Fig. (14), show that, the macronutrients content in soils which irrigated with

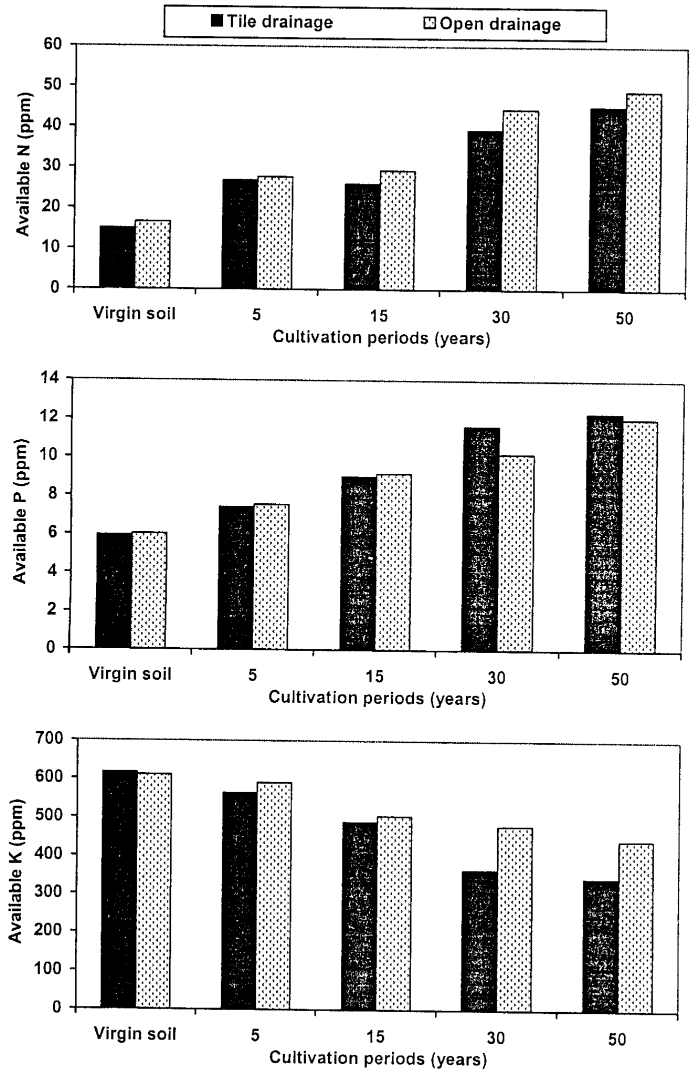


Fig. (13): Effect of drainage system on available NPK contents.

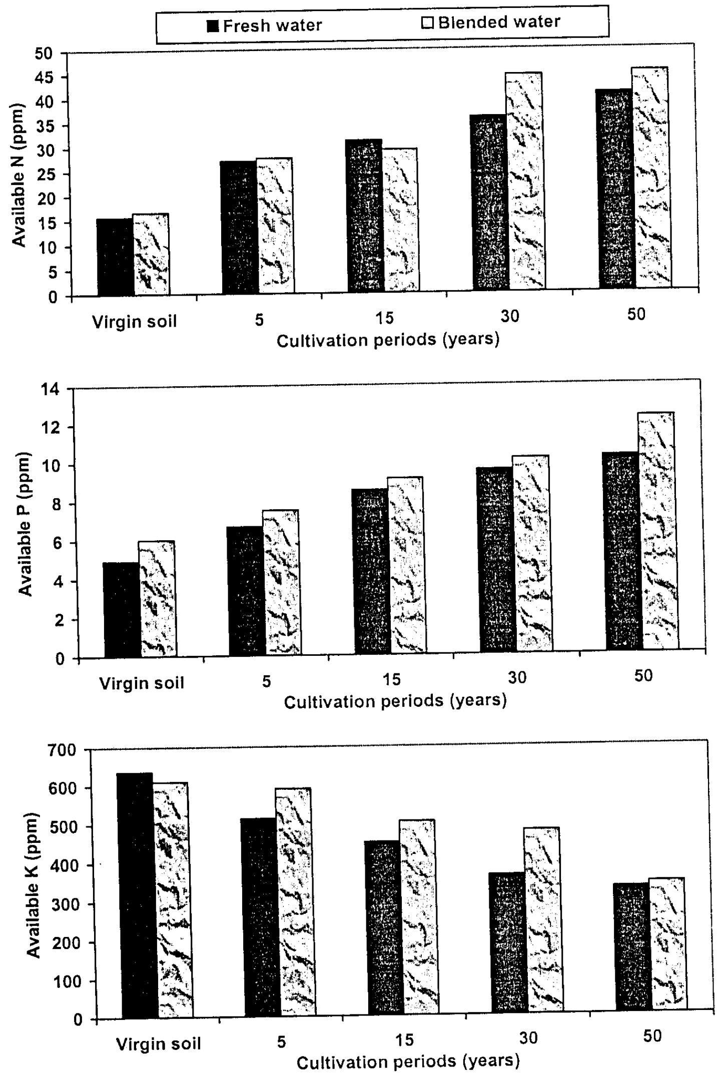


Fig. (14): Effect of irrigation water types on available NPK contents.

blended water, was higher than those irrigated with fresh water at different cultivation periods, where the mean values of N, P and K in the soil irrigated by fresh water were obviously lower than there irrigated by blended water, after the same period of cultivation (Fig. 14).

Data also revealed that, macronutrients content in the surface layers were higher than subsurface layers. This could be attributed to the higher content of added fertilizers and more organic matter in the surface layers, than subsurface layers. **Omar *et al.* (2001)** reported that irrigation with drainage water or blended water, increased the soil available NPK compared to fresh water after two crops, sugar beet and canola. Such increase was probably due to the high content of these elements in drainage water than fresh water

**5.1.4.2.2. Micronutrients:**

Data in Tables (6a and 6b) showed that, soil micronutrient contents (Fe, Mn, Zn and Cu), ranged between 6.4 and 33.99 ppm for Fe, 3.97 and 9.86 ppm for Mn, 2.56 and 6.14 ppm for Cu and between 0.44 and 1.87 ppm for Zn.

Results in Tables (6a and 6b), indicate that the soil micronutrients content increased with increasing cultivation period. These results were similar with those obtained by **Tripathi *et al.* (1994), El-Azab (1997) and Abou Hussien (1999),** who reported the increase of available micronutrients (Fe, Mn, Cu and Zn), with increasing of the cultivation period, may be resulted from the large amounts of those micronutrients which added to the soil, through the

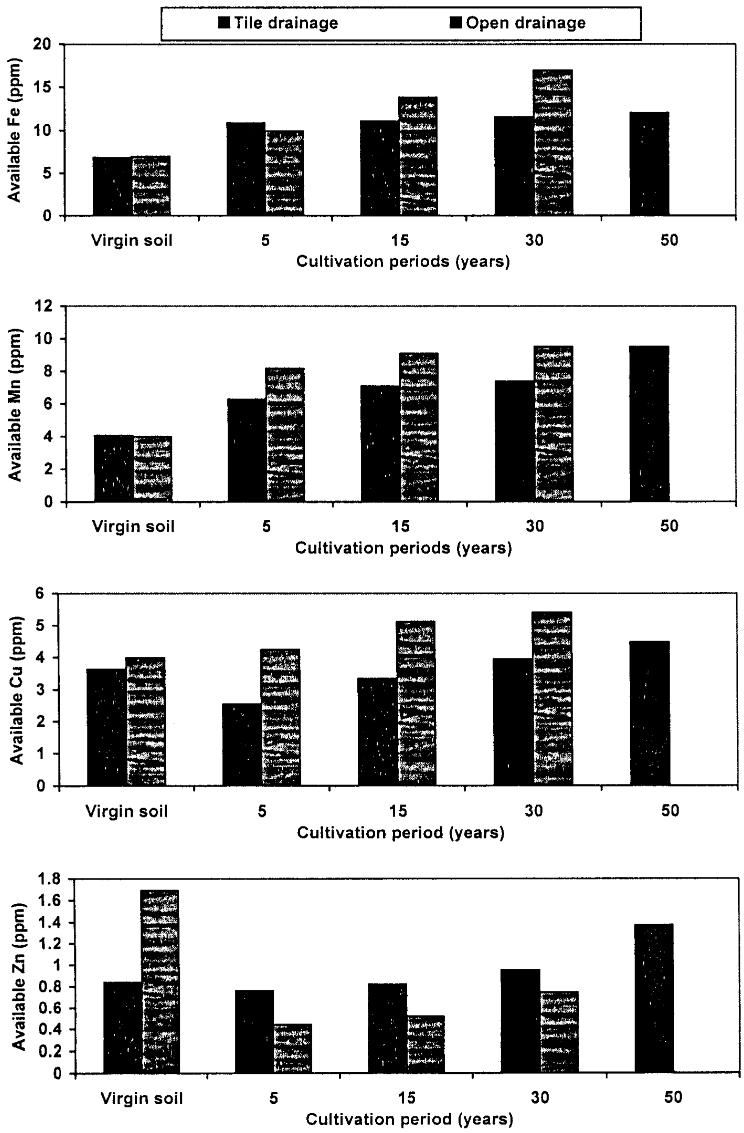


Fig. (15): Effect of drainage system on the amounts of soil micronutrients (Fe, Mn, Cu and Zn).

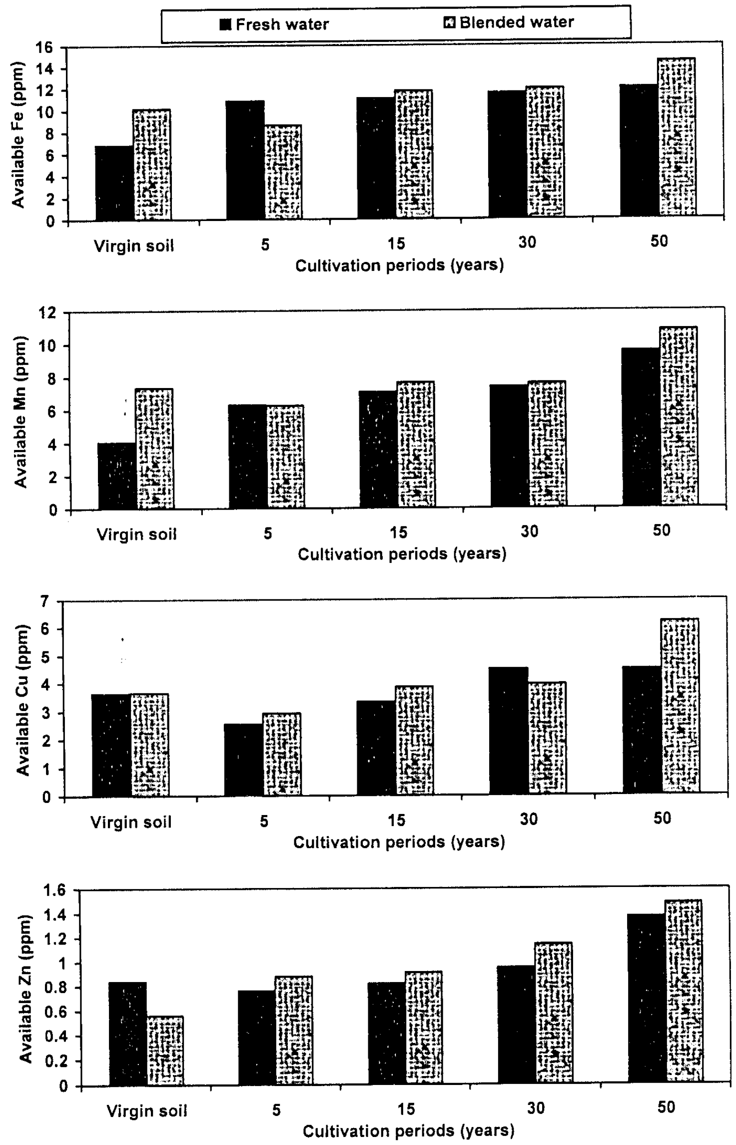


Fig. (16): Effect of irrigation water types on the amounts of soil micronutrients (Fe, Mn, Cu and Zn).

organic manure addition, and the application of mineral fertilizers to the plants, which used in large amounts in the later years.

Regarding the effect of drainage system on micronutrients contents, data in Tables (6a and 6b) and Fig. (15) showed that, soil under tile drainage have lower content of micronutrients (Fe, Mn, Cu and Zn), than those under open drainage system at the different periods of land cultivation. This may be attributed to higher efficiency in leaching of soluble ions including micronutrients from soil profile under tile drainage system than those under open drainage. These results were in harmony with those obtained by **Abou-Hussein and Abou El-Khir (1999)**, they pointed out that after the first year of the tile drainage establishment, the available content of the trace elements decreased such decrease was more clear in the surface layers of soil profile and in the soil profile above drains.

With respect to the effect of irrigation water type on the soil micronutrients content, data in Tables (6a and 6b) and Fig. (16) showed slightly increase in the mean values of micronutrients (Fe, Mn, Cu and Zn) in the soils that irrigated by blended water, than that irrigated by fresh water. This may be attributed to high content of elements in blended water than fresh water. These results were similar to those obtained by **Amira (1997) and Omar *et al.* (2001)**.

**5.1.4.3. Exchangeable Ca and Mg:**

Data revealed that exchangeable calcium ranged from 4.62 cmol $kg^{-1}$ (profile 10) to 7.25 cmol $kg^{-1}$ (profile. 15) in virgin soils, while exchangeable magnesium ranged from 3.10 cmol $kg^{-1}$ (profile 10) to 5.27 cmol $kg^{-1}$ (profile 15).

Data revealed that the cultivation tends to cause an increase in the exchangeable Ca and Mg, at the surface and subsurface layers. This trend could be ascribed mainly to the addition of manure, as well as, bearing calcium fertilizers.

Data in Tables (6a and 6b) showed that, exchangeable calcium in the soil served by tile drainage was more pronounced increase, than the soil served by open drainage. The increase was 140% in the soil served by tile drainage, while it was 46% in the soil served by open drainage, as shown in profiles (4) and (9), after 30 years of cultivation period. This may be attributed to the leaching efficiency, in the case of tile drainage, which increase the adsorption of calcium on the colloidal system, replacing Na which leached out with the drainage water.

Data also, showed that using fresh water for irrigation led to increase of exchangeable calcium, this increase was more clear in the soil irrigated by fresh water than blended water. The increase was 187% in the soil irrigated by fresh water, while it was 133% in the soil irrigated by blended water, after 50 years of cultivation period, as shown in profiles (5 and 14). Data also, indicated that, exchangeable magnesium take the same trend of exchangeable calcium but with a lesser extent.

## 5.2. Effect of fish farming on soil properties:

Fish farming has become one of considerable resource of agricultural income, large areas of the North Delta had been subjected under fish farming, due the fast reward of land use. It was recommended to use the virgin and highly saline soils as fish farms to leach salts out of the soil profiles. It was considered as one of techniques of leaching salts as continuous method under the flooding conditions of fish farms.

Unfortunately, nowadays large areas of highly productive agricultural lands turned into fish farms due to the higher income.

The question is, what soil is preferable to be used as fish farms? and to what extent the agricultural land can be used as fish farm?

To answer the abovementioned questions, fish farms had been considered as one of the agricultural practices common in the North Delta. It was valuable to under investigation. Four soil profiles were selected to study the influence of fish farming, on soil properties under the same prevailed conditions in a district areas. Profile 10 represents virgin soil, profile No. 12 represents soil cultivated for 15 years profile No. 20 represents soil subjected under fish farming for 15 years and profile No. 21 represents turning of cultivated soil for 15 years into fish farm for about 10 years. The effect of using soils as fish farms compared to the other agricultural practices were discussed in the following paragraphs.

**5.2.1. Physical properties:**

**5.2.1.1. Soil bulk density (*ρa*):**

Data in Table (7) and Fig. (17) revealed that, bulk density values in soils used as fish farms for 10 and 15 years, have lower values of bulk density than the virgin soils, while the lowest value of bulk density was obtained under soils cultivated for 15 years. This may be due to formation of great soil aggregations, and consequently formation of big voids, which led to decrement in soil bulk density. These results were in agreement with those obtained by **Abo-Soliman *et al.* (1992)** who stated that, soil organic matter increased due to the organic manure application, where organic matter acts as cementing materials, so the formation of aggregates and void ratio were increased and consequently the soil bulk density was decreased.

The soil which cultivated and then converted to fish farm for 10 years (Prof. No. 21), had the highest bulk density values, compared to the soil which was directly cultivated for 15 years, under the same agricultural conditions. These results were in agreement with those obtained by **El-Arquan and Abd El-Hafez (1982) and El-Henawy 2000**, who reported that bulk density increased from 1.54 to 1.71 g/cm$^3$ due to puddling process. On the other hand, the soil used as fish farms for about 15 years had bulk density value (1.30 g/cm$^3$), as in profile No. 20. While the soil cultivated for 15 years had low value of bulk density (1.13 g cm$^3$) for profile No. 12. These results were in agreement with those obtained by **Abd El-Hafez (1982)** who reported that bulk density values were relatively higher after harvesting in comparison to before planting.

**Table (7):** Effect of land use type (fish farming or/cultivation) and cultivation periods, on some physical properties.

| Profile No. | Depth, cm | ρa g/cm³ | SP % | Particle size distrib. Sand % | Silt % | Clay % | Texture Class | W.T. Depth, cm | S.F | K.S cm/h | Aggregation parameters WSA % | OSA, % | MWD, mm | AI | SC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Virgin soil** | | | | | | | | | | | | | | | |
| 10 | 0-30 | 1.323 | 94.04 | 20.44 | 36.57 | 42.99 | Clay | 90 | 16.19 | 0.35 | 23.30 | 12.90 | 0.24 | 0.12 | 0.31 |
| | 30-60 | 1.30 | 101.54 | 19.89 | 33.89 | 46.22 | Clay | | 7.25 | | 23.38 | 11.80 | 0.22 | 0.11 | 0.30 |
| | 60-90 | 1.40 | 94.49 | 23.24 | 37.96 | 47.40 | Clay | | 22.13 | | 22.70 | 10.40 | 0.20 | 0.10 | 0.29 |
| | 90-120 | 1.44 | 73.16 | 14.02 | 34.45 | 48.02 | Clay | | 32.59 | | 20.22 | 9.50 | 0.18 | 0.09 | 0.025 |
| | Mean | 1.37 | 90.81 | 19.40 | 34.45 | 46.15 | Clay | 90 | 19.54 | 0.35 | 22.40 | 11.15 | 0.21 | 0.11 | 0.29 |
| **Cultivated soils about 15 years** | | | | | | | | | | | | | | | |
| 12 | 0-30 | 1.10 | 83.91 | 16.06 | 34.39 | 49.55 | Clay | 85 | 26.86 | 0.50 | 39.20 | 17.15 | 0.39 | 0.20 | 0.64 |
| | 30-60 | 1.13 | 93.132 | 18.27 | 31.80 | 49.93 | Clay | | 24.37 | | 34.80 | 15.96 | 0.32 | 0.16 | 0.53 |
| | 60-90 | 1.16 | 109.06 | 17.73 | 30.36 | 51.91 | Clay | | 39.84 | | 30.40 | 13.35 | 0.29 | 0.15 | 0.44 |
| | 90-120 | 1.13 | 120.29 | 19.83 | 29.66 | 50.51 | Clay | | 36.49 | | 28.00 | 12.00 | 0.28 | 0.14 | 0.39 |
| | Mean | 1.13 | 101.60 | 17.97 | 31.55 | 50.48 | Clay | 85 | 31.85 | 0.50 | 33.10 | 14.62 | 0.32 | 0.16 | 0.50 |
| **Fish farming about 15 years** | | | | | | | | | | | | | | | |
| 20 | 0-30 | 1.28 | 79.15 | 18.26 | 32.71 | 49.03 | Clay | 78 | 24.73 | 0.35 | 27.50 | 17.50 | 0.31 | 0.16 | 0.38 |
| | 30-70 | 1.30 | 91.20 | 13.03 | 31.13 | 55.85 | Clay | | 27.80 | | 25.40 | 16.35 | 0.26 | 0.13 | 0.34 |
| | 70-95 | 1.29 | 112.70 | 17.62 | 35.31 | 47.07 | Clay | | 24.08 | | 24.00 | 16.04 | 0.23 | 0.12 | 0.32 |
| | 95-120 | 1.33 | 120.13 | 17.05 | 35.82 | 47.13 | Clay | | 25.39 | | 22.30 | 14.95 | 0.21 | 0.10 | 0.29 |
| | Mean | 1.30 | 100.80 | 16.49 | 33.74 | 49.77 | Clay | 78 | 25.50 | 0.35 | 24.80 | 16.10 | 0.25 | 0.13 | 0.33 |
| **Fish farming 10 years after cultivation about 15 years** | | | | | | | | | | | | | | | |
| 21 | 0-30 | 1.28 | 72.18 | 14.98 | 39.40 | 45.62 | Clay | 68 | 30.49 | 0.38 | 27.12 | 14.19 | 0.24 | 0.12 | 0.37 |
| | 30-75 | 1.30 | 86.33 | 13.20 | 29.16 | 57.64 | Clay | | 25.59 | | 25.15 | 11.03 | 0.22 | 0.11 | 0.34 |
| | 75-110 | 1.32 | 94.16 | 9.27 | 38.80 | 51.93 | :Clay | | 22.75 | | 16.45 | 12.39 | 0.19 | 0.10 | 0.20 |
| | Mean | 1.30 | 84.22 | 12.48 | 35.79 | 51.73 | Clay | 68 | 26.27 | 0.38 | 21.91 | 12.54 | 0.22 | 0.11 | 0.30 |

**5.2.1.2. Hydraulic conductivity Ks (cm/h):**

Data in Table (7) and Fig. (18) revealed that, the virgin soil and fish farming for 15 years had the lowest hydraulic conductivity value (0.35 cm/h). The hydraulic conductivity slightly increased with cultivated soil that converted to fish farming, for about 10 years (0.38 cm/h), while the highest one (0.5 cm/h) was obtained for cultivated soil for about 15 years, under the same conditions. This could be due to increase of soluble sodium content, where the mean value of soluble sodium content was 691.30 meq/L and ESP value was 59.49 for virgin soil (Prof. 10) as shown in Table (8). While, the fish farming led to soil despersion and lower hydraulic conductivity for abovementioned discussion, the hydraulic conductivity values for the studied soils were corresponded with both ESP and SAR values (Table 8). In this respect, **Madkour *et al.* (1999)** found that, hydraulic conductivity has negative significant correlation with soluble sodium and exchangeable sodium percentage in the sodic soils. These results are in agreement with obtained by **El-Maddah (2000), El-Shanawany *et al.* (2000) and Saad *et al.* (2001).**

**5.2.1.3. Aggregation parameters:**

Data in Table (7) and Fig. (19) showed that most of the studied aggregation parameters were decreased under the conditions of fish farming, compared to the soils cultivated for 15 years (profile 12). Converting the cultivated soils for 15 years into fish farms for 10 years (profile 21), exhibited the lowest values of most aggregation parameters, approximately to the virgin soil. It could be concluded that continuous submergence under the conditions of fishponds,

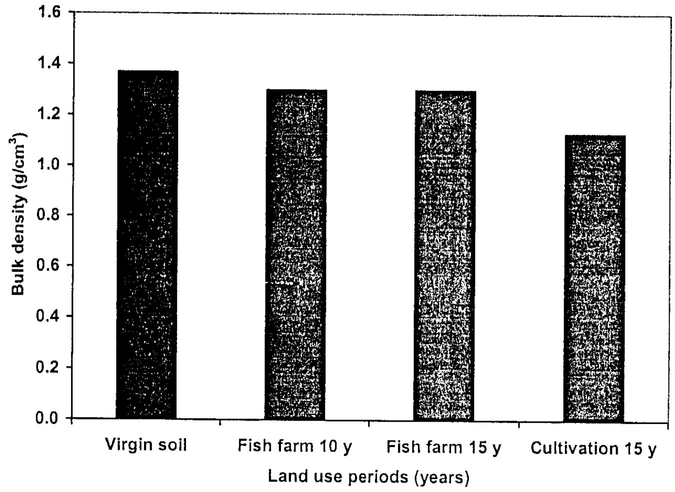


Fig. (17): Effect of land use type and time on soil bulk density.

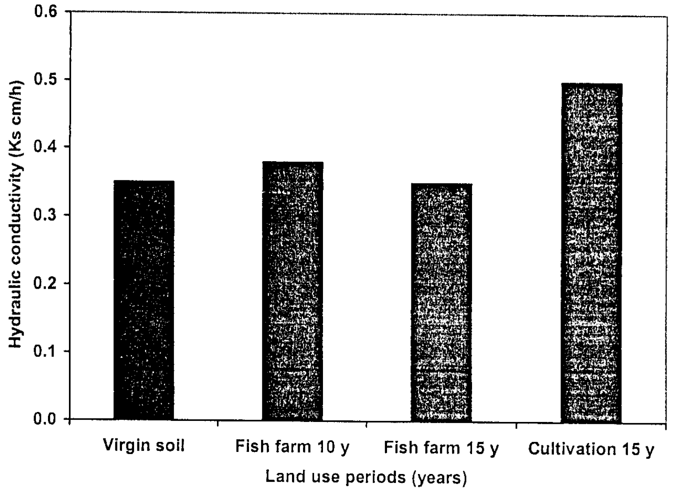


Fig. (18): Effect of land use type and time on soil hydraulic conductivity.

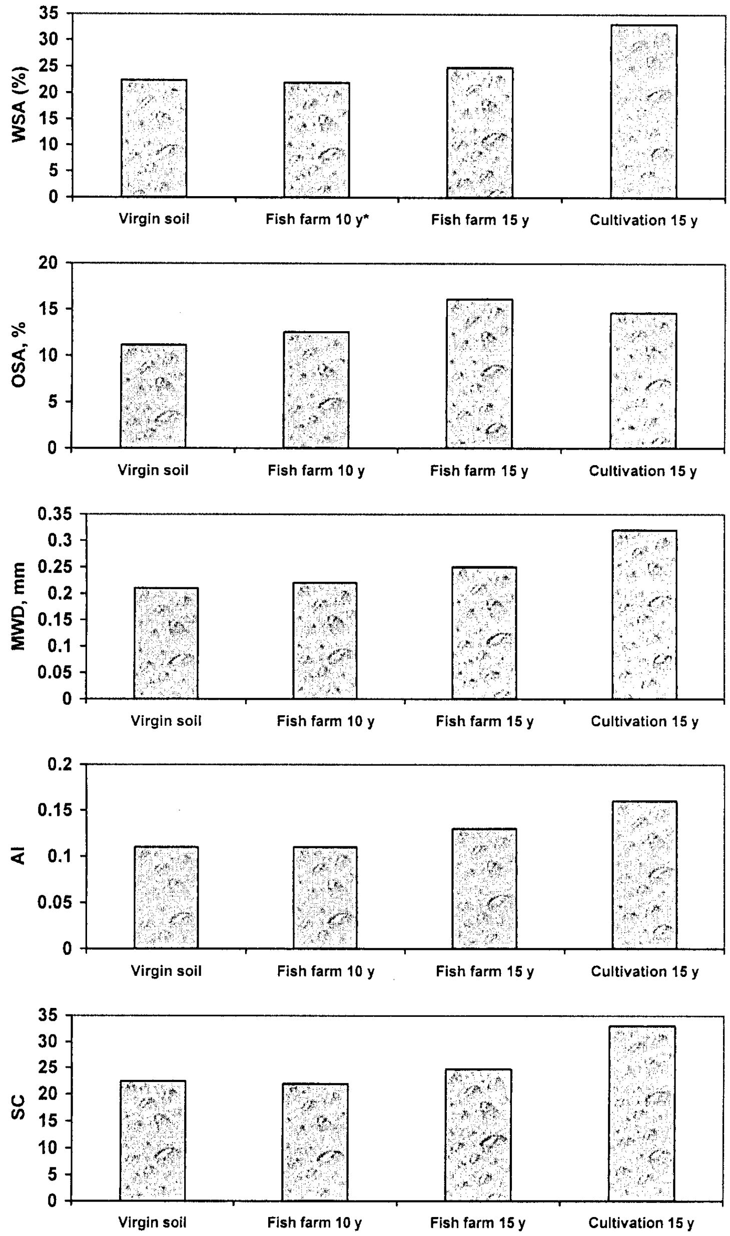


Fig. (19): Effect of land use type and time on aggregation parameters.

caused marked deterioration of the aggregation parameters. It is highly recommended to avoid subjecting the stable agricultural soils under fish farming, particularly in the presence of large areas of virgin and soils with low qualities.

The lowest values of aggregation parameters recorded to either virgin soil, or soils under fish farming, could be due to the impact of stress chemical quality in the form of dominance of sodium adsorption. On the contrary, the highest values of aggregation parameters could be ascribed to crop residues, organic manures and gypsum application to the soil leading to water stable aggregates, and improving the different parameters of aggregation. These results were in agreement with those of **Hammoud (1992) and Koriem (1993)**. In this respect **Omar *et al.* (1990)** found highly significant relationship between the added organic matter and soil aggregation.

**5.2.2. Chemical properties:**

**5.2.2.1. Soil pH:**

Data in Table (8) showed the effect of fish farming on pH value, and revealed that, the soil used as fish farm for 15 years (Prof. 20), had the highest value of pH compared to the virgin soil (Prof. 10), and soil cultivated for 15 years (Profile 12). The increase in pH value due to use the soil as fish farm, may be due to the predominance of sodium and magnesium ions in the soil than $Ca^{++}$ ions as shown in Table (8), where the drainage water used in fish farming led to increase $Na^{+}$ ion concentration and consequently increase pH values.

The increase in pH values as a result of water flooding was reported by **Ghosh *et al.* (1976) and Nashy (1986)**. In this respect **Islam and Islam (1973)** in their study on effect of submergence on various soils in Bangladesh, stated that, the increase in pH was noticed under the reducing conditions of the soil. This may be attributed to drainage water use, containing high $Na^{+}$ and $Mg^{++}$ in submergence soils.

**5.2.2.2. Soil salinity (ECe dS/m):**

Data in Table (8) and Fig. (20) showed the salinity in the soil profiles, representing both the fish farms and cultivated soils. Data revealed that, soil salinity increased gradually with depth, maximum values were recorded near to the ground water.

On the other hand, data in Table (8) and Fig. (20) showed much salt accumulation in the surface of the virgin soil, due to rising of soil solution with the capillary rise, enhanced by the high evaporation rate, where the ECe values of surface layer was 63.30 dS/m, while, it ranged between 45.29 to 47.86 dS/m for subsurface layers (Profile 10).

Data in Table (8) and Fig. (20) revealed that subjecting the soil under different types of land use, is better than leaving it without utilization. Converting the cultivated soil to fish farming (profile 21), caused degradation of the soil quality, i.e. salinity increased compared to the cultivated soil (profile No. 12). It is highly recommended in arid and semi-arid regions not to leave soil without utilization, especially with the heavy clay texture and high water table level.

**Table (8):** Effect of land use type (fish farming or/cultivation) and cultivation periods, on some chemical properties of tested soils.

| Prof. No. | Depth, cm | pH 1:2.5 | EC dS/m | Soluble anions, meq/L | | | | Soluble cations, meq/L | | | | SAR | CEC cmol/kg | $CaCO_3$ % | ESP % | Gyp. % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $HCO_3^-$ | $CO_3^{--}$ | $Cl^-$ | $SO_4^{--}$ | $Ca^{++}$ | $Mg^{++}$ | $Na^+$ | $K^+$ | | | | | |
| **Virgin soil** | | | | | | | | | | | | | | | | |
| 10 | 0-30 | 8.30 | 63.30 | 7.87 | 0.00 | 593.06 | 155.88 | 115.58 | 133.09 | 505.14 | 2.80 | 44.37 | 27.00 | 1.54 | 70.96 | 0.30 |
| | 30-60 | 8.30 | 47.74 | 6.00 | 0.00 | 500.83 | 110.38 | 86.35 | 101.15 | 427.52 | 2.14 | 44.15 | 26.00 | 1.32 | 54.11 | 0.40 |
| | 60-90 | 8.20 | 45.29 | 5.67 | 0.00 | 473.94 | 84.40 | 84.15 | 92.97 | 385.50 | 1.39 | 40.96 | 19.20 | 3.30 | 58.80 | 0.40 |
| | 90-120 | 8.30 | 47.86 | 6.01 | 0.00 | 503.16 | 111.06 | 93.08 | 101.64 | 423.37 | 2.14 | 42.91 | 17.00 | 3.08 | 54.07 | 0.10 |
| | Mean | 8.28 | 51.05 | 6.39 | 0.00 | 517.74 | 115.37 | 94.79 | 107.21 | 435.38 | 2.12 | 43.10 | 22.30 | 2.31 | 59.49 | 0.30 |
| **Cultivated soils about 15 years** | | | | | | | | | | | | | | | | |
| 12 | 0-30 | 8.10 | 7.40 | 1.50 | 0.00 | 77.20 | 6.30 | 11.20 | 9.00 | 63.80 | 1.00 | 20.08 | 28.00 | 1.64 | 18.71 | 0.50 |
| | 30-60 | 8.13 | 8.10 | 1.50 | 0.00 | 78.00 | 12.50 | 12.40 | 11.40 | 67.00 | 1.20 | 19.42 | 25.20 | 1.32 | 25.27 | 0.30 |
| | 60-90 | 8.15 | 8.70 | 1.50 | 0.00 | 80.00 | 18.50 | 14.00 | 12.40 | 72.00 | 1.60 | 10.17 | 24.40 | 1.77 | 39.68 | 0.10 |
| | 90-120 | 8.19 | 9.20 | 2.00 | 0.00 | 85.00 | 23.00 | 18.20 | 14.00 | 76.00 | 1.80 | 18.94 | 24.80 | 2.31 | 43.56 | 1.10 |
| | Mean | 8.14 | 8.35 | 1.62 | 0.00 | 80.05 | 15.08 | 13.95 | 11.70 | 69.70 | 1.40 | 17.15 | 25.60 | 1.76 | 31.81 | 0.50 |
| **Fish farming about 15 years** | | | | | | | | | | | | | | | | |
| 20 | 0-30 | 8.25 | 16.50 | 4.20 | 0.00 | 126.10 | 62.26 | 39.73 | 39.59 | 108.49 | 475 | 17.23 | 28.40 | 2.54 | 27.90 | 0.40 |
| | 30-70 | 8.38 | 16.00 | 3.00 | 0.00 | 121.80 | 44.37 | 22.61 | 29.57 | 115.77 | 1.22 | 22.67 | 28.60 | 2.21 | 32.60 | 0.60 |
| | 70-95 | 8.30 | 15.50 | 2.33 | 0.00 | 83.67 | 81.60 | 27.12 | 20.31 | 119.86 | 0.31 | 24.61 | 24.00 | 2.21 | 48.58 | 0.50 |
| | 95-120 | 8.35 | 18.00 | 2.35 | 0.00 | 102.03 | 92.22 | 33.52 | 23.00 | 139.30 | 0.78 | 26.20 | 22.30 | 3.52 | 52.38 | 0.60 |
| | Mean | 8.32 | 16.50 | 2.97 | 0.00 | 108.40 | 70.11 | 30.74 | 28.11 | 120.86 | 1.77 | 22.68 | 25.83 | 2.62 | 40.37 | 0.53 |
| **Fish farming 10 years after cultivation about 15 years** | | | | | | | | | | | | | | | | |
| 21 | 0-30 | 8.18 | 12.66 | 5.48 | 0.00 | 87.45 | 47.63 | 25.23 | 21.00 | 92.02 | 3.31 | 19.35 | 28.40 | 3.52 | 32.11 | 0.30 |
| | 30-75 | 8.20 | 14.20 | 2.78 | 0.00 | 103.75 | 34.05 | 22.78 | 23.22 | 93.18 | 1.40 | 19.43 | 31.00 | 4.18 | 31.29 | 0.30 |
| | 75-110 | 8.25 | 15.74 | 3.00 | 0.00 | 111.22 | 38.76 | 26.00 | 18.88 | 107.20 | 0.90 | 2.63 | 32.00 | 5.72 | 36.38 | 0.30 |
| | Mean | 8.21 | 14.20 | 3.75 | 0.00 | 100.80 | 40.15 | 24.34 | 21.03 | 97.47 | 1.87 | 20.47 | 30.46 | 4.47 | 33.26 | 0.30 |

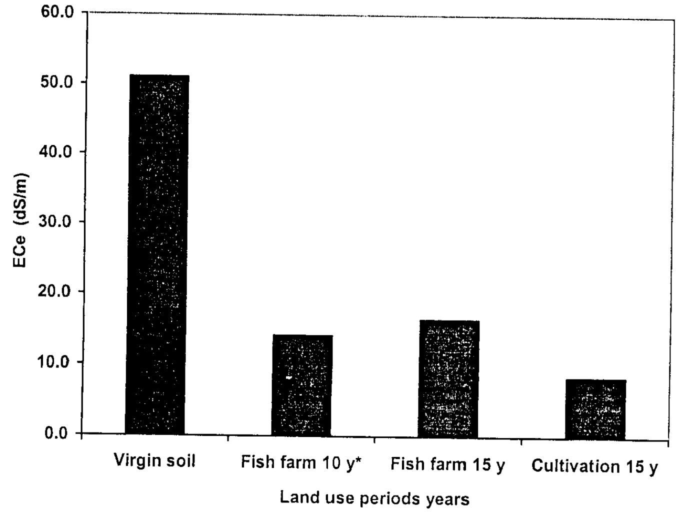


Fig. (20): Effect of land use type and time on soil salinity.

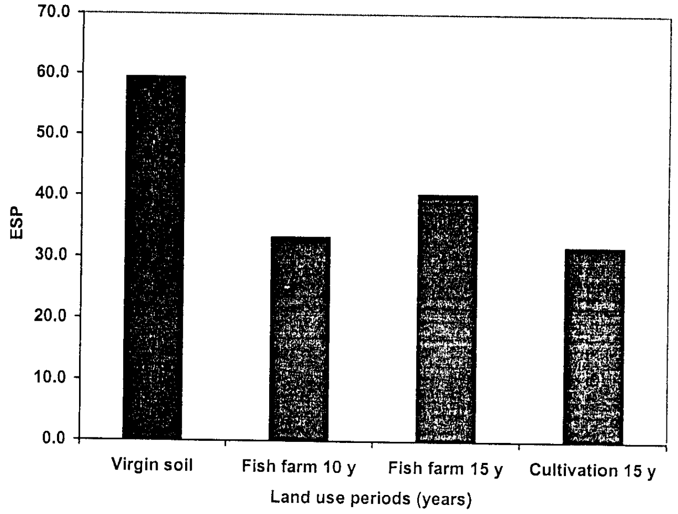


Fig. (21): Effect of land use type and time on soil alkalinity (ESP).

**5.2.2.3. Soil alkalinity (ESP):**

Data in Table (8) and Fig. (21) showed that, sodium cations were the dominant adsorbed in soils of the studied area. Where ESP value reached 59.49% in the virgin soil. Using the soil, either in cultivation or fish farming, decreased the soil alkalinity, where ESP decreased twice times in these soils, compared to the virgin one. **Schellekens *et al.* (1990)** reported that alkalinity had been improved in parallel with salinity by drainage in Kafr El-Sheikh heavy clay soil, meaning that during the leaching of excess salts, enough $Na^+$ on colloid surfaces is exchanged by more desirable cations (especially $Ca^{++}$) already present in the soil.

As can be noticed in Table (8), the lowest ESP values have been obtained in the upper layers of cultivated soil (Profile 12), and fish farming (Profile 20), then increased gradually with depth. This may be due to the annual additions of super phosphate fertilizer to fish farms, or to the effect of leaching. **Hamdi *et al.* (1968)** reported that sodium ions are more readily lost by leaching than calcium.

**Giraldez and Remero (1975)** concluded that decreasing the ESP when salts are leached out without developing alkalinity, can be accounted on the type of salts present in the soil. **Hassanein and Rushdi (1975)** showed that sodium was the highest soluble and exchangeable cations to be leached.

**5.2.2.4. Total calcium carbonate ($CaCO_3$%):**

Data in Table (8) showed that, except the virgin soil, $CaCO_3$ % concentrated in the upper part of the soil profiles, then relatively decreased with depth. The soil under flooding by Fish farming, may cause differential mobility of mono and divalent cations. It means that the rate of removing $Na^{+}$ is higher than $Ca^{++}$ and $Mg^{++}$, therefore, $CaCO_3$ may precipitate under these condition (**Ramadan *et al.*, 1994**). Also, the increase of Ca ions on the upper part of soil, may be due to the addition of Ca-bearing materials, such as super phosphate, which added to fish farms. On the other hand, the high levels content of NaCl salts and soluble $Mg^{++}$ may enhance the solubility product of $CaCO_3$ in the upper part of the virgin soil profile (**Hassett and Jurink, 1971**).

### 5.2.3. Fertility status of soils under fish farming:

#### 5.2.3.1. Organic matter content (OM%):

Data in Table (9) indicated that, organic matter content varied among the different studied soil profiles. The virgin soil had the lowest value of OM (0.42%) (Profile 10), with general decrease with depth. The soils used as fish farm (Profile 20), contained relatively higher OM contents and was proportional to the land use period. This is due to the regular addition of organic matter to feed fish. On the other hand, the soil used in agricultural production for the same period (15 years) (Profile 12), had the highest value (1.20%) of organic matter content, as a result of agricultural practices, addition of FYM and plant residues to the cultivated soils.

#### 5.2.3.2. Macronutrients (NPK):

Data in Table (9) showed that, the highest mean values of N and P were achieved with the soil used for Agriculture, where mean

**Table (9):** Effect of land use type (fish farming or/cultivation) and cultivation periods, on the soil fertility status.

| Prof. No. | Depth, cm | OM % | Available macronutrients (ppm) | | | DTPA extractable micronutrients (ppm) | | | | Exchangeable cations (cmol/kg) | | Ca & Mg increase, % | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | N | P | K | Fe | Mn | Cu | Zn | Ca | Mg | Ca | Mg |
| **Virgin soils** | | | | | | | | | | | | | |
| 10 | 0-30 | 0.47 | 15.16 | 6.60 | 650.00 | 10.58 | 8.84 | .66 | 0.96 | 3.34 | 2.40 | | |
| | 30.60 | 0.36 | 15.00 | 5.30 | 580.00 | 9.80 | 5.86 | 3.64 | 0.16 | 5.90 | 3.80 | | |
| | Mean | 0.42 | 15.08 | 5.95 | 615.00 | 10.19 | 7.35 | 3.65 | 0.56 | 4.62 | 3.10 | 0 | 0 |
| **Cultivated soils about 15 years** | | | | | | | | | | | | | |
| 12 | 0-30 | 1.35 | 48.87 | 10.50 | 492.00 | 11.50 | 7.68 | 4.20 | 1.40 | 11.23 | 9.35 | | |
| | 30-60 | 1.05 | 48.03 | 7.50 | 484.00 | 10.04 | 7.64 | 3.54 | 0.42 | 9.15 | 7.29 | | |
| | Mean | 1.20 | 48.45 | 9.00 | 488.00 | 10.77 | 7.66 | 3.87 | 0.91 | 10.19 | 8.32 | 120 | 168 |
| **Fish farming about 15 years** | | | | | | | | | | | | | |
| 20 | 0-30 | 1.40 | 27.45 | 9.99 | 492.66 | 21.72 | 10.92 | 5.44 | 1.28 | 9.94 | 8.39 | | |
| | 30-70 | 0.80 | 7.86 | 7.12 | 496.20 | 17.41 | 6.70 | 4.78 | 0.72 | 9.97 | 7.24 | | |
| | Mean | 1.10 | 17.66 | 8.65 | 494.43 | 19.57 | 8.81 | 5.11 | 1.00 | 9.96 | 7.82 | 116 | 152 |
| **Fish farming 10 years after cultivation about 15 years** | | | | | | | | | | | | | |
| 21 | 0-40 | 1.20 | 20.12 | 8.98 | 516.12 | 21.65 | 13.52 | 5.46 | 1.80 | 9.40 | 8.18 | | |
| | 40-70 | 0.90 | 19.42 | 6.10 | 492.66 | 15.47 | 10.70 | 4.62 | 1.58 | 7.00 | 7.62 | | |
| | Mean | 1.05 | 19.77 | 7.54 | 504.39 | 18.56 | 12.11 | 5.04 | 1.69 | 8.20 | 7.90 | 77 | 155 |

values of N and P were 48.45 and 9 ppm, as recorded in (profile 12), available K take the opposite trend. The lowest one were achieved with virgin soil (profile 10), where the mean values of N and P were 15.08 and 5.95 ppm, and the mean value of available K was 615 ppm. The increase in available N and P in cultivated soil (profile 12), may be due to the addition of farmyard manure, mineral fertilizers and amendments where the decrease of available K may be due to its depletion by plants, fertilization with K was not common for long time.

The soil used as fish farm (profile 20), had lower macronutrients than that used for agriculture and converted to fish farming, where the mean value of NPK were 17.66, 8.65 and 494.43 ppm, for fish farming soils (profile 21). While, macronutrients were 19.77, 7.54 and 504.39 ppm for soil used for agriculture and converted to fish farm (profile 20). This may be attributed to farmyard manure and mineral fertilizer which addition to the agriculture soils. The macronutrients were higher in surface layer than in sub surface layer as shown in Table (9).

**5.2.3.3. Micronutrients:**

Data in Table (9) showed that, values of DTPA extractable Fe, Mn, Cu and Zn, vary widely within the soils under study, the lowest mean values of micronutrients, 10.19, 7.35, 3.65 and 0.56 ppm for Fe, Mn, Cu and Zn, respectively, were achieved in virgin soil (profile 10).

The cultivated soil had higher content of micronutrients than virgin soil (Table 9). This may be due to agricultural practices i.e. farmyard manure and mineral fertilizer addition. The mean values of Fe, Mn, Cu and Zn were 10.77, 7.66, 3.87 and 0.91 ppm, respectively (profile 12).

Results showed that, the soil used as fish farm contained micronutrients higher than virgin soil. The vertical distribution of available Fe, Mn, Cu and Zn in the studied profiles, showed tendency for accumulation in the surface layers, as shown in Table (9).

**5.2.3.4. Exchangeable Ca & Mg:**

Data of exchangeable Ca and Mg showed that using soil in cultivation for 15 years, increased exchangeable calcium and magnesium, comparing the virgin soil, the increase was 120% and 168% for Ca and Mg respectively, as shown in Table (9).

Data showed that, the increase rate of exchangeable Ca and Mg in cultivated soil, found to be higher than those obtained in the case of fish farming, the increase was 120% and 168% for Ca and Mg, respectively in agriculture soil, while were 116 and 152% for Ca and Mg, respectively in fish farming soil, for the same cultivation period (profile 20).

## 5.3. Land evaluation of soil under different agricultural practices:

### 5.3.1. Land capability using ASEL program:

Values of soil index (S.I), fertility index (F.I), irrigation water index (W.I), environmental index (E.I), final index of land evaluation (FILE) and land capability classes in the study area were calculated according to **Ismail *et al.* (1994),** and presented in Table (10). Such data indicated that the lowest values of FILE were recorded in profiles No. 1, 6, 10 and 15, which represent the virgin soil (control), under the different agricultural practices. The FILE values of the virgin soils varied from 16.73 (profile No. 10) to 19.68 (profile No. 1). It was noticed that, increasing cultivation period caused marked increase in FILE value, highest FILE value was recorded in profile No. 5 (71.64). Which represents the cultivated soil for 50 years, using fresh water as a source of irrigation under tile drainage. It was noticed from Table (10) and (Fig. 23), that establishment of tile drainage exhibited pronounced improvement of soil quality.

The FILE value increased from 59.24 (profile No. 2) to 71.64 (profile No. 5), which reflects the increase of FILE with increasing the cultivation period, for soils served with tile drainage and fresh water. Increasing rate of FILE was lesser in the case of using open drainage, compared to tile drainage under the same source of irrigation water, and the same periods of land cultivation (profiles 6, 7, 8 and 9).

**Table (10):** Land capability for the studied soils using ASLE program.

| Prof. no. | S.I | F.I | W.I | E.I | FILE. | Capability Class | Class name | Limitations |
|---|---|---|---|---|---|---|---|---|
| **Fresh water, tile drainage under different cultivation periods** | | | | | | | | |
| 1 | 6.59 | 33.51 | 96.10 | 80.21 | 19.68 | $C_5$ | Very poor | GWS, OM, P |
| 2 | 41.99 | 48.63 | 94.91 | 79.28 | 59.24 | $C_3$ | Fair | |
| 3 | 45.74 | 48.80 | 98.29 | 78.27 | 61.25 | $C_2$ | Good | |
| 4 | 52.91 | 56.06 | 96.10 | 77.83 | 66.68 | $C_2$ | Good | |
| 5 | 58.76 | 62.69 | 96.28 | 80.12 | 71.64 | $C_2$ | Good | |
| **Fresh water, open drainage under different cultivation periods** | | | | | | | | |
| 6 | 5.87 | 46.18 | 94.61 | 74.20 | 18.51 | $C_5$ | Very poor | GWD, GWS ECe, N, P |
| 7 | 40.52 | 44.18 | 96.65 | 77.35 | 56.67 | $C_3$ | Fair | |
| 8 | 43.03 | 50.06 | 96.12 | 76.30 | 59.95 | $C_3$ | Fair | |
| 9 | 46.00 | 54.16 | 96.20 | 70.77 | 61.83 | $C_2$ | Good | |
| **Blended water, tile drainage under different cultivation periods** | | | | | | | | |
| 10 | 5.39 | 35.48 | 89.82 | 69.56 | 16.73 | $C_5$ | Very poor | GWD, Ks, ECe, GWS OM, N, P |
| 11 | 42.53 | 54.82 | 89.91 | 70.24 | 59.60 | $C_3$ | Fair | |
| 12 | 42.27 | 53.77 | 88.73 | 73.20 | 59.53 | $C_3$ | Fair | |
| 13 | 47.12 | 53.38 | 90.18 | 69.26 | 61.08 | $C_2$ | Good | |
| 14 | 50.42 | 55.20 | 88.41 | 78.80 | 63.12 | $C_2$ | Good | |
| **Blended water, open drainage under different cultivation periods** | | | | | | | | |
| 15 | 5.52 | 46.88 | 58.38 | 60.20 | 16.93 | $C_5$ | Very poor | GWD, GWS ECe, EC IW |
| 16 | 39.49 | 53.08 | 57.03 | 67.58 | 52.29 | $C_3$ | Fair | |
| 17 | 40.26 | 55.53 | 57.23 | 67.58 | 53.25 | $C_3$ | Fair | |
| 18 | 41.28 | 51.13 | 57.78 | 66.95 | 52.61 | $C_3$ | Fair | |
| 19 | 54.51 | 51.76 | 57.26 | 68.55 | 54.54 | $C_3$ | Fair | |

Where: GWS = Ground water salinity, OM = Organic matter content, S.I. = Soil index, F.I.L.E. = Final index land evaluation, GWD = Ground water depth, N = Available Nitrogen, F.I. – Fertility index, Ks = Hydraulic conductivity, P = Available phosphorus, W.I = Water index, ECe = Soil salinity, EC IW = Irrigation water salinity, E.I.= Environmental index

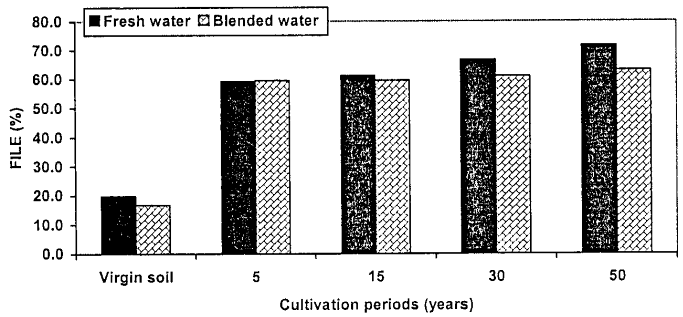


Fig. (22): Effect of water type on FILE % under different cultivation periods.

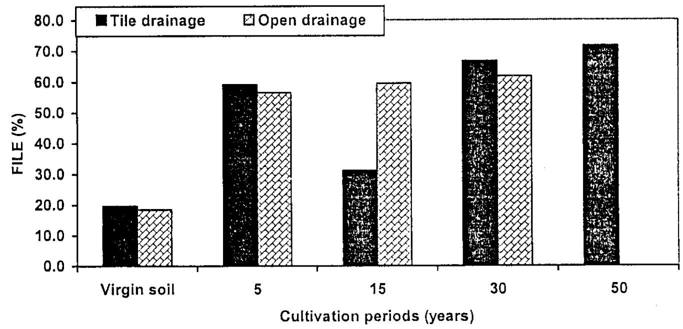


Fig. (23): Effect of drainage system on FILE, % under different cultivation periods.

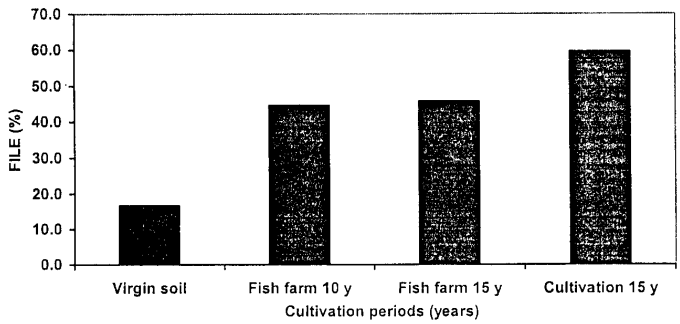


Fig. (24): Effect of land use type and time on FILE.

The water of low quality (blended water), caused relative decrease of FILE values, under the two types of drainage systems, along the different periods of land cultivation.

### 5.3.2. Multi-categories classification of land capability:

Land capability was classified into multi-categories; classes, subclasses, units and sub units as follow:

1. The classes category revealed that, the final index of land evaluation values can be assigned to soil capability classes as follows:

| Class | Degree of capability | Final value |
|---|---|---|
| $C_1$ | Excellent | 100-80% |
| $C_2$ | Good | 79-60% |
| $C_3$ | Fair (Moderate) | 59-40% |
| $C_4$ | Poor (Marginal) | 39-20% |
| $C_5$ | Very poor | 19-10 |
| $C_6$ | Non-agricultural | < 10 |

2. **Land capability subclasses:**

This category referred to the most limiting factors related to soil, fertility, water quality ...... etc.

3. **Land capability units:**

Which represent the major limiting characteristics for the land capability in the area, for example, physical soil properties and soil chemical properties. Organic matter and macronutrient related to soil fertility ....... etc.

**4. Land capability sub-units:**

Land capability sub-units represent the detailed limitation properties, under different land capability units, for examples; hydraulic conductivity, ground water depth as soil physical properties, soil salinity and ground water salinity as soil chemical properties, and nitrogen, phosphour and macronutrients.....etc.

Data in Table (10) showed the different categories of land capability, for the different cases of agricultural practices (drainage system and water quality under different cultivation periods).

Data revealed that, The studied virgin soils were classified as $C_5$ (very poor class). Virgin soils in the different locations had the same limitating factors, they were hydraulic conductivity, soil aggregates as soil physical properties and soil salinity, alkalinity and ground water salinity as soil chemical properties. Also, organic matter, available nitrogen and phosphorus as soil fertility.

Soils irrigated by fresh water, and served by tile drainage were classified as $C_3$ (fair), for the soil cultivated for 5 years, while they were $C_2$ (good) for those cultivated for 15, 30 and 50 years. The most limiting factors were, ground water salinity (GWS) (appendix 1) as soil chemical properties, organic matter and available phosphorus as soil fertility. Data also, revealed that, the soil class was increased from $C_5$ to $C_3$ after cultivation for 5 years, and to $C_2$ after cultivation for 15, 30 and 50 years, which reflect the improvement of soil properties with increasing the cultivation period.

Soils irrigated by fresh water and served by open drainage system are classified as $C_3$ (fair) for 5 and 15 years of cultivation periods, and as $C_2$ in the soil cultivated for 30 years. The most limitating factors were, ground water depth, ground water salinity and soil salinity, as soil properties, and organic matter and available N and P as fertility status, thus indicating, the importance of water quality for soil improvement.

Data also revealed that soils irrigated by blended water under tile drainage were classified as $C_3$, for the soil cultivated for 5 and 15 years and $C_2$ in the soil cultivated for 30 and 50 years. The most limiting factors were, ground water depth and hydraulic conductivity as soil physical properties, soil salinity and ground water salinity as soil chemical properties, organic matter and available nitrogen and phosphorus as soil fertility. Improving in soil properties was observed with increasing the cultivation period, but at lesser extent, compared to the soil irrigated with fresh water.

Regarding the soil irrigated by blended water with open drainage system, data in Table (10) showed that, although the final index of land evaluation (FILE), was generally increased with increasing cultivation period, the soil class still fixed with cultivation period and still $C_3$ (as fair category).

From aforementioned discussion, it is noticed that, the prevailing agricultural practices in Gharb Al-Mansoura region, (irrigation with blended water and using open drainage) prevent soil development to the higher classes of land capability.

Drainage conditions and water quality were considered to be the main factors affecting the future of soil reclamation, and improvement of soil productivity, in the North Nile Delta Region. In this respect, the World Bank (2006) stated that the drainage irrigated crops, benefit substantially when soil hydraulic properties are improved by deep ploughing and by the removal of excess salts away from the active root zone.

Data in Table (11) and Fig. (23) showed that, the soils used as fish farm for about 10 and 15 years, profiles number (21 and 20), respectively, have FILE values higher than those of virgin soil, but it was lesser than that recorded for cultivated for 15 years (Profile No. 12) under the same conditions. These soils are belonged to land capability class $C_3$ (fair). Also, data indicated that the soil class was improved from $C_5$ to $C_3$ after using these soils as fish farms, for about 10 and 15 years. The most limiting factors were, ground water depth and hydraulic conductivity as soil physical properties, ground water salinity and soil salinity as soil chemical properties, organic matter, available nitrogen and available phosphorus as soil fertility parameters.

**Table (11):** Land capability for the fish farming soils using ASLE program.

| Prof. no. | S.I | F.I | W.I | E.I | FILE | Capability Class | Class name | Limitations |
|---|---|---|---|---|---|---|---|---|
| Virgin soil | | | | | | | | |
| 10 | 5.39 | 35.48 | 89.82 | 69.56 | 16.73 | $C_5$ | Very poor | GWD, Ks, GWS ECe, OM, N and P |
| Fish farming about 15 years | | | | | | | | |
| 20 | 23.81 | 49.58 | 88.75 | 71.28 | 45.73 | $C_3$ | Fair | |
| Fish farming 10 years after cultivation about 15 years | | | | | | | | |
| 21 | 28.02 | 47.16 | 57.02 | 64.78 | 44.52 | $C_3$ | Fair | |
| Cultivated soils about 15 years | | | | | | | | |
| 12 | 42.27 | 53.77 | 88.73 | 73.20 | 59.53 | $C_3$ | Fair | |

**5.3.3. Land suitability for crops:**

The land suitability is defined as, the fitting degree of specific soil for alternative major kind of land uses. The new applied evaluation system ASLE suggested a differentiation between two evaluating terms, land suitability and land use possibility. Land suitability refers to the degree of fitting in high suitability classes (S1 and S2), and indicate high suitability of the studied land for crops, while land use possibility refers to the entire ability of cultivation under any degree of suitability $S_1$, $S_2$, $S_3$ and $S_4$

Land suitability classes for crops were determined by matching land qualities, climatic data and crops requirements throughout the suggested computer model (Table 12).

Data in Table (12a) showed that the land suitability, for the area irrigated by fresh water and served by tile drainage, was highly suitable for sugar beet, sunflower, barley, wheat, rice, cotton, berseem, cabbage. While, land use possibility indicated that the area could be used for all crops except, olive, water melon, faba bean, soya bean and citrus (Table 12a, 12b and 12c).

Concerning the area which irrigated by blended water and served by tile drainage, data reveled that, it was highly suitable for sugar beet, wheat, barley, sunflower, rice, cotton, sugar cane, maize, sorghum, alfalfa and cabbage. While, land use possibility indicated that, the area could be used for all crops, except for potato, onion and citrus (Table 12a, 12b and 12c).

**Table (12-a):** Land suitability indices for different field crops.

| Prof. no. | Sugar beet % | Barley % | Wheat % | Sunflower % | Rice % | Maize % | Soya bean % | Faba bean % | Cotton % |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 6.85 | 6.86 | 6.86 | 6.35 | 6.90 | 6.35 | 6.20 | 6.20 | 6.38 |
| 2 | 78.45 | 82.94 | 80.33 | 72.63 | 71.44 | 14.32 | 6.12 | 6.12 | 67.57 |
| 3 | 83.64 | 80.08 | 77.56 | 77.44 | 74.50 | 19.95 | 6.32 | 6.32 | 72.05 |
| 4 | 79.39 | 79.48 | 76.98 | 85.74 | 73.95 | 18.90 | 20.62 | 20.62 | 82.36 |
| 5 | 79.45 | 82.94 | 79.35 | 85.89 | 73.82 | 70.23 | 67.72 | 68.72 | 82.50 |
| 6 | 6.27 | 6.42 | 6.42 | 6.77 | 6.45 | 6.77 | 6.61 | 6.61 | 6.80 |
| 7 | 68.59 | 67.57 | 67.57 | 71.75 | 60.09 | 21.28 | 6.53 | 6.74 | 23.40 |
| 8 | 77.11 | 76.76 | 76.76 | 80.66 | 68.26 | 65.29 | 20.03 | 20.68 | 77.48 |
| 9 | 77.17 | 79.19 | 76.70 | 80.72 | 68.21 | 65.24 | 20.04 | 20.69 | 80.06 |
| 10 | 6.92 | 6.79 | 6.79 | 6.80 | 6.82 | 6.26 | 6.26 | 6.26 | 6.44 |
| 11 | 80.26 | 78.53 | 78.53 | 74.31 | 69.84 | 19.30 | 6.26 | 6.26 | 69.14 |
| 12 | 76.86 | 77.01 | 77.01 | 83.01 | 68.49 | 63.49 | 20.61 | 20.61 | 79.73 |
| 13 | 77.94 | 78.28 | 75.82 | 84.8 | 67.43 | 64.38 | 20.90 | 20.90 | 83.48 |
| 14 | 76.61 | 79.76 | 77.25 | 82.75 | 68.70 | 63.29 | 20.54 | 20.54 | 82.06 |
| 15 | 19.86 | 19.22 | 19.22 | 20.78 | 18.95 | 6.57 | 6.01 | 6.20 | 6.78 |
| 16 | 79.24 | 79.63 | 79.63 | 73.36 | 69.47 | 18.42 | 6.62 | 6.62 | 68.25 |
| 17 | 73.56 | 73.54 | 73.54 | 79.45 | 64.16 | 19.95 | 6.11 | 6.11 | 73.91 |
| 18 | 83.72 | 85.11 | 82.44 | 77.51 | 71.92 | 57.31 | 16.85 | 17.39 | 74.45 |
| 19 | 76.98 | 79.39 | 76.89 | 83.14 | 67.08 | 74.60 | 17.63 | 17.56 | 79.86 |
| 20 | 65.04 | 65.15 | 65.15 | 70.25 | 21.25 | 6.69 | 6.69 | 6.69 | 65.35 |
| 21 | 82.93 | 83.26 | 79.59 | 74.37 | 72.64 | 56.78 | 16.85 | 17.39 | 71.43 |

**Table (12-b):** Land suitability indices for different vegetables and forage crops.

| Prof. no. | Onion % | Cabbage % | Pea % | Potato % | Tomato % | Pepper % | Water melon % | Alfalfa % | Sorghum % |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.20 | 6.38 | 6.20 | 1.95 | 3.25 | 2.85 | 2.85 | 6.86 | 6.35 |
| 2 | 10.51 | 64.59 | 20.37 | 5.94 | 32.89 | 27.71 | 8.67 | 76.79 | 21.83 |
| 3 | 33.44 | 72.05 | 21.04 | 6.14 | 36.68 | 27.58 | 8.95 | 74.15 | 23.27 |
| 4 | 31.74 | 79.77 | 23.29 | 18.53 | 40.61 | 31.53 | 29.19 | 73.59 | 75.89 |
| 5 | 31.79 | 79.90 | 71.88 | 20.04 | 40.68 | 31.58 | 31.58 | 76.85 | 76.02 |
| 6 | 2.92 | 6.80 | 6.61 | 2.36 | 3.46 | 3.04 | 3.04 | 6.72 | 6.77 |
| 7 | 9.19 | 65.89 | 20.78 | 6.06 | 33.54 | 3.10 | 9.55 | 64.59 | 22.99 |
| 8 | 10.33 | 77.04 | 23.36 | 18.58 | 37.71 | 31.62 | 29.27 | 73.38 | 73.71 |
| 9 | 10.34 | 74.12 | 23.38 | 18.59 | 40.76 | 31.64 | 29.30 | 73.32 | 73.77 |
| 10 | 3.17 | 6.11 | 22.26 | 2.81 | 11.66 | 9.29 | 3.10 | 20.65 | 22.48 |
| 11 | 10.55 | 33.65 | 20.85 | 16.91 | 33.65 | 26.81 | 8.70 | 73.29 | 21.35 |
| 12 | 10.10 | 72.42 | 22.70 | 18.08 | 37.59 | 30.92 | 28.60 | 71.88 | 73.47 |
| 13 | 10.25 | 73.44 | 23.61 | 18.33 | 38.11 | 31.35 | 29.03 | 70.76 | 74.50 |
| 14 | 10.07 | 58.14 | 23.21 | 18.02 | 40.47 | 30.82 | 28.53 | 72.10 | 73.24 |
| 15 | 8.95 | 21.58 | 19.11 | 1.87 | 10.80 | 2.98 | 2.98 | 18.87 | 6.96 |
| 16 | 9.68 | 62.30 | 18.78 | 5.67 | 32.69 | 8.36 | 8.36 | 68.81 | 21.08 |
| 17 | 8.99 | 67.46 | 20.33 | 5.68 | 35.40 | 27.89 | 9.05 | 68.63 | 22.82 |
| 18 | 10.23 | 65.82 | 19.84 | 17.63 | 34.54 | 28.10 | 26.01 | 76.91 | 68.60 |
| 19 | 9.40 | 70.60 | 21.28 | 16.96 | 37.05 | 30.14 | 27.40 | 71.76 | 73.59 |
| 20 | 9.66 | 22.48 | 22.26 | 2.81 | 11.66 | 9.29 | 3.10 | 20.65 | 6.85 |
| 21 | 20.19 | 65.20 | 19.65 | 16.91 | 34.22 | 9.03 | 25.77 | 71.94 | 64.97 |

**Table (12-c):** Land suitability indices for different fruit trees.

| Prof. no. | Citrus % | Banana % | Olive % | Pear % | Data palm % | Fig % |
|---|---|---|---|---|---|---|
| 1 | 2.00 | 6.70 | 2.76 | 6.55 | 2.10 | 2.10 |
| 2 | 20.59 | 20.86 | 9.49 | 20.38 | 23.25 | 6.60 |
| 3 | 19.42 | 20.14 | 9.80 | 19.86 | 22.69 | 6.95 |
| 4 | 20.30 | 58.88 | 31.94 | 57.53 | 23.26 | 20.58 |
| 5 | 20.59 | 58.78 | 33.04 | 57.43 | 23.29 | 21.29 |
| 6 | 2.31 | 6.77 | 2.94 | 6.13 | 2.61 | 2.42 |
| 7 | 1.91 | 5.88 | 9.99 | 5.75 | 19.83 | 6.44 |
| 8 | 6.40 | 18.22 | 30.62 | 17.80 | 22.30 | 19.73 |
| 9 | 19.72 | 56.08 | 30.65 | 54.79 | 22.31 | 19.75 |
| 10 | 1.99 | 6.52 | 2.79 | 6.32 | 1.94 | 1.99 |
| 11 | 6.13 | 6.51 | 9.71 | 6.31 | 22.48 | 6.75 |
| 12 | 6.54 | 18.82 | 31.93 | 18.10 | 23.25 | 21.61 |
| 13 | 7.12 | 57.07 | 32.38 | 55.32 | 23.57 | 20.86 |
| 14 | 20.09 | 58.14 | 31.83 | 56.36 | 23.17 | 20.51 |
| 15 | 2.14 | 5.60 | 2.89 | 5.37 | 5.61 | 1.86 |
| 16 | 7.50 | 6.46 | 9.58 | 6.19 | 21.66 | 6.67 |
| 17 | 5.60 | 5.96 | 10.38 | 5.72 | 21.72 | 6.69 |
| 18 | 9.18 | 60.67 | 29.81 | 58.15 | 22.89 | 20.75 |
| 19 | 8.83 | 54.81 | 31.98 | 54.24 | 22.73 | 20.61 |
| 20 | 1.99 | 6.11 | 2.79 | 6.02 | 1.94 | 1.94 |
| 21 | 2.73 | 18.41 | 26.99 | 18.22 | 21.68 | 18.78 |

Regarding the area which irrigated by blended water and served by open drainage, data in Table (12a) revealed that, these soils are highly suitable for sugar beet, wheat, barley, sunflower, rice, cotton, sugar cane, alfalfa and cabbage. While the possibility use indicated that, these soils could be used for all crops except onion, soya bean, faba bean, potato and citrus (Tables 12a, 12b and 12c).

Regarding the soils that irrigated by fresh water and served by open drainage, data in Table (12a) showed that, these soils were highly suitable for sugar beet, barley, wheat, sunflower, rice, cotton, sugar cane, alfalfa and cabbage. On the other hand, the land possibility showed that, these soils can possibly cultivated by all crops except Fig, potato, peanut, onion, citrus and grape (Table 12a, 12b and 12c).

Concerning the soils than that used as fish farms, for about 15 years (P. 20) and that cultivated then converted to fish farming for 10 years (p. 21), data in Table (12a) showed that, these soils were highly suitable for sugar beet, wheat, barley, sunflower, cotton.

On the other hand, the land possibility showed that, these soils are possibly cultivated for all crops except fig, pepper, pear, Banana, potato, soya bean, faba bean, citrus (Tables 12a, 12b and 12c).

### 5.3.4. Soil improvement for selected field crops using ASLE program:

The data obtained from ASLE program indicated that, the main treatments needed for improving soils under investigation are addition of gypsum requirements and leaching requirements.

Gypsum requirements must be added in the rate of 4.32 ton/feddan for the soil cultivated for 5 years (profile 2) and 1.26 ton/feddan for the soil cultivated 30 years (profile 4), that irrigated by fresh water under tile drainage, for achieving the highest production of barley, wheat, sunflower, sugarbeet, alfalfa and rice.

Also, for achieving the highest yield production of cotton, gypsum requirements must be added in the rate of 6.76 ton/feddan for the soil cultivated for 5 years (profile 2) and 2.47 ton/feddan for the soil cultivated for 50 years (profile 5) which were cultivated under the previous conditions for water irrigation and drainage system.

On the other hand, the soil irrigated by fresh water under open drainage, gypsum requirements must be applied in the rate of 6.23 ton/feddan for soil cultivated for 5 years (profile 7) and 2.51 ton/feddan for soil cultivated for 30 years (profile 9) to get the highest production of barley, whet, sunflower, sugarbeet, alfalfa and rice. While gypsum requirements must be added in the rate of 8.08 ton/feddan and 4.46 ton/feddan for soil cultivated for 5 years and 30 years, respectively to maximize cotton production as shown in (Appendix 2).

The obtained results showed that, the soil irrigated with blended water and served by tile drainage system need to gypsum requirements addition in the rate of 5.68 and 2.51 ton/feddan for soil cultivated for 5 years (profile 11) and 50 years (profile 14), respectively, for the highest production of barley, wheat, sunflower, sugar beet, alfalfa and rice. While to maximize cotton production under the same previous conditions gypsum requirements must be added in the rate of 8.34 and 4.19 ton/feddan for achieving the highest production of cotton at 5 years and 50 years cultivation periods, respectively.

To maximize the production of barley, wheat, sunflower, sugar beet, alfalfa and rice in the soils irrigated with blended water and served by open drainage system, it must be applied by gypsum requirements in the rate of 5.92 and 2.9 ton/feddan for soil cultivated for 5 years and 50 years, respectively (profiles 16 and 19). Also, gypsum requirements must be added in the rate 8.58 and 5.05 ton/feddan for soil cultivated for 5 and 50 years, respectively for achieving the highest production of cotton under the previous conditions. Concerning the leaching requirements the ASLE program reported that, irrigation water must be applied in excess to provide considerable leaching of salts from soil cultivated by different crops due to the adoption of surface irrigation system.

# CONCLUSION

Land cultivation for long-term agricultural (50 years), improved the class of productivity. Where the productivity class increased from $C_5$ (very poor) for virgin soil, to $C_3$ (fair) after 5 years of cultivation period, and to $C_2$ (good) after 50 years of cultivation period, under different agricultural practices, except in the case of using blended water for irrigation under open drainage system, where the class of productivity remained as $C_3$ (fair), although the cultivation periods increased from 5 to 50 years.

The obtained data revealed that, the drainage factor is the main limiting practices for improving the productivity, or capability class to the highest capability one. Where the soil irrigated by fresh water and served by tile drainage, showed the highest productivity class $C_2$ (good), after 15 years of cultivation period. The same productivity class ($C_2$) was achieved after 30 years of cultivation, under the open drainage.

The results showed that the establishment of tile drainage in the soil irrigated by blended water, decreased the hazard of using the low quality water for irrigation on soil productivity. The presence of tile drainage, resulted in achieving the highest class productivity $C_2$ (good), after 30 years of cultivation. While the soil served by open drainage remained in the same class $C_3$ (fair), even after 50 years.

The obtained results showed that, highest land suitability index was achieved, using fresh water in irrigation on soils served by tile drainage. While, the lowest one was obtained with blended water as a sources of irrigation under open drainage condition.

The continuous irrigation with blended water under either tile or open drainage did decreased the suitability of the soil for the different crops.

* In the case of cotton cultivation, drainage conditions in studied area, seem to be the most limiting factor, for the suitability of soils to cotton production.
* The most constrains that affect the soil suitability for different crops to be growing in study area were.
  - Water table salinity and depth.
  - Soil salinity.
  - Low organic matter and available N and P content.
  - High salt content in blended irrigation water.
  - Low values of hydrophysical soil properties such as hydraulic conductivity.

From data obtained and previous discussion, the following agricultural practices could be recommended on the farm level, to maximize the soil productivity:

1. Cultivation of the most salt tolerant crops such as barley, sugar beet, cottons. Also, the rice crop can be used in such saline soil to prevent the hazard of seawater intrusion.
2. Increasing the drainage condition efficiency, through periodical maintenance of tile drainage system.
3. Carrying out subsoiling processes to remove salts and/or hard pans may exist in such heavy clay soil.
4. Deep ploughing should be carried out for disturbing the capillary tubes, to prevent the upward movement of saline ground water to the soil surface.

5. When fresh water is available, it must be used in irrigation during the most sensitive physiological stages of plants especially in germination stage.
6. Application of leaching requirements especially when blended water is used in irrigation, to prevent salt accumulation in the root zone.
7. Application of organic matter, to improve physical soil properties, and to decrease the hazard of soil salinity.
8. Application of soil amendments, such as gypsum, to improve soil physical properties, and to prevent the formation of soil alkalinity.
9. Carrying out land leveling, to increase water distribution efficiency.
10. Suitable seed bed preparation to avoid the effect of salt on seeds.
11. Proper fertilization (type, time, amount and place of application) must be followed under the saline soil conditions.
12. Salt-affected soils could be used as fish farms, especially during the leaching process, to increase the farmer income.
13. The capacity building of farmers and extension works, must be developed when using low quality water for irrigation of salt-affected soils.

# 6. SUMMARY

The current study was carried out to evaluate the reclaimed soils under different agricultural practices i.e. land use periods, irrigation water sources, drainage systems and fish farming. To achieve such aim, two regions in North Delta area (namely) Al-Zawea region and Al-Mansur West region were chosen.

- Twenty one profiles were selected in these regions, to represent variations in agricultural practices.
- Sources of irrigation water were fresh water and blended water.
- Drainage systems in both regions were tile drainage and open drainage.
- Land cultivation periods were, (virgin soil), 5, 15, 30 and 50 years. All profiles were described according to macro-morphological features of different layers, soil samples were collected from the subsequent layers, for physical and chemical analysis and fertility status.
- Five water samples from the different irrigation types (Al-Ghabat, Al-Halafi and Al-Daramally canals) in Al-Zawea region, and (Kom Al-Teen Canal and Al-Mansur canal) in Al-Mansur West region, were collected for chemical analysis.
- Land evaluation of the studied area was assessed, using applied system of land evaluation (ASLE program), which suits the different environmental conditions of Egypt. Four main factors were used for land evaluation; soil properties, fertility status, irrigation water quality and environmental conditions. The final index of land evaluation (F.I.L.E.) was calculated.

The main obtained results could be summarized as follow:

**A. Effect of agricultural practices on the different soil properties:**

**Soil physical properties:**

The studied soil physical properties were improved as results of increasing cultivation period, using fresh water for irrigation and tile drainage system, hence the values of bulk density were decreased, and the values of aggregation parameters and hydraulic conductivity were increased.

**Soil chemical properties:**

The soil chemical properties of the studied samples were improved, as a result of increasing cultivation period, using fresh water for irrigation and tile drainage system. Values of soil salinity (ECe), soil alkalinity (ESP), soil adsorption ratio (SAR) and total calcium carbonate were decreased.

**B. The effect of agricultural practices on soil fertility status:**

**1. Organic matter:**

- The soil organic matter was increased with increasing cultivation periods, especially in the surface layers.
- Organic matter content was higher in cultivated soils than virgin soils.
- The OM content of soil increased under tile drainage system and fresh irrigation water source, than open drainage and blended water.

2. **Available N, P and K:**

- The NPK content of soil irrigated by blended water and served by open drainage, was higher than those irrigated with fresh water and served by tile drainage.
- The N and P content of soil increase with increasing cultivation periods, while K content decrease.

3. **Available micronutrients (Fe, Mn, Zn and Cu):**

The available micronutrients (Fe, Mn, Zn and Cu) content were increased with increasing cultivation periods, for the soil under open drainage. While it were decreased with soil under tile drainage. On the other hand, there was no clear effect on micronutrients due to irrigation water quality.

**C) The effect of using fish farming on soil properties:**

1. **Soil physical properties:**

The fish farming caused deterioration of soil physical properties, comparing with the soil that directly cultivated, the soil bulk density values were increased, while aggregation parameters and hydraulic conductivity values, were decreased in the soil used as a fish farm.

2. **Soil chemical properties:**

The fish farming resulted in leaching of salts out of soil profile, comparing with virgin soil, values of ECe were decreased by about (67.68 and 72.18%), for soil that used as fish farm, for about 15 and 10 years respectively. ESP was decreased by about (32.14 and 44.09%) for soil used as fish farm, for the same periods. These values were still higher than those obtained for cultivated soils.

**D) Land capability of the studied area using ASEL program:**

Final index of land evaluation were calculated, to evaluate the influence of different agricultural practices on soil productivity. The obtained data could be summarized as follows:

1. Soils under tile drainage had the higher values of F.I.L.E. compared to the soil under open drainage at the same period of cultivation.
2. The soil irrigated with fresh water had F.I.L.E. values higher than those irrigated with blended water, at the same cultivation periods.
3. The F.I.L.E. values were increased with increasing cultivation period.
4. Virgin soil in the different locations had the capability class of $C_5$ (very poor), the limitations of such soil were, the hydraulic conductivity, soil aggregation, soil salinity, alkalinity, ground water salinity, organic matter content and available nitrogen and phosphorus.
5. The soil irrigated with fresh water under tile drainage, classified as $C_3$ (fair), for soil cultivated for 5 years and was $C_2$ (good), for soil cultivated about 15, 30 and 50 years. The most limiting factors for these soils were, ground water salinity, organic matter, available nitrogen and phosphorous.
6. The soils irrigated by fresh water with open drainage were classified as $C_3$ (fair), in the soil cultivated for 5 and 15 years and to $C_2$ (good), in the soil cultivated for 30 years. The most limiting factors were, ground water depth, ground water salinity, soil salinity, organic matter, available nitrogen and phosphorus.
7. The soils that irrigated by blended water under tile drainage were classified as $C_3$ (fair)s for the soil cultivated for 5 and 15 years,

and to $C_2$ (good), for soil cultivated for 30 and 50 years. The most limiting factors were, ground water depth, the hydraulic conductivity, ground water salinity, organic matter content and available nitrogen and phosphorus.

8. The soil that irrigated by blended water and served by open drainage, was classified into $C_3$ (fair), with different cultivation periods. The most limiting factors were, ground water depth, ground water salinity, soil salinity, organic matter content and available nitrogen and phosphorus.
9. Soils that used as fish farming for about 15 years was classified as $C_3$ (fair). Also, the soil that cultivated about 15 years, then converted to fish farming, for 10 years was classified as $C_3$ (fair). The most limiting factors were, ground water depth, hydraulic conductivity, ground water salinity, soil salinities organic matter content and available nitrogen and phosphorus.

Thus, the most limiting factors prevailed in the soil located at the North Nile delta were high water table depth and salinity (due to inefficient drainage system), sea water intrusion, salinity and sodicity, insufficient content of organic matter and available macronutrients, as well as fresh water shortage, (since these soils located at the tail-end of irrigation canals).

**E) Land suitability for crops:**

The study area is highly suitable for sugar beet, barley, wheat, berseem and cabbage, as winter crops and sunflower, rice and cotton, as summer crops.

From the current study, the following recommendations could be recommended:

1. The most high salt tolerant crops (barley-sugar beet, cotton) and tolerant crops (wheat - rice - sunflower) must be grown.
2. Follow-up the drainage condition and increasing its efficiency through periodical maintenance of tile drainage system and using some drainage accessories such as mole drain and subsoiling.
3. When fresh water is available, it must be used in irrigation during the most sensitive physiological plant stage especially in germination and seedling stage.
4. Establish fish farm in salt-affected soils during the leaching stage to increase the farmers income.
5. Forbidden using the productive agricultural land as fish farming to maintain its quality and prevent degradation of its properties.

# REFERENCES

**Abd El-Aal, N.I. (1994).** Influence of soil organic matter on the behaviour of some trace elements in soils. Ph.D. Thesis, Fac. of Agric. Cairo Univ. Egypt.

**Abd El-Hafez, S.A. (1982).** Effect of irrigation and fertilizer on rice yield and soil properties. Ph.D. Thesis, Fac. Agric., Mansoura Univ. Egypt.

**Abdel-Daym, S. and G.A. Oosterban (1995).** Ruse of drainage water in the Nile Delta; Monitoring, Modeling and analysis. Drainage Research Institute, Cairo.

**Abdel-Kawy, O.R.M. (2004).** Integrating GIS, Remote sensing and modeling for agricultural land suitability evaluation at East Wadi El-Natrun, Egypt. M.Sc. Thesis, Fac. Agric. Alex. Univ.

**Abdel-Mawgood, A.S.A. (1987).** Studies on tile drainage in sugarcane growing areas in upper Egypt. M.Sc. Thesis, Faculty Agric. Cairo Univ., Egypt.

**Abdul Wahid, Shamshad Akhtar; Iftikhar Ali and Ejaz Rasul (1998).** Amelioration of saline-sodic soils with organic matter and their use for wheat growth. Commun. Soil Sci. Plant Anal,, 29: 2307-2318.

**Abo-Soliman, M.S.M.; E.A. Gazia; M.M. Said and M.A. Abou El-Soud (2002).** Evaluation of mole drain practices under heavy clay salt affected soils at North Delta. National Symposium on Problems of Land Degradation in Egypt and Africa, 22-24 March.

**Abo-Soliman, M.S.M.; M.R. Khalifa; W.S. El-Sabry and K.M. Sayed (1992).** Use of drainage water in irrigation at north of Nile Delta, its effects on soil salinity and wheat production. J. Agric. Res. Tanta Univ., 18(2): 1992.

**Abo-Soliman, M.S.M.; M.M. Saied; H.A. Shams and M.A. Abou El-Soud (2001).** Environmental impact of marginal water reuse. II. Effect of marginal water on soil physical and chemical properties. Zagazig J. Agric. Res., 28(6): 1189-1207.

**Abou-Hussien, E.A. (1999).** Effect of different cultivation periods of Banana plants On: Soil Chemical properties and some nutrients status. Minufiya J. of Agric. Res. 24(2): 685-699.

**Abou Hussien, E.A. and A.M. Abou El-Khir (1999).** Evaluation of the effect of tile drainage and gypsum application on soil chemical properties and some nutrients and trace elements status. J. Agric. Sci. Mansoura Univ., 24(7): 3725-3736.

**Aboulreoos, S.A.; E.A. Awadallah and SA. Taha (1981).** Effect of flooding and clover straw addition on the redox potential, pH and concentration of manganese in some soils. Alexandria, Sci., Exch. 2(2): 147-160.

**Abou-Sinna, M.A. (1991).** Efficiency of tile drainage for providing good air-water balance in soil. Ph.D. Thesis Fac. of Agric.,, Cairo Univ., Egypt.

**Abo-Waly, M.E.; S.M. Youssef; .I. El-Shahawy and A. Gendy (1996).** Some problems of youth Graduates soils in North and West of the Nile Delta. J. Agic. Sci. Mansoura Univ., 21(12): 4593-4607.

**Abo-Zied, M.M.A. and Nashida, I. Abd El-All (2004).** Assessment of soil suitability for agricultural purposes at the western desert outskirt at Armant area, the upper Egypt region. Egypt. J. Appl. Sci., 19(9A).

**Aly, M.S.; E.A. Abou Hussien and A.S.M. Anter (2002).** Effect of tile drainage on soil properties and crop yields at north of Nile Delta. Zagazig J. Agric. Res., 29(1): 169-190.

**Amer, A.A.; S.A. AB El-Wahab and M.A. Abou El-Soud (1997).** Effect of water quality on soil salinity and some crops production. J. Agric. Sci., Mansoura Univ., 22(4): 1287-1295.

**Amer, M.H. (1996).** History of agricultural drainage in Egypt Ministry of Public Works and Water Resources (In Arabic).

**Amer, M.H. (2004).** Assessment and drainage needs in North Africa First African Regional Conference on Drainage.

**Amer, M.H. and M. Abu-Zeid (1989).** History of land drainage in Egypt. Drainage Research Institute/DRI, Cairo, Egypt.

**Amira, M.S.E. (1997).** Effect of long-term irrigation with polluted water on morphological and chemical properties of some soils of the Nile Delta. Menofia J. Agric. Res. 22(6): 1749-1765.

**Anter, A.S. (2005).** Movement of some nitrogen forms, Atrazine and Malathion in clay soils as affected by drain spacings. Ph.D. Thesis, Fac. Agric., Kafr El-Sheikh, Tanta Univ.

**Armestrong, A.B.; G.R. Pearce; D.W. Rycorft and T.W. Tanton (1990).** Field testing of a new reclamation technique for saline clay soils. Symposium on land drainage for salinity control in Arid and Semi-Arid Regions 2: 89-98.

**Attia, F.A.R and Tuinhor A. (1989).** Feasibility of tube-will drainage in the Nile valley, in Amer. M.H. and de Ridder N.A. (1989). land Drainage in Egypt Drainage Research Institute/DRI, Cairo, Egypt.

**Awad, Y.H. (1998).** Newly reclaimed soil and wheat yield as affected by FYM and Gypsum under different irrigation regimes. Zagazig J. Agric. Res. 25: 671-677.

**Awad, Y.M.; H.M. Ramadan and E.M.E. El-Fayomy (1996).** Effect of sulphur phosphorus and nitrogen fertilizers on micronutrients availability, uptake and wheat production in calcareous soils. Alexandria J. of Agric. Res., 41(3): 311: 327.

**Bacic, I.L.Z.; D.G. Rossiter and A.K. Breget (2003).** The use of land evaluation information by land use planners and decision. Markes: A case study in Santa Catarina, Brazil Soil Use land Management, 19, 1, 12-18. (Viewed at w.w.w., cab direct.com).

**Bahanassy, M.; H. Ramadan; F.H. Abdel-Kader and H.A. Yehia (2001).** Coupling GIS with modeling tools to support land use planning and management of sugar beet area, West Nubaria, Egypt. Alex. J. of Agric. Res., 46(1): 169-180.

**Baver, L.D.; W.H. Gardner and W.R. Gardner (1972).** Soil physics John Wiley and Sons., Inc., New York 4th edition.

**Beshay, N.F. and A.Sh. Sallam (2001).** Effect of land management practices on soil characteristics and sustainable productivity (East of the Nile Delta). Egypt. J. Sci., 41(3): 135-378.

**Black, C.A. (1965).** Methods of soil analysis. Part 2. Agron. Monograph. No. 9, ASA Madison, Wisc, USA.

**Chattopadhyay, C.N. and L.N. Mandal (1980).** Effect of different levels of water salinity on the decomposition of organic manure in a brackish water fish pond soil. Hydrobiologia, 72: No. 3: 287-292.

**Chauchan, C.P.S. and Tripathi, B.R. (1983).** Reclamation studies on highly saline-sodic soil of semi-arid tract in Uttar Pradesh. J. Indi. Soc. of Soil Sci. 13(4): 587-595.

**Chawla, K.L. and R. Chhabra (1991).** Physical properties of gypsum amended sodic soil as affected by long term use of fertilizers. J. Ind. Soc. of Soil Sci. 39: 40-45.

**Cottenie, A.; M. Nerloo; G. Velghe and L. Kiekens (1982).** Biological and analytical aspects of soil pollution. Lab. of analytical Agro. State Univ. Ghent-Belgium.

**De La Rosa, D.; J.A. Moreno; L.V. Garcia and A. Almorza (1992).** Micro LEIS: A microcomputer-based Mediterranean land evaluation in formation system. Soil Use and Management. 8: 89-96.

**Edwards, J.H.; C.W. Wood; D.L. Thurlow and M.E. Ruf (1992).** Tillage and crop rotation effects on fertility status of a hapludult soil. Soil Science Society of American Journal (USA). 56(5): 1577.

**El-Arquan, M.S. and S.A. Abd El-Hafez (1982).** Effect of puddling and paddy cultivation of rice on soil physical properties. J. Agric. Sci., Mansoura Univ., 7: 114-125.

**El-Fakharani, Y.M. (1997).** Response of broad beans to gypsum and poultry manure in salt-affected arid environment. J. Agric. Sci., Mansoura Univ., 22: 4023-4034.

**El-Fayoumy, M.E. (1989).** New approach of land evaluation of some Egyptian regions. Ph.D. Thesis, Fac. of Agric., Univ. of Alexandria.

**El-Gala, A.M.; M.A. Eid and H.G. Al-Shandoody (1998).** The effect of organic matter, sulphur and Fe applications on the availability of certain nutrients in the soils of El-Dhahera area, Sultanat of Oman. Arab Univ. J. of Agric. Sci. 6(2): 607-623.

**El-Gazzar, A.A. (1966).** Use of low quality water in irrigation and its effect on soil properties. Ph.D. Thesis, Faculty of Agric. Moshtohor, Zagazig Univ., Benha branch, Egypt.

**El-Ghazoli, M.A. (1998).** Studies on some organic residues enriched with some macro and microntrients. Ph.D. Thesis, Fac. Agric. Moshtohor, Zagazig Univ., Benha Branch, Egypt.

**El-Gohary, S.A.; A.A. El-Leithi and H.H. Ali (1989).** Effect of tile drainage and nitrogen fertilization on some soil properties and yield as well as components of wheat in heavy clay soils. J. Agric. Res., Tanta Univ., Egypt. 15(3): 569-582.

**El-Henawy, A.S.E. (2000).** Impact of available water sources at North Delta on soil and some field crops. M.Sc. .Thesis, Fac. agric. Kafr El-Sheikh Tanta Univ.

**El-Hessy, Farida and El-Kady, Mona (1997).** Interventions of water saving for Egypt 's Nile Irrigation system. Second International Water Technology Conference, IWTC, Alexandria.

**El-Maaz, E.I.M. (1997).** Classification and evaluation of some soils in western side of Nile Delta. M.Sc. Thesis, Fac. of Agric. Minofiya Univ., Egypt.

**El-Maddah, E.I. (2000).** Effect of some amendments on some physical and hydrophysical soil properties. Agric. Sci. Mansoura Univ., 25(7): 4765-4775.

**El-Morssi, S.A.El. (1990).** Some soil properties and sugar beet yield as affected by ploughing depths and fertilization in salt affected soil. M.Sc. Thesis, Fac. Agric., Kafr El-Sheikh, Tanta Univ.

**El-Mowelhi, N.M.; M.S.M. Abo-Soliman; M.A. Abo-El-Soud; and S.A. Hassanein (1995).** Studies on using different drainage water resources in relation to soil salinity and productivity of some summer crops. Proceeding of the Second Conference. On Farm Irrigation and Agroclimatology. Soil and Water Research Institute, Agriculture Institute, Agricultural Research Center, 187-195.

**El-Nahal, M.A.; Sh. Abdel-Aal; A.A. El-Wahed and I. Raafat (1977).** Soil studies on the Nile Delta Egypt. J. Soil. Sci. 17(1): 66-75.

**El-Sabry, W.S. (1986).** Reclamation processes and their effects on some properties and crops yield in deteriorated soils, at north delta. Ph.D. Thesis, Fac. Agric., Ain Shams Univ.

**El-Sabry, W.S.; M.A. Abou El-Soud, M.S.M. Abo-Soliman and M.A. El-Abaseri (1992).** Effect of sandy back filled mole on some physical and chemical properties and productivity of clay compacted soil. J. Agric. Sci. Mansoura Univ., 17(8): 2790-2797.

**El-Sakka, M.M.A. (2004).** Soil evaluation in Egypt. Ph.D. Thesis, Fac. of agric. Zagazig Univ.

**El-Samanoudi, I.M. (1992).** Impact of applying drainage water on hydrophysical properties of clayey soils in Fayoum Depression. Egypt. J. Soil. Sci. 32(3): 373-390.

**El-Shanawany, El. A.; A.T.S. Bobal and M.E.A. Khall (2000).** Utilization of gypsum and sub-soiling application for increasing the yield of wheat crop. Fayoum, J. Agric. Res. & Dev., Vol. 14, No. 1, January.

**El-Toukhy, M.M. (2004).** Classification and evaluation of some soils in the North Western coast of Egypt. Egypt. J. Appl. Sci. 19: 378-390.

**Elwan, I.M. and A.M. Kandil (1992).** Effect of water salinity on the growth and the chemical composition of marjoram plants. Effect of salinity on chemical composition. Annals Agric. Sci. Ain Shams, Cairo 37(1): 243-252.

**Faltas, R.L.; B.H. Naguib and M.M. Seleim (1991).** Changes of physicochemical soil properties and crop yield of different drain spacing. Egypt. J. Appl. Sci., 6(12): 374-387.

**FAO (1976).** A Framework for land evaluation. FAO Soils Bulletin, No. 32, 72p.

**FAO (1990).** Guidelines for soil profile description. 3rd ed. FAO, Rome.

**FAO (1992).** The use of saline water for crop production.

**FAO (1993).** Guidelines for land-use planning development series, 1, Rome.

**Fayed, R.I.M. (2003).** Impact of land management practices on soil quality in sandy soils, El-Bostan Region-Egypt. Ph.D. Thesis, Fac. Agric. Alex Univ.

**Foth, H.D. (1990).** Fundamentals of soil science. John Wiley & Sons, New York.

**Gazia, E.A.E. (2001).** Effect of different water sources under soil moisture depletion on soil salinity, alkalinity and the yield of sugar beet and sunflower plants. Minufia J. Agric., Res. 26(3): 905-919.

**Gendy, A.A.S. (2001).** Pedological changes of the Nile Delta soils as affected by the tile drainage. Ph.D. Thesis Fac. Agric. Kafr El-Sheikh. Tanta Univ.

**Ghabour, Th.K.; M.I. El-Taweel and F.B. Labib (1994).** Land suitability classification of El-Katta Farm, Giza Governorate, Egypt. Egypt. J. Soil. Sci. 34(4) 357-372.

**Ghazy, M.A. (2002).** Effect of water quality and irrigation practices on some soil properties and productivity. J. Agric. Sci. Mansoura Univ., 27(10): 7101-7115.

**Ghazy, M.A. (2003).** Impact of different irrigation water sources on hydrophysical properties of some soil types. J. Agric. Sci. Mansoura Univ., 28(10): 7519-7530.

**Ghosh, S.N.; A.K. Kar and S.P. Dhua (1976).** Effect of sampling variation on $E_h$, pH and available P, Fe and Mn in submerged rice soils. J. Indian, Soc. Soil Sci. Vol. 24(1): 86-87.

**Giraldez, J.V. and Gruz Remero (1975).** Salt movement in Gaudalquiver marshy soils under field and laboratory conditions. Egypt. J. Soil Sci. 15(1): 79-93.

**Gomaa, M.H. (1998).** Effect of drainage spacing, sub-soiling tillage and gypsum application on properties and productivity of El-Hamoul soils. Fayoum Agric. Res., Dev., 12: 173-180.

**Gouda, M.; M.S. Omar and S.A. Hammad (1990).** Years of land use in relation to moisture characteristics and porosity in sandy soils. Egypt. J. Soil Sci., 30(3): 521-525.

**Habib, E.K. (1999).** Effect of irrigation water salinity on water consumptive use of Sudan grass and properties of African calcareous soils. M.Sc. Thesis, Institute of African Res. Arid Studies Dep. Natural Resources Cairo Univ.

**Hamdi, H.; S.Y. Metwally and F.M. Ibrahim (1968).** Salt movement in a saline soils of the U.A.R.J. of Soil Sci. 8(1): 35-49.

**Hamissa, M.R.; Serry, A. and El-Mowelhi, N.M. (1993).** Fertilizer management for corn in Egypt. Soil and Water Reseach Institute, Cairo, Egypt, p. 36.

**Hamoud, H.S.M. (1992).** Some factors affecting sugar beet yield in some Egyptian soils. M.Sc. Thesis Fac, Agric., Kafr El-Sheikh, Tanta Univ.

**Hassan, E.A.; A.H. Ibrahim; A.F. Amer and O.M. El-Sheikh (2003).** Some soil salinity problems in relation to irrigation with low quality. Zagazig J. Agric. Res., 30(2).

**Hassanien, H.G. and M.K. Rushdi (1975).** Desalinization trial of salt affected calcareous soil. Egypt. J. Soil Sci., Special Issue, 245-254.

**Hassanien, H.G.; M.L. Abu Zeid; M.H. Nafady and M.M. Ahmed (1992).** The effect of organic manure and Nile sediments on the capacity of sandy calcareous soil for supplying K. Assiut Journal of Agric. Sci. 23(4): 187-202.

**Hassett, J.J. and J.J. Jurink (1971).** Effect of $Mg^{++}$ ion on the solubility of solid carbonates. Soil Sci. Soc. Amer. Proc. 35: 403-406.

**Higab, I.A. (2005).** An evaluation of some soils of south El-Borolous lake area. Ph.D. Thesis, Fac. Agric., Al-Azhar Univ.

**Ibrahim, S.M. (1998).** Movement of water and salt in flood and drip irrigated clay soils as affected by tile drainage. Proceeding of the Seventh International Drainage Symposium 8-10 March, Amer, Soc. Agric. Engines, 2950 Niles Red. St. Joseph. Michigan, 4085-96-59.

**Islam, A. and W. Islam (1973).** Chemistry of submerged soils and growth and yield of rice. 1- Benefits from submergence. Plant and Soil 39, 555-565.

**Ismail, H.A.; S.M. Marie and M.E. El-Fayoumy (1994).** A modified approach for land evaluation under arid and semi-arid condition. 12: Basis and Computer Program. J. Agric. Sci. Mansoura Univ., 19(10): 3483-3295.

**Ismail, H.A.; I.M. Morsy; E.M. El-Zahaby and F.S. El-Nagar (2001).** A developed expert system for land use planting by coupling and modeling. Alex. J. Agric. Res. 46(3): 141-154.

**Jackson, M.L. (1973).** Soil chemical analysis. Advanced course Ed. 2. A manual of methods useful for instruction and research in soil chemistry, Physical Chemistry a of soils, soil fertility and soil genesis. Revised from original Edition of 1956.

**Kandil, N.F. (1990).** Effect of using drainage water on soil physical, chemical and hydrological properties in some soils of Egypt. Ph.D. Thesis Fac. Agric. Univ. of Ain Shams, Cairo, Egypt.

**Kaoud, E.E.; Omar, M.S.; Hamad, S.A. and Metwally, S.A. (1989).** Effect of management of sodium affected soil on rice production. Egypt. J. Soil Sci., 29: 435-444.

**Khalifa, M.R. (1990).** Evaluation of suitability of drainage water for irrigation purposes. Its effect on some properties of clay soil in North Delta. J. Agric. Res. Tanta Univ., 16(3).

**Khater, E.A. (1988).** Water movement conditions in some soils of Fayoum Governorate. Egypt. J. Soil Sci. 28(1): 103.

**Klingebiel, A.A. and P.H. Montgomery (1966).** Agricultural Hand Book No. 210, USDA Washington, D.C.

**Klute, A. (1986). Methods of soil analysis (Part 1).** America Society of Agronomy, Inc. Soil Sci. Soc. of Amer. Inc. Madison, Wisconsin, USA. Second Edition.

**Kobkiet, P.; W. Chairoj and B. Pradit (1993).** Improvement of soils for field crops in the Northeast, Thailand. Workshop on Research Activities of ADRC contributed to Agricultural Development in Northeast Thailand, Agricultural Development Research Center in Northeast, Khon Kaen (Thailand).

**Koriem, M.A. (1993).** Influence of sewage sludge and farmyard manure applications on some properties of clay soil and root yield of carrot. J. Agric. Res., Tanta Univ. 19: 1012-1022.

**Koriem, M.A. (1994).** Effect of irrigation water qualities and N-forms on some soil properties and elemental composition and egg plant fruits grown in different soils. J. agric. Res. Tanta Univ. 26(2): 325-334.

**Koriem, M.A.; M.R. Khalifa; M.A. Ibrahim and S.A. Ghaeen (1988).** Effect of irrigation with different water qualities on some chemical and physical properties of the soil at two levels of moisture depletion. J. agric. Res. Tanta Univ., 14(4): 1988.

**Labib, F. (1963).** Morphological and chemical studies on the soils. M.Sc. Thesis, Fac. of Agric. Ain Shams Univ., Egypt.

**Levy, G.J.; N. Sharshekeev and G.L. Zhuravskaya (2002).** Water quality and sodicity effects on soil bulk density and conductivity in interrupted flow. Soil Sci. 167(10): 692-700.

**Lindsay, W.L. and W.A. Norvell (1978).** Development of a DTPA soil test for Zinc., Iron, manganese and copper" soil Sci. Soc. Amer Proc., 43:L 421-428.

**Madkour, H.E.A.; A.M.M. Hamouda and S.A. Moussa (1999).** Hydraulic conductivity and structure factor of alluvial soils as affected by some soil properties. J. Agric. Sci. Mansoura Univ., 24(8): 4249-4258.

**Madramootoo, C.A. and C. Buckland (1990).** Assessing drainage benefits on a heavy clay soil in Quebec Transactions of the ASAE, 33(4): 1217-1223.

**Mahmoud, H.M.M. (1994).** Microbiological studies on the management urban wats. Ph.D. Thesis, Fac. of Agric. Moshtohor, Zagazig Univ., Egypt.

**Mahmoud, M.R.; N.M. Badr and M.H.E. Salem (2001).** Influence of gypsum, sulphur and farmyard manure applications on some soil properties and yield of sunflower grown on saline-sodic soil. Minufiya. J. Agric. Res. 26(1): 215-223.

**Mahmoud, S.A.; T.H. Sheta and M.H. Gomaa (1996).** Effect of applied gypsum and water regime on some chemical and nutrition properties of Newly reclaimed saline alkali soils. J. Agric. Sci. Mansoura Univ., 21: 2399-2407.

**Marei, S.M.; H.A. Ismail and H. Meshref (1987).** A computer program for land evaluation in Egypt. J. Agric. Sci. Mansoura Univ. 12(4): 1427-1447.

**McConkey, B.G.; Ulirich and F.B. Dyck (1997).** Slope position and subsoiling effect on soil water and spring wheat yield. Can. J. Soil Sci. 77: 83-90.

**Ministry of Water Resources and irrigation (MWRI, 2005).** Water for the Future National Water Resources Plan 2017.

**Mostafa, M.A.; A.B. El-Menshawy; K.M. Sayed and M.I. El-Shahawy (1997).** Land capability and predicting optimum cropping pattern by linear programming Technique for some Egyptian soils. Menofiya. J. Agric. Res. 22(6): 1719-1731.

**Mostafa, M.A.; Sh.M. Gawish and E.A. Basyouny (2001).** Effect of enriched organic manures with Fe and/or Zn on the availability of Fe, Zn in newly reclaimed soils. Minufiya J. Agric. Res. 26(6): 1667-1680.

**Mostafa, M.A.; E.M. Khaled; A.M. El-Sweedy and A.Sh. Abd El-Nour (1992).** The effect of irrigation water quality on some chemical properties of certain soils of Egypt. Egypt. J. Soil Sci. 32(3): 391-406.

**Moukhtar, M.M.; E. El-Hadidy and M.A.B. El-Shewikh (2003).** Drainage and degrading salty clay soil in Egypt. The International Drainage Workshop September 10-13, Utrecht the Netherlands.

**Moustafa, F.B.; F.M. Ibrahim and S. Fikry (1990).** Drainage efficiency and soil productivity in Fayoum Governorate. Agric. Res. Rev., 68(2): 253-261.

**Nadia, M.B.; Khalil, M.E.A. and El-Emam, M.A.A. (2000).** Availability of N, P and K in sandy and clayey soils as affected by the addition of organic materials. Egypt. J. Soil Sci. 40: 265-183.

**Nagarajarao, Y. and G. Jayasree (1994).** Effect of different long-term soil management practices on strength and well-shrink characteristics, Voids and microstructure. 15th World Congress of Soil Science, Acapulco, Mexico, Transactions, Vol. 6a: commission. V: Symposia. 27, 308.

**Naguib, B.H. (1987).** Tile drainage in relation to soil characteristics and plant growth, Ph.D. Thesis, Fac. Agric. Moushtohor Zagazig Univ. (Benha branch) Egypt.

**Nairooz, F. (1967).** Land utilization in its physical frame-work, in Fayoum Governorate. M.Sc. Thesis, Fac. of Agric., Ain-Shams Univ., Cairo.

**Nashy, R.A.M. (1986).** Some chemical and physical variations in soil properties under conditions of fish farming. M.Sc. Thesis, Fac. Agric. Moshtohor, Zagazig University.

**Nasr El-Din, I.E.I. (2001).** Evaluation of some different soils from Kafr El-Sheikh under different crop patterns. Ph.D. Thesis, Fac. of Agric. Kafr El-Sheikh Tanta Univ.

**Noaman, K.I. and A.S. Sheta (1988).** Chemical and mineralogical studies on some deposits in North Eastern Delta Region, Egypt. J. Soil Sci. 28, 274.

**Olsen, S.R.; C.V. Colc; F.S. Watanabe and L.A. Dean (1954).** Estimated of available phosphorus in soil by sodium bicarbonate. U.S. Dept. Agric. Circ. 939.

**Omar, E.H.; E.A. Gazia; M.A. Ghazy and M.A.A. Abd Allah (2001).** Effect of irrigation water quality and sludge application on soil salinity, sugar beet and canola yields and irrigation efficiencies. Minufia J. Agric. Res. 26(6): 1651-1665.

**Omar, M.S.; S.A. Hammad and M. Gouda (1990).** Infiltration characteristics of sodium affected soil as related to soil management. Egypt. J. Soil Sci., 30(4): 579.

**Omer, M.A. and O.A. El-Kholie (1970).** Optimum allocation of agricultural inputs to soils with variable productivities. Tropical and Subtropical Inst., Liebsig, Germany.

**Page, A.L. (1982).** Methods of soil analysis part 2: Chemical and microbiological properties (2nd ed.) Amer. Soc. Agron. in soil Sci. Soc. Amer. Inc. Madison, Wisconsin, USA Chapter 12: pp. 199-223.

**Piper, C.S. (1950).** Soil and Plant Analysis. Inter. Sci. Publ. Inc. New York, U.S.A.

**Ponnamperuma, F.N. (1972).** The chemistry of submerged soils. Advances in Agronomy: 24, 29-96.

**Rabie, Farida; A.S. Sheta and O. El-Sharif (1988).** Anthropioc influences on the properties of some sandy soils in Egypt. Egypt. J. Soil Sci. 28(2), 153.

**Ramadan, S.A.; M. Abo-Waly and R.A. Ali (1994).** The influence of fish farming on clayey salt affected soils. J. Agric. Sci. Mansoura Univ., 19(1): 387-400.

**Ramadan, S.A.; A.A.S. Gendy; N.I. Talha and A.A. El-Leithi (2006).** Effect of distance from drain line on wheat crop under different rates of nitrogen fertilization in clay soil. J. Agric. Mansoura Univ., 31(4): 2583-2591.

**Ramadan, S.A.; S.A. El-Gohary and A.A. El-Leithi (1994).** Influence of tile drainage spacing under rice cultivation on some chemical and physical properties of heavy clay soil. J. Agric. Sci. Mansoura Univ., Egypt. 19(9): 3119-3133.

**Rany, W.A.; T.W. Edminster and W.H.A. Allaway (1995).** Current status of research in soil compaction. Soil. Sci. Soc. Amer. Proc. 19, 423.

**Rechcigl, Jack, E. (1995).** Soil amendments and environmental quality. LEWIS. Publ., SHERS New York, London.

**Rehman, H.A.A.; M.H. Dahab and M.A. Mustafa (1996).** Impact of soil amendment on intermittent evaporation, moisture distribution in saline sodic clay soil columns. Soil Sci. 161: 793-802.

**Rhoads, J.D.; A. Kandiah and A.M. Mashali (1992).** The use of saline waters for crop production, FAO irrigation and drainage paper 48. Rome.

**Rice, T.D. (1936).** Physical characteristics of the soil profile as applied to land classification. Soil Sci of Amer. Proc. 1: 455-458.

**Richards, L.A. (1954).** Diagnosis and improvement of saline and alkali soils. USDA Agriculture Handbook, No. 60

**Riquier, J.; D.L. Bramoo and J.P. Cornet (1970).** A new system of soil appraisal in terms of actual and potential productivity. FAO soil Resources development and Conservation Service, Land and Water Development Division. FAO, Rome. 38.

**Rossiter, D.C. (1990).** A framework for land evaluation using a microcomputer. Soil Use and Management. 7: 7-20.

**Rossiter, D.C. and A.R. Van Wambek (1995).** Automated land evaluation system (ALES), version 4-1 Cornell Univ. USA.

**Saad, A.F.; A.M. Gomah and A.M. Amin (2001).** Role of soil amendments on the efficient of leaching process in salt affected soils of El-Farafra oasis. Egypt. J. Agric. Sci. Mansoura Univ., 26(10): 6511-6523.

**Salem, F.S. (2003).** Effect of some soil amendments on the clayey soil properties and some crops production. Minufiya. J. Agric. Res. 28(5): 1705-1715.

**Sangwan, B.S. and K. Singh (1993).** Vertical distribution of Zn, Mn, Cu and Fe in the semi-arid soils of Haryana and their relationships with soil properties. J. of Indian Soc. Soil Sci., 41(3): 403-407.

**Schellekens, M.; L.K. Smedma; B. Shindi and El-Gayar (1990).** Drainage and desalinization trials in heavy clay soils in the Kafr El-Sheikh area in Egypt. Symp. on Land Drainage for Salinity control in arid and semi-arid-regions. Vol. 3, Feb. 25th to March 2nd 1990 Cairo Egypt.

**Shams El-Din, H.A. (2001).** Productivity of heavy clay soils as affected by soil amendments and drainage treatments. J. Agric. Sci. Mansoura Univ., 26(12): 8169-8180.

**Shams El-Din, H.A.; E.A. Gazia ; M.A. Abo El-Soud and M.M. Ragab (2000).** On-farm soil amelioration procedures of some slat affected soils at North Delta 8th Conf. Agric. Dev. Res., Fac. Agric., Ain Shams Univ., Cairo, November 20-22, 2000 Annals Agric. Sci. Sp. Issuel, 269-288.

**Sobh, M.M.; E.A. Mashaly and M.H. Amer (1997).** Effect of diluted sea water on some soil chemical properties of some calcareous and non calcareous soils and mineral composition and yield of wheat plants. Zagazig. J. Agric., Res. Vol. 24 No. (5).

**Sojka, P.E.; D.C.W. Ross and C.J. Baker (1997).** Subsoiling and surface tillage effects on soils physical properties and forage oat stand and yield. Soil and Tillage Research 40: 125-144.

**Soliman, H.S.H. (1982).** The effect of the functional groups of some nutrients produced during decomposition of organic matter in plant nutrition. Ph.D. Thesis Fac. of Agric. Zagazig Univ., Egypt.

**Storie, R.E. (1937).** An index for rating agricultural value of soils. Bull. 556. Univ. of California, Berkeley, CA.

**Sys, C. and R. Frankart (1971).** Land capability classification in the Humid Tropics. African Soils, Vol. XVI, No. 3: 153-175.

**Sys, R.C.; E. Van Ranst and J. Debaveye (1991).** Land evaluation. Part II. Methods in land evaluation. Agric. Publ. No. 7. Belgium.

**Tayel, M.Y.; M. Abd El-Hady and E.E. El-Dardiry (2003).** Method of using drainage water in irrigation. 1. Its effect on soil aggregation. Egypt. J. Soil Sci., 43(2): 153-164.

**Tiwari, R.C.; U.N. Verma and A.K. Mishra (1995).** Effect of long-term cropping systems on chemical characteristics of soil profiles. J. of Indian Soc. Soil Sci., 43(2): 278-279.

**Tripathi, D.; K. Singh and O.P. Upadhyaay (1994).** Distribution of micronutrients in some representative soil profiles of Himachal proadesh. J. of Indian Soc. Soil Sci. 42(1): 143-145.

**USBR (1953).** Reclamation Manual. Vol. V Irrigated land use. Part 2. Land Classification U.S.B.R., Denver, Colorado.

**Van Beers, W.F.J. (1970).** The auger hole method. Bull. No. 8, ILRI Wageningen, the Netherlands.

**Verma, L.P.; R. Singh and P.N. Dwivedi (1994).** Changes in properties of the salt affected soils under different fruit species. J. of Indian. Soc. Soil Sci. 42(1): 141-142.

**Wahdan, A.A.; A.M. Helalia and H.M. Nasr (1992).** Impact of subsurface drainage on some soil properties in upper Egypt. Proceeding of the $5^{th}$ International Drainage Workshop Lahore, Pakistan, ICID, IWASRI, Vol. 111. 671-679.

**Wahdan, A.A.; M.M. El-Shall and A.T. Mostafa (1985).** Soil physical properties changes associated with tile drainage application in upper Egypt. Egypt. J. Soil Sci. 25(1): 11-20.

**World Bank (2006).** Regional initiative for dry land management final report.

**Youssef, N.N. (1992).** Availability of some essential nutrients during submergence in gypsum treated saline sodic soil under different conditions. Zagazig J. Agric. Res. 19: 2509-2522.

**Zhang, H.; K.H. Hartge and H. Ringe (1997).** Effectiveness of organic matter incorporation in reducing soil compactibility. Soil Sci. Soc. Am. J. 61: 239-245.

**Zien, F.I.; E.H. Omar; M.A.A. Abd Allah and M.S. El-Yamani (2002).** Influence of irrigation water quality on heavy metals content of soils, water table and some crops at the Northern Nile Delta. Egypt. J. Soil Sci. 42(4): 739-750.

**Zien, F.I.; K.M. Sayed and A.A. El-Leith (1996).** Effect of gypsum and farmyard manure on: II. The physical characteristics of moderately salt affected soils. J. Agric. Sci., Mansoura Univ., 21: 2409-2419.

عبد الحميد فتحى (١٩٥٧). "تقييم الاراضى الزراعية المصرية "مجلة العلوم الزراعية المجلد العاشر العدد الاول اكتوبر ١٩٥٧م.

محمد احمد عبد المطلب وسيف الدين احمد حسين (١٩٨٥). "تقييم الاراضى الزراعية". كلية الزراعه – جامعة الازهر.

# APPENDICES

# Appendix 1

Ground water samples analysis.

| Prof. No. | EC dS/m | Soluble anions, meq/L | | | | Soluble cations, meq/L | | | | SAR |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $HCO_3^-$ | $CO_3^=$ | $Cl^-$ | $SO_4^=$ | $Ca^{++}$ | $Mg^{++}$ | $Na^+$ | $K^+$ | |
| A. Al-Zawea Region | | | | | | | | | | |
| 1 | 160.00 | 5.50 | 0.0 | 1560.00 | 120.40 | 67.50 | 120.00 | 1487.90 | 10.50 | 153.58 |
| 2 | 50.00 | 5.10 | 0.0 | 435.09 | 115.93 | 80.00 | 18.71 | 455.20 | 2.21 | 64.79 |
| 3 | 42.00 | 4.60 | 0.0 | 354.50 | 90.81 | 64.55 | 15.57 | 365.91 | 3.88 | 57.81 |
| 4 | 40.00 | 2.33 | 0.0 | 352.80 | 45.24 | 57.58 | 14.42 | 326.51 | 1.86 | 54.42 |
| 5 | 25.90 | 1.90 | 0.0 | 218.60 | 11.18 | 24.48 | 38.55 | 166.03 | 2.62 | 29.62 |
| 6 | 119.00 | 5.90 | 0.0 | 1142.40 | 180.20 | 41.70 | 166.60 | 1106.70 | 13.50 | 108.44 |
| 7 | 80.00 | 4.50 | 0.0 | 760.00 | 126.60 | 32.60 | 120.00 | 728.00 | 10.50 | 83.34 |
| 8 | 74.00 | 4.30 | 0.0 | 710.00 | 122.40 | 39.20 | 109.00 | 680.00 | 8.50 | 79.00 |
| 9 | 66.00 | 6.50 | 0.0 | 627.00 | 96.20 | 37.70 | 95.80 | 587.20 | 6.50 | 71.87 |
| B. Al-Mansour west region | | | | | | | | | | |
| 10 | 116.00 | 4.60 | 0.0 | 1079.00 | 173.20 | 46.50 | 162.40 | 1044.00 | 4.00 | 102.18 |
| 11 | 57.00 | 5.50 | 0.0 | 488.90 | 125.60 | 38.80 | 145.50 | 432.50 | 3.20 | 45.05 |
| 12 | 50.00 | 4.50 | 0.0 | 434.50 | 91.00 | 46.70 | 106.80 | 371.30 | 4.20 | 42.38 |
| 13 | 44.00 | 4.00 | 0.0 | 325.00 | 131.00 | 34.40 | 110.60 | 310.80 | 4.20 | 36.50 |
| 14 | 33.00 | 3.50 | 0.0 | 235.10 | 111.40 | 31.50 | 107.10 | 206.90 | 4.50 | 24.85 |
| 15 | 130.00 | 7.50 | 0.0 | 1261.00 | 153.70 | 44.20 | 156.00 | 1209.00 | 13.00 | 120.80 |
| 16 | 68.00 | 6.00 | 0.0 | 940.80 | 118.10 | 24.30 | 127.40 | 891.80 | 11.40 | 99.18 |
| 17 | 66.00 | 6.30 | 0.0 | 758.40 | 70.90 | 27.70 | 86.90 | 711.00 | 10.00 | 93.93 |
| 18 | 70.00 | 5.40 | 0.0 | 676.00 | 79.20 | 28.00 | 91.00 | 637.00 | 4.60 | 82.58 |
| 19 | 65.00 | 5.80 | 0.0 | 598.00 | 78.00 | 21.50 | 80.80 | 617.50 | 5.00 | 86.34 |
| C. Fish Farms | | | | | | | | | | |
| 20 | 57.00 | 6.00 | 0.0 | 504.00 | 70.00 | 36.00 | 90.00 | 450.00 | 4.00 | 56.69 |
| 21 | 81.00 | 4.50 | 0.0 | 740.00 | 51.50 | 42.00 | 80.00 | 670.00 | 4.00 | 85.78 |

## Appendix (2)

**Gypsum requirements (ton/feddan) needed to maximize the production of selected crops using ASLE program**

| Profile No. | Agric-periods | Cotton | Sugar beet | Sun-flower | Barley | Wheat | Rice | Alfalfa |
|---|---|---|---|---|---|---|---|---|
| Fresh irrigation water, tile drainage system | | | | | | | | |
| 2 | 5 years | 6.76 | 4.32 | 4.32 | 4.32 | 4.32 | 4.32 | 4.32 |
| 3 | 15 years | 5.77 | 3.10 | 3.10 | 3.10 | 3.10 | 3.10 | 3.10 |
| 4 | 30 years | 4.14 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 |
| 5 | 50 years | 2.47 | No | No | No | No | No | No |
| Fresh irrigation water, open drainage system | | | | | | | | |
| 7 | 5 years | 8.08 | 6.23 | 6.23 | 6.23 | 6.23 | 6.23 | 6.23 |
| 8 | 15 years | 5.50 | 2.75 | 2.75 | 2.75 | 2.75 | 2.75 | 2.75 |
| 9 | 30 years | 4.46 | 2.51 | 2.51 | 2.51 | 2.51 | 2.51 | 2.51 |
| Blended irrigation water, tile drainage system | | | | | | | | |
| 11 | 5 years | 8.34 | 5.68 | 5.68 | 5.68 | 5.68 | 5.68 | 5.68 |
| 12 | 15 years | 6.05 | 3.92 | 3.92 | 3.92 | 3.92 | 3.92 | 3.92 |
| 13 | 30 years | 5.18 | 3.01 | 3.01 | 3.01 | 3.01 | 3.01 | 3.01 |
| 14 | 50 years | 4.19 | 2.04 | 2.04 | 2.04 | 2.04 | 2.04 | 2.04 |
| Blended irrigation water, open drainage system | | | | | | | | |
| 16 | 5 years | 8.58 | 5.92 | 5.92 | 5.92 | 5.92 | 5.92 | 5.92 |
| 17 | 15 years | 7.23 | 4.81 | 4.81 | 4.81 | 4.81 | 4.81 | 4.81 |
| 18 | 30 years | 6.16 | 3.60 | 3.60 | 3.60 | 3.60 | 3.60 | 3.60 |
| 19 | 50 years | 5.05 | 2.90 | 2.90 | 2.90 | 2.90 | 2.90 | 2.90 |

## Appendix (3)

**Profile No.: 1**

**Date of description: 24-12-2003**

**Location:** Taba Village-8 kg North West Sugar Factory

**Coordinates:** Longitude 31° 01.587 E-Latitude 31° 19.340 N

**Topography:** Flat

**Slope**: Level

**Land use period**: Virgin soil

**Land use**: Non cultivated or bare soil

**Irrigation source:** Al-Halafi canal-Fresh water

**Drainage system**: Tile drainage

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Dark grayish (10 YR 4/1) dry to grayish brown (10 YR5/2) moist, clay, massive structure, very compact, very sticky, very plastic wet, firm moist, very hard dry, few decayed organic residues, salt formations, slightly effervescence with HCl, diffuse boundary to |
| $C_1$ (30-60) | Dark grayish brown (10 YR 4/2) dry to grayish brown (10 YR 5/2) moist, clay, massive very compact, very sticky, very plastic wet, firm moist, very hard dry, few small sub rounded spherical white soft carbonate nodules, slightly effervescence with HCl smooth sharp boundary to |
| $C_2$ (60-90) | Dark grayish brown (10 YR 4/2) dry to grayish brown (10 YR 5/2) moist, clay, massive, very compact, very sticky, very plastic wet, firm moist, very hard dry, few small sub rounded spherical white soft carbonate nodules, decayed organic residues, slightly effervescence with HCl, diffuse boundary to |
| $C_3$ (90-120) | Gray (10 YR 5/1) dry to grayish brown (10 YR 5/2) moist, clay, massive, compact, slightly sticky, slightly plastic wet, slightly hard dry, slightly effervescence with HCl. |

**Profile No.**: 2

**Date of description**: 26-12-2003

**Location**: Tyba Village 500 m West Sugar Factory.

**Coordinates**: Longitude 31° 03.358 E Latitude 31° 15.891 N

**Topography**: Flat

**Slope:** Level

**Land use period**: 5 years

**Land use**: Cultivated (clover crop)

**Irrigation source**: Al-Ghabat canal (fresh water)

**Drainage system**: Tile drainage

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Dark grayish brown (10 YR 3/2) dry to very dark grayish brown (10 YR 3/2) moist, clay, massive structure, sticky, plastic wet, firm moist, hard dry, few fine and medium roots, few fresh healthy few subrounded sperieal white soft carbonate nodules, few effervescence with HCl, diffuse boundary to |
| $C_1$ (30-60) | $C_1$ (30-60) dark grayish brown (10 YR 4/2) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure, very sticky, very plastic wet, firm moist, hard dry, few decayed organic residues, few effervescence with HCl, smooth sharp boundary to. |
| $C_2$ (60-90) | Grayish brown (10 YR 3/3) dry to dark grayish brown (10 YR 4/2) moist clay, massive structure, very sticky, very plastic wet, firm moist, hard dry, few decayed organic residues, slightly effervescence with HCl, smooth sharp boundary to |
| $C_3$ (90-120) | Brown (10 YR 4/3) dry to grayish brown (10 YR5/2) moist, silty clay, massive structure, very sticky, very plastic wet, firm moist, very hard dry, small subrounded spherical white soft carbonate nodules, slightly effervescence with HCl, diffuse boundary to |

**Profile No.:** 3

**Date of description:** 21-12-2003

**Location:** Taba Village, 8 kg North West of Sugar Factory

**Coordinates:** Longitude 31° 01.914 E- latitude 31° 18.498 N

**Topography:** Flat

**Slope:** Level

**Land use period**: 15 years

**Land use**: Cultivated clover crop

**Irrigation source:** Al-Halafi canal (Fresh water)

**Drainage system**: Tile drainage

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Very dark grayish brown (10 YR 3/2) dry to very dark grayish brown (10 YR 3/2) moist, clay, massive structure, compact, sticky, plastic wet, firm moist, very hard dry, many fine to medium healthy roots, slightly effervescence with HCl, diffuse boundary to |
| $C_1$ (30-60) | Very dark grayish brown (10 YR 3/2) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure, very compact, sticky, plastic wet, firm moist, very hard dry, many fine healthy roots, few medium subrounded spherical soft white carbonate nodules, slightly effervescence with HCl, diffuse boundary to |
| $C_2$ (60-90) | Dark grayish brown (10 YR 3/2) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure, sticky, plastic wet, few fine roots, slightly effervescence with HCl, diffuse boundary to |
| $C_3$ (90-120) | Dark grayish brown (10 YR 3/2) dry to grayish brown (10 YR 5/2) moist, clay, massive structure, massive, slightly sticky, slightly plastic wet, slightly hard dry, slightly effervescence with HCl. |

**Profile No. :** 4

**Date of description: 24-12-2003**

**Location:** Taba Village, 8 k North Wet of Sugar Factory

**Coordinates:** Longitude 31° 00.210 E-latitude 31° 18.420 N

**Topography:** Flat

**Slope**: Level

**Land use period**: 30 years

**Land use**: Cultivated (broad been)

**Irrigation source:** Al-Halafi Canal (Fresh water)

**Drainage system**: Tile drainage.

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Dark grayish brown (10 YR 3/2) dry to very dark grayish brown (10 YR 3/2) moist, clay, blocky structure, compact, sticky, plastic wet, firm moist, very hard dry, many fine healthy roots, few medium subrounded medium spherical soft white carbonate nodules, slightly effervescence with HCl. boundary |
| $C_1$ (30-60) | Dark gray (10 YR 4/1) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure, compact, sticky, plastic wet, firm moist, very hard dry, few very fine roots, few medium sub rounded spherical soft white carbonate nodules, medium effervescence with HCl; diffuse boundary to |
| $C_2$ (60-90) | Dark grayish brown (10 YR 4/2) dry to grayish brown (10 YR 5/2) moist, clay, massive, slightly sticky, slightly plastic wet, slightly hard dry, slightly effervescence with HCl, diffuse boundary to |
| $C_3$ (80-120) | Dark grayish brown (10 YR 4/2) dry to grayish brown (10 YR 5/2) moist, firm moist, slightly compact, slightly sticky, slightly plastic wet, slightly hard dry, slightly effervescence with HCl. |

**Profile No.: 5**

**Date of description:** 26-12-2003

**Location:** Typa Village near to Sugar Factory

**Coordinates:** 31 01.829 E -latitude 31° 15.5978 N

**Topography:** Flat

**Slope:** Level

**Land use period**: 50 years

**Land use**: Cultivated (wheat crop)

**Irrigation source:** Al-Halafi Canal (fresh water)

**Drainage system**: Tile drainage

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Grayish (10 YR 3/2) dry to very dark brown (10 YR 2/2) moist, clay, sub angular blocky structure, slightly sticky, slightly plastic wet, firm moist hard dry, many fine to medium healthy roots diffuse in the upper 10 c slightly effervescence with HCl, diffuse boundary to |
| $C_1$ (30-60) | Dark grayish brown (10 YR 4/2) dry to dark grayish brown (10 YR 3/2) moist, clay, massive structure, sticky, plastic wet, firm moist, hard dry, few fine healthy roots, slightly effervescence with HCl, smooth sharp boundary to |
| $C_2$ (60-90) | Dark grayish brown (10 YR 4/2) dry to grayish brown (10 YR 5/2) moist, clay, massive structure, sticky, plastic wet, firm moist, hard dry decayed organic residues, very slightly effervescence with HCl, smooth sharp boundary to |
| $C_3$ (90-120) | Dark grayish brown (10 YR 4/2) dry to grayish brown (10 YR 5/2) moist, clay, massive, sticky, plastic wet, firm moist, hard dry, very few decayed organic residues, slightly effervescence with HCl. |

**Profile No.: 6**

**Date of description**: 10-4-2004

**Location**: About 1 km North West of Al-Kadysia village

**Coordinates**: Longitude 30° 58.975 E-latitude 31° 21.527 N

**Topography**: Flat

**Slope:** Level

**Land use period**: Virgin soil (bare soil)

**Land use**: Uncultivated soils

**Irrigation source:** Al-Daramally Canal (fresh water).

**Drainage system:** Ditch (open drainage).

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Brown (10 YR 4/3) dry to gray (10 YR 6/1) moist clay, massive, compact, very sticky, very plastic wet, firm moist very hard dry, few carbonate nodules, few effervescence with HCl, diffuse boundary to |
| $C_1$ (30-60) | Dark brown (10 YR 4/3) dry to dark grayish brown (10 YR 4/2) moist, clay, massive, compact, very sticky, very plastic wet, firm moist, hard dry, few decayed organic residues, slightly effervescence with HCl, diffuse boundary to |
| $C_2$ (60-90) | Dark brown (10 YR 4/3) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure, very sticky, very plastic wet, firm moist, very hard dry, few effervescence with HCl, diffuse boundary to |
| $C_3$ (90-120) | Brown (10 YR 3/3) dry to grayish brown (10 YR 5/2) moist, clay, massive structure, very sticky, very plastic wet, firm moist, very hard dry, slightly effervescence with HCl |

**Profile No.**: 7

**Date of description**: 10-4-2004

**Location**: About 100 m North Beshla village

**Coordinates**: Longitude 30° 59.946 E-latitude 31° 19.575 N

**Topography**: Flat

**Slope:** Level

**Land use period**: 5 years

**Land use**: Cultivated (clover crop)

**Irrigation source**: Al-Daramally canal (fresh water)

**Drainage system**: Ditch (open drainage)

| Depth (cm) | Description |
|---|---|
| AP (0-25) | Very dark grayish brown (10 YR 3/2) dry to very dark grayish brown (10 YR 3/2) moist, clay, massive structure, sticky, plastic wet, firm moist, hard dry, many fine roots diffuse in the layer, medium soft whit carbonates nodules, medium effervescence with HCl, smooth sharp boundary to |
| $C_1$ (25-60) | Dark grayish brown (10 YR 4/2) dry to dark grayish brown (10 YR 4/2) moist, clay massive structure, sticky, plastic wet, firm moist, hard dry, few fine roots diffuse in the upper part of layer and decrease with depth, few soft white carbonate nodules, slightly effervescence with HCl, smooth sharp boundary to |
| $C_2$ (60-90) | Grayish brown (10 YR 5/2) dry to grayish brown (10 YR 5/2) moist, clay, massive structure, very sticky, very plastic wet, very firm moist, very hard dry, slightly effervesence with HCl, diffuse boundary to |
| $C_3$ (90-115) | Brown (10 YR 5/3) dry to grayish brown (10 YR 5/2) moist, clay, massive structure, very sticky, very plastic wet, firm moist, very hard dry, few effervesence with HCl |

**Profile No.**: 8

**Date of description**: 10-4-2004

**Location**: About 1 km North of Al-Kadysia village

**Coordinates**: Longitude 30° 59.987 E-latitude 31° 21.827 N

**Topography**: Flat

**Slope:** Level

**Land use period**: 15 years

**Land use**: Cultivated (sugar beet)

**Irrigation source**: Al-Daramally canal (fresh water)

**Drainage system**: Ditch (open drainage)

| Depth (cm) | Description |
|---|---|
| AP (0-40) | Dark grayish brown (10 YR 4/2) dry to very dark grayish brown (10 YR 3/2) moist, clay, sub angular blocky structure, many fine to medium healthy roots in layer, slightly sticky, slightly plastic wet, firm moist, hard dry, common continuos vertical craks to 60 cm depth, small soft and hard carbonates nodules, slightly effervescence with HCl, diffuse boundary to |
| $C_1$ (40-80) | Dark grayish brown (10 YR 4/2) dry to dark grayish brown (10 YR 4/2) moist, clay, blocky structure, sticky, plastic wet, firm moist, hard dry, few decayed organic residues, few carbonate nodules few effervescence with HCl, diffuse boundary to |
| $C_2$ (80-110) | Brown (10 YR 4/3) dry to dark brown (10 YR 4/3) moist, clay, massive structure, very sticky, very plastic wet, firm moist, very hard dry, few decayed organic residues, few effervescence with HCl |

**Profile No.**: 9

**Date of description**: 10-4-2004

**Location**: About 400 m North of Beshla village

**Coordinates**: Longitude 30° 59.924 E-latitude 31° 20.154 N

**Topography**: Flat

**Slope:** Level

**Land use period**: 30 years

**Land use**: Cultivated (sugar beet)

**Irrigation source**: Al-Daramally Canal (fresh water)

**Drainage system**: Open drainage.

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Park brown (10 YR 3/3) dry to very dark brown (10 YR 3/2 moist) clay, sub angular blocky structure, firm moist, slightly sticky, slightly plastic wet, hard dry, few fine and medium healthy roots diffuse in layer, common continuous vertical craks to 60 cm depth, few spherical white hard carbonate nodules, few effervescence with HCl, diffuse boundary to |
| $C_1$ (30-80) | Brown (10 YR 4/3) dry to dark brown (10 YR 3/3) moist, clay, sub angular blocky, structure, sticky, plastic wet, firm moist, hard dry, few decayed organic residues, few effervescence with HCl, diffuse boundary to |
| $C_2$ (80-105) | Brown (10 YR 5/3) dry to grayish brown (10 YR 5/2) moist, clay, massive structure, compact, very sticky, very plastic wet, firm moist, very hard dry, slightly effervescence with HCl |

**Profile No.**: 10

**Date of description**: 15-3-2004

**Location**: 50 m North Abo-Sekeen Village. Al-Hamoul

**Coordinates**: Longitude 31° 07.610 E-latitude 31° 24.620 N

**Topography**: Flat

**Slope:** Level

**Land use period**: Virgin soil (Bare soil)

**Land use**: Uncultivated soil(bare soil)

**Irrigation source**: Al-Mansour Canal (Blended water)

**Drainage system**: Tile drainage

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Brown (10 YR 5/3) dry to grayish brown (10 YR 5/2) moist, clay, massive structure, compact, slightly sticky slightly plastic wet, firm moist, slightly hard dry, salts formations, very few decayed organic residues, slightly effervescence with HCl, diffuse boundary to |
| $C_1$ (30-60) | Dark brown (10 YR 4/3) dry to grayish brown (10 YR 5/2) moist, clay, massive structure, sticky, plastic wet, firm moist, hard dry, few irregular hard carbonate nodules, slightly effervescence with HCl, diffuse boundary to |
| $C_2$ (60-90) | Dark brown (10 YR 4/3) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure slightly sticky, slightly plastic wet, firm moist, slightly hard dry, medium subrounded spherical soft white carbonate nodules, medium effervescence with HCl, diffuse boundary to |
| $C_3$ (90-120) | Dark brown (10 YR 4/3) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure, very sticky, very plastic wet, firm moist, very hard dry, medium soft white carbonate nodules, medium effervescence with HCl. |

**Profile No.**: 11
**Date of description**: 11-3-2004
**Location**: 13.5 km North Al-Hamoul city
**Coordinates**: Longitude 31° 06.608E - latitude 31° 06.608 N
**Topography**: Flat
**Slope:** Level
**Land use period**: 5 years
**Land use**: Cultivated (clover crop)
**Irrigation source**: Al-Mansour canal (blended water)
**Drainage system**: Tile drainage
**Water Table:**

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Dark brown (10 YR 3/3) dry to very dark grayish brown (10 YR 3/2) moist clay, massive structure, coarse to medium moderate angular, very compact, sticky, plastic wet, firm moist, very hard dry, many fine to medium healthy roots diffuse in upper 10 cm, slightly effervescence with HCl, diffuse boundary to |
| $C_1$ (30-65) | Dark yellowish brown (10 YR 3/4) dry to very dark brown (10 YR 3/3) moist, clay, compact, coarse to moderate weak angular blocky in the upper part of layer and massive structure in the rest of layer, sticky, plastic wet, firm moist, very hard dry, many fine healthy roots, very slightly effervescence with HCl, diffuse boundary to |
| $C_2$ (65-90) | Dark grayish brown (10 YR 4/2) dry to very dark yellowish brown (10Y R 3/4) moist, massive structure, clay, slightly compact, slightly sticky, slightly plastic wet, firm moist, hard dry, few decayed organic residues, slightly effervescence with HCl, diffuse boundary to |
| $C_3$ (90-120) | Dark brown (10 YR 4/3) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure, sticky plastic wet, firm moist, hard dry few small subrounded spherical soft white carbonate nodules, few effervescence with HCl |

**Profile No.**: 12
**Date of description**: 11-3-2004
**Location**: about 10 km North Al-Hamoul City
**Coordinates**: Longitude 31° 07.222 E-latitude 31° 25.040 N
**Topography**: Flat
**Slope**: Level.
**Land use period**: 15 years
**Land use**: Cultivated (clover crop)
**Irrigation source**: Al-Mansour Canal (Blended water)
**Drainage system**: Tile drainage

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Very dark grayish brown (10 YR 3/2) dry to very dark gray (10 YR 3/1) moist, clay, blocky structure, compact, sticky, plastic wet, very firm moist, very hard dry, many fine to medium healthy roots diffuse in the upper 10 cm, few small subrounded spherical white soft carbonate nodules, slightly effervescence with HCl, diffuse sharp boundary to |
| $C_1$ (30-70) | Dark brown (10 YR 4/3) dry to very dark grayish brown (10 YR 3/2) moist, clay, massive structure, slightly sticky, slightly plastic wet, firm moist, slightly hard dry, very few fine roots, very few subrounded spherical white soft carbonate nodules, few effervescence with HCl, diffuse sharp boundary to |
| $C_2$ (70-95) | Dark grayish brown (10 YR 4/2) dry to dark brown (10 YR 3/3) moist, clay, massive structure, slightly sticky, slightly plastic wet, firm mist, slightly hard dry, few fine roots, very slight effervescence with HCl, diffuse boundary to |
| $C_3$ (95-120) | Grayish brown (10 YR 5/2) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure, sticky, plastic wet, firm moist, hard dry few small sub rounded spherical soft carbonate nodules, slightly effervescence with HCl. |

**Profile No.**: 13

**Date of description**: 11-3-2004

**Location**: About 13 km North Al-Hamoul city

**Coordinates**: Longitude 31° 07.234 E-latitude 31° 25.125 N

**Topography**: Flat

**Slope:** Level

**Land use period**: 30 years

**Land use**: Cultivated (clover crop)

**Irrigation source**: Al-Mansour Canal (blended water)

**Drainage system**: Tile drainage

| Depth (cm) | Description |
|---|---|
| AP (0-25) | Very dark grayish brown (10 YR 3/2) dry to very dark brown (10 YR 2/2) moist clay, blocky, medium sub angular blocky, very compact, sticky, plastic wet, firm moist, very hard dry, many fine to medium roots diffuse in upper 10 cm, slightly effervescence with HCl, smooth sharp boundary to |
| $C_1$ (25-55) | Dark brown (10 YR 3/3) dry to very dark brown (10 YR 2/2) moist, clay loam, massive structure, slightly compact, slightly sticky, slightly plastic wet, friable moist, slightly hard dry, few fine healthy roots, slightly effervescence with HCl, diffuse sharply boundary to |
| $C_2$ (55-85) | Brown (10 YR 4/3) dry to very dark brown (10 YR 3/2) moist, clay, massive, few organic matter, slightly sticky, slightly plastic wet, firm mist, slightly hard dry, very few decayed organic residues slightly effervescence with HCl, diffuse sharply boundary to |
| $C_3$ (85-110) | Brown (10 YR 4/3) dry to dark yellowish brown (10 YR 3/4) moist, massive structure, sticky, plastic wet, few firm moist, few hard dry, very slightly effervescence with HCl |

**Profile No.**: 14

**Date of description**: 15-3-2004

**Location**: About 1 km North Al-Hamoul city

**Coordinates**: Longitude 31° 08.069 E-Latitude 31° 18.950 N

**Topography**: Flat

**Slope:** Level

**Land use period**: 50 years

**Land use**: Cultivated (clover crop)

**Irrigation source**: Kom Al-Teen (blended water)

**Drainage system**: Tile drainage

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Dark brown (10 YR 3/3) dry to very dark brown (10 YR 2/2) moist, clay, weak coarse sub angular blocky, slightly sticky, slightly plastic wet, firm moist, very hard dry, many fine to medium healthy roots, few medium sub rounded spherical soft white carbonate nodules, medium effervescence with HCl, diffuse boundary to |
| $C_1$ (30-60) | Dark yellowish Brown (10 YR ¾) dry to dark brown (10 YR 3/3) moist, clay, massive structure slightly sticky, slightly plastic wet, firm moist, hard dry, few fine healthy roots, few soft white carbonate nodules, slightly effervescence with HCl, diffuse boundary to |
| $C_2$ (60-90) | Brown (10 YR 4/3) dry to dark grayish, brown (10 YR 4/2) moist, clay, massive structure, sticky, plastic wet, firm moist, hard dry, few decayed organic residues, few effervescence with HCl, diffuse boundary to |
| $C_3$ (90-120) | Brown (10 YR 4/3) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure, sticky, plastic wet, firm moist, very hard dry, very few soft whit carbonate nodules, few effervescence with HCl |

**Profile No.**: 15

**Date of description**: 25-3-2004

**Location**: 100 m North of 65 village

**Coordinates**: Longitude 30 58.1287 E-latitude 31° 23.444 N

**Topography**: Flat

**Slope:** Level

**Land use period**: Virgin soil

**Land use**: Uncultivated soil (Bare soil)

**Irrigation source**: Kom Al-Teen Canal (Blended water)

**Drainage system**: Ditch drain (open drainage)

| Depth (cm) | Description |
|---|---|
| AP (0-35) | Brown (10 YR 5/3) dry to grayish brown (10 YR 5/2) moist, clay, massive, structure, slightly sticky, slightly plastic wet, firm moist, slightly hard dry, medium subrounded spherical soft white carbonate nodules, slightly effervescence with HCl, diffuse boundary to |
| $C_1$ (35-80) | Dark grayish brown (10 YR 4/2) dry to dark grayish brown (10 YR 4/2) moist, clay, compact, massive structure, sticky, plastic wet, firm moist, hard dry, small subrounded spherical white soft carbonate nodules, slightly effervescence with HCl, sharp diffuse boundary to |
| $C_2$ (60-90) | Dark brown (10 YR 4/3) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure, very sticky, very plastic wet, firm moist, hard dry, few decayed organic residues, few effervescence with HCl |

**Profile No.**: 16

**Date of description**: 25-3-2004

**Location**: 300 m west of 56 village

**Coordinates**: Longitude 30° 58.187 E-latitude 31° 23.444 N

**Topography**: Flat

**Slope:** Level

**Land use period**: 5 years

**Land use**: Cultivated (clover crop)

**Irrigation source**: Kom Al-Teen Canal (Blended water)

**Drainage system**: Ditch (open drainage)

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Very dark grayish brown (10 YR 3/2) dry to very dark grayish brown (10 YR 3/2) moist, clay compact, massive, sticky, plastic wet, firm moist, hard dry, many fine to medium healthy roots, slightly effervescence with HCl, diffuse boundary to |
| $C_1$ (30-70) | Dark grayish brown (10 YR 4/2) dry to very Dark grayish brown (10 YR 3/2) moist, clay, very compact, massive structure, sticky, plastic wet, firm moist, hard dry, few decayed organic residues, slightly effervescence with HCl, diffuse boundary to |
| $C_2$ (70-95) | Dark grayish brown (10 YR 4/2) dry to dark grayish brown (10 YR 4/2) moist, clay massive, very compacted, very sticky, very plastic wet, very firm moist, very hard dry, few effervescence with HCl, diffuse boundary to |
| $C_3$ (95-110) | Gray (10 YR 5/1) dry to dark brown (10 YR 3/3) moist, clay, very compact, massive structure, very sticky, very plastic wet, firm moist, very hard dry, few effervescence with HCl |

**Profile No.**: 17
**Date of description**: 25-3-2004
**Location**: 800 m West of 56 village
**Coordinates**: Longitude 30° 57.720 E-latitude 31° 23.720 N
**Topography**: Flat
**Slope:** Level
**Land use period**: 15 years
**Land use**: Cultivated (clover crop)
**Irrigation source**: Kom Al-Teen Canal (blended water)
**Drainage system**: Ditch (open drainage)

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Very dark grayish brown (10 YR 3/2) dry to very dark grayish brown (10 YR 3/2) moist, clay, massive structure, sticky, plastic wet, firm moist, hard dry, slightly soft white carbonate nodules, few fine to medium healthy roots in the upper part of layer decrease with depth, few soft white carbonate nodules, slightly effervescence with HCl, sharp diffuse boundary to |
| $C_1$ (30-60) | Dark gray (10 YR 4/1) dry to very dark grayish brown (10 YR 3/2) moist, clay, massive structure, compact, sticky, plastic wet, firm moist, hard dry, few fine healthy roots, slightly soft carbonate nodules, slightly effervescence with HCl, diffuse boundary to |
| $C_2$ (60-90) | Dark grayish brown (10 YR 4/2) dry to dark brown (10 YR 4/3) moist, silty clay, massive structure, very stick, plastic wet, firm moist, very hard dry, few decayed organic residues, slightly effervescence with HCl, diffuse boundary to |
| $C_3$ (90-120) | Dark gray (10 YR 4/1) dry to dark gray (10 YR 4/1) moist, silty clay, massive structure, very sticky, very plastic wet, firm moist, hard dry, few soft white carbonate nodules, few decayed organic residues, few effervescence with HCl |

**Profile No.: 18**
**Date of description**: 25-3-2004
**Location**: About 1200 M North of 56 village
**Coordinates**: Longitude 30° 58.183 E-latitude 31° 23.059 N
**Topography**: Flat
**Slope:** Level
**Land use period**: 30 years
**Land use**: Cultivated (clover crop)
**Irrigation source**: Kom Al-Teen canal (blended water)
**Drainage system**: Ditch (open drainage)

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Very dark grayish brown (10 YR 3/2) dry to dark grayish brown (10 YR 3/2) moist, clay, massive structure, slightly sticky, slightly plastic wet, firm moist, slightly hard dry, abundant fine to moderate healthy roots, few white hard carbonate nodules, slightly effervescence with HCl, diffuse boundary to |
| $C_1$ (20-50) | Dark grayish brown (10 YR 4/2) dry to dark grayish brown (10 YR 3/2) moist, clay, compact, massive structure, sticky, plastic wet, firm moist, hard dry, small fine to medium spherical soft and hard carbonate nodules, few fine healthy roots, slightly effervescence with HCl, diffuse boundary to |
| $C_2$ (50-90) | Grayish brown (10 YR 5/2) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure, very compact, very sticky, very plastic wet, firm moist, very hard dry, decayed organic residues, few soft whit carbonate nodules, few effervescence with HCl, diffuse boundary to |
| $C_3$ (90-120) | Grayish brown (10 YR 5/2) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure, very sticky, very plastic wet, firm moist, very hard dry, few soft white carbonate nodules, few effervescence with HCl |

**Profile No.**: 19

**Date of description**: 10/4/2004

**Location**: About 1 km South of 56 village

**Coordinates**: Longitude 30° 58.180 E-latitude 31° 22.646 N

**Topography**: Flat

**Slope:** Level

**Land use period**: 50 years

**Land use**: Cultivated (clover crop)

**Irrigation source**: Kom Al-Teen Canal (blended water)

**Drainage system**: Ditch (open drainage)

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Dark brown (10 YR 3/3) dry to very dark brown (10 YR 2/2) moist, clay, massive structure, sticky, plastic wet, firm moist, hard dry, many fine to medium healthy roots diffuse in the upper part of layer, few medium sub-rounded spherical soft white carbonate nodules, moderate effervescence with HCl, smooth sharp boundary to |
| $C_1$ (30-60) | Dark brown (10 YR 3/3) dry to very dark yellowish brown (10 YR 3/2) moist, clay, massive structure, , slightly sticky, slightly plastic wet, firm moist, slightly hard dry, few fine roots, few small subrounded spherical white soft carbonate nodules, white soft carbonate nodules, slightly effervescence with HCl, smooth boundary to |
| $C_2$ (60-90) | Brown (10 YR 4/3) dry to very dark brown (10 YR 4/2) moist, clay, massive structure, sticky, plastic wet, firm moist, hard dry, few decayed organic residues, few subrounded spherical white soft carbonate nodules, slightly effervescence with HCl, diffuse boundary to |
| $C_3$ (90-120) | Dark brown (10 YR 4/3) dry to dark brown (10 YR 4/2) moist, silty clay, massive structure, few stick, few plastic wet, firm moist, hard dry, very few soft white carbonate nodules, few effervescence with HCl |

**Profile No.**: 20

**Date of description**: 15-3-2004

**Location**: About 15 km North E-Hamoul city

**Coordinates**: Longitude 31° 06.610 E-latitude 31° 25.480 N

**Topography**: Flat

**Slope:** Level

**Land use period**: 5 year

**Land use**: Fish farming

**Irrigation source**: Al-Mansour Canal (Blended water)

**Drainage system**: Tile drainage

| Depth (cm) | Description |
|---|---|
| AP (0-30) | Very dark grayish brown (10 YR 3/2) dry to very dark brown (10 YR 3/2) moist, clay, blocky structure, salt formations as crust, very compact, sticky, plastic wet, firm moist, very hard dry, few soft white carbonate nodules, slightly effervescence with HCl, diffuse boundary to |
| $C_1$ (30-55) | Very dark grayish brown (10 YR 3/2) dry to very dark brown (10 YR 3/2) moist, massive, clay, sticky, plastic wet, firm moist, hard dry, decayed organic residues, slightly effervescence with HCl, diffuse boundary to |
| $C_2$ (55-85) | Dark brown (10 YR 4/3) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure slightly sticky, slightly plastic wet, firm moist, hard dry, slightly effervescence with HCl, diffuse boundary to |
| $C_3$ (85-120) | Gray (10 YR 5/1) dry to gray (10 YR 5/1) moist, clay, massive structure, sticky, plastic wet, firm moist, hard dry, few decayed organic residues, broken marine shells, medium effervescence with HCl. |

**Profile No.**: 21

**Date of description**: 25-3-2004

**Location**: About 1 in North of 56 village

**Coordinates**: Longitude 30° 58.186 E-latitude 31° 23.725 N

**Topography**: Flat

**Slope:** Level

**Land use period**: 10 years

**Land use**: Fish farm

**Irrigation source**: Al-Mansoura canal (blended water)

**Drainage system**: Ditch (tile drainage)

| Depth (cm) | Description |
|---|---|
| AP (0-40) | Dark grayish brown (10 YR 4/2) dry to very dark grayish brown (10 YR 3/2) moist, clay, massive, slightly sticky, slightly plastic wet, firm moist, hard dry, few medium spherical white hard carbonate nodules, slightly effervescence with HCl, diffuse boundary to |
| $C_1$ (40-70) | Dark brown (10 YR 3/3) dry to dark grayish brown (10 YR 4/2) moist, clay, massive structure, sticky, plastic wet, small to moderate sub rounded spherical white hard carbonate nodules, few decayed organic residues, slightly effervescence with HCl, diffuse boundary to |
| $C_2$ (70-105) | Dark grayish brown (10 YR 4/2) dry to grayish brown (10 YR 5/2) moist, clay, massive structure, very sticky, very plastic wet, very firm moist, very hard dry, moderate sub rounded spherical white carbonate nodules, few decayed organic residues, marine shells, moderate effervescence with HCl |

# ARABIC SUMMARY

# المستخلص العربى

# "تقييم أراضى شمال الدلتا تحت أنواع مختلفة من الممارسات الزراعية"


## بهجت عبد القوى عبد الحميد زامل



أجريت هذه الدراسة لتقييم الأراضى المستصلحة تحت مختلف الممارسات الزراعية مثل فترات استخدام الأرض ــ مصادر مياه الرى ــ نظم الصرف والأستزراع السمكى. ولإنجاز هذا الهدف اختيرت منطقتين فى شمال الدلتا وهى: منطقة الزاوية ومنطقة غرب المنصور. أختير واحد وعشرون قطاع أرضى فى كلا المنطقتين لتمثل الاختلافات فى الممارسات الزراعية حيث كانت مصادر مياه الرى ماء عذب وماء خلط ، وكانت نظم الصرف فى كلا المنطقتين هما الصرف المغطى والصرف المفتوح. وكانت فترات الأستزراع هى (٥ ، ١٥ ، ٣٠ ، ٥٠ عاما) بالإضافة إلى الأرض غير المستصلحة. وقد تم وصف القطاعات موروفولوجيا ، وأخذ العينات الممثلة لها لإجراء التحليلات المعملية للخواص الفيزيائية والكيميائية وكذلك حالة الخصوبة. أخذت (٥) عينات ماء رى من مختلف مصادر الرى (ترعة الغابات ــ الحلافى ــ الدرمللى) فى منطقة الزاوية وكوم التين والمنصور فى منطقة غرب المنصور ، لمختلف التحليلات الكيميائية. وقيمت الأرض المدروسة باستخدام برنامج ASEL*. النظام التطبيقى لتقييم الأراضى. وهو يناسب مختلف الظروف البيئيه فى مصر ، والذى يعتمد على أربع عوامل رئيسية فى التقييم وهى: خواص التربة ــ نوعية مياه الرى ــ خصوبة التربة والظروف البيئية ويحسب من هذه العوامل الدليل النهائى لتقييم الأراضى F.I.L.E.


**ويمكن تلخيص النتائج المتحصل عليها فى الآتى:**

**١- تأثير الممارسات الزراعية على مختلف خواص التربة:**

- **الخواص الفيزيائية:** حدث تحسن فى خواص التربة الفيزيائية نتيجة زيادة فترة الأستزراع واستخدام مياه عذبة فى الرى واستخدام الصرف المغطى. حيث انخفضت قيم الكثافة الظاهرية وإزدادت قيم عوامل التحبب والتوصيل الهيدروليكى.
- **خواص الأرض الكيميائية:** تحسنت الخواص الكيميائية للأرض المدروسة كنتيجة لزيادة فترة الأستزراع. وأيضا استخدام الماء العذب فى الرى واستخدام الصرف المغطى حيث انخفضت قيم كل من ملوحة التربة (ECe) والقلوية (ESP) ونسبة الصوديوم المدمص (SAR) وأيضا كربونات الكالسيوم.

**٢- تأثير الممارسات الزراعية على حالة الخصوبة:**

- **المادة العضوية:** ازدادت المادة العضوية بزيادة فترة الأستزراع وبخاصة فى الطبقات السطحية وكان محتوى المادة العضوية أعلى فى الأراضى المنزرعة عن الأرض غير المستصلحة. مع ملاحظه عدم وجود تأثير واضح لكل من نوع نظام الصرف ونوعية ماء الرى على محتوى الأرض من المادة العضوية.
- **العناصر الغذائية الكبرى الميسرة NPK:** وجد أن محتوى الأرض التى تروى بمياه خلط كانت أعلى عن تلك التى تروى بمياه عذبة ، ووجد أن الأرض التى تخدم بنظام الصرف المفتوح كان محتواها أعلى من تلك التى يوجد بها صرف مغطى عند مختلف فترات الأستزراع.
- **العناصر الغذائية الصغرى الميسرة (Fe, Mn, Zn, Cu):** زاد محتوى الأرض من العناصر الغذائية الصغرى الميسرة بزيادة فترة الأستزراع فى الأرض التى تخدم بنظام الصرف المفتوح عن تلك الأرض التى تخدم بنظام الصرف المغطى. ومن جهة أخرى لم يكن هناك تأثير ملحوظ لنوعية مياه الرى على محتوى الأرض من العناصر الغذائية الصغرى الميسرة.

**٣- تأثير استخدام الأستزراع السمكى على خواص التربة:**

- **خواص التربة الطبيعية:** أدى وضع الارض تحت الأستزراع السمكى الى تدهور فى خواص التربة الفيزيائية مقارنة بالأرض التى زرعت مباشرة. حيث تظهر النتائج زيادة فى الكثافة الظاهرية ، وانخفاض فى عوامل تحبب التربة والتوصيل الهيدروليكى فى الأرض المستخدمه كمزارع سمكيه.
- **خواص التربة الكيميائية:** يؤدى الأستزراع السمكى إلى غسيل الأملاح مقارنة بالأرض غير المستصلحة. حيث انخفضت قيم التوصيل الكهربى بنسبة ٦٧,٦٨، ٧٢,١٨% فى أرض المزارع السمكيه لمدة ١٥ ، ١٠ سنوات على الترتيب. وانخفضت القلوية بنسبة ٣٢,١٤ ، ٤٤,٠٩% بالنسبه لأرض المزارع السمكيه لمدة ١٥ ، ١٠ سنوات على الترتيب مقارنة بالأرض غير المستصلحة ، ولكن هذه القيم مازالت مرتفعة مقارنة بالأرض المنزرعة.

**٤- تقييم مقدرة الأرض الإنتاجة باستخدام برنامج ASEL:**

تأثير الممارسات الزراعية المدروسة على الدليل النهائى لتقييم الأرض (F.I.L.E):

١- الأرض تحت نظام الصرف المغطى لها قيم (F.I.L.E) أعلى من الأرض تحت نظام الصرف المفتوح عند نفس الفترات الزراعية.

٢- الأرض التى تروى بمياه عذبة لها (F.I.L.E) أعلى مقارنة بالأرض التى تروى بمياه خلط عند نفس الفترات الزراعية.

٣- قيم الـ FILE زادت مع زيادة الفترات الزراعية.

٤- لم تحتوى مناطق الدراسه على ارض درجه اولى وكانت اعلى رتبه تم الحصول عليها هى الدرجة الثانيه والثالثه.

٥- تصنف الأرض غير المستصلحة فى منطقتى الدراسة فى الرتبه الخامسه (ضعيفة جدا) $C_5$ (very poor) ، وكانت معوقات تلك الأرض هى نقص التوصيل الهيدروليكى ، نقص عوامل تحبب التربة ، زيادة ملوحة التربة ، زيادة القلوية ، زيادة ملوحة الماء الأرضى ، نقص المادة العضوية ، نقص النيتروجين والفوسفور الميسر.

٦- تم تصنيف الأرض التى تروى بماء عذب تحت نظام الصرف المغطى فى الرتبه الثالثه كأرض متوسطة (fair) $C_3$ للأرض المنزرعة لمدة ٥ سنوات ، الرتبه الثانيه أرض جيدة $C_2$ (good) للأرض المنزرعة ١٥ ، ٣٠ ، ٥٠ سنة معظم العوامل المعوقه لهذه الأرض كانت زيادة ملوحة الماء الأرضى ــ نقص المادة العضوية ــ نقص النيتروجين والفوسفور الميسر.

٦- صنفت الأرض التى تروى بماء عذب وتحت نظام الصرف المفتوح فى الرتبه الثالثه كأرض متوسطة $C_3$ (fair) للأرض المنزرعة لمدة ٥ ، ١٥ سنة ثم الرتبه الثانيه $C_2$ (good) للأرض التى زرعت لمدة ٣٠ سنة وكانت معظم المحددات لتلك الأرض ارتفاع الماء الأرضى ، وزيادة ملوحة الماء الأرضى وزيادة ملوحة التربة ونقص المادة العضوية والفوسفور والنيتروجين الميسر.

٧- تم تصنيف الأرض التى تروى بماء خلط وتخدم بنظام الصرف المغطى فى الدرجه الثالثه كأرض متوسطة $C_3$ (fair) للأرض التى زرعت لمدة ٥ ، ١٥ سنة والرتبه الثانيه أرض جيدة $C_2$ (good) للأرض التى زرعت لمدة ٣٠ ، ٥٠ سنة. معظم العوامل المحددة لتلك الأرض كانت ارتفاع الماء الأرضى ــ نقص التوصيل الهيدروليكى ــ زيادة ملوحة الماء الأرضى ــ نقص المادة العضوية والفوسفور الميسر والنيتروجين.

٨- صنفت الأرض التى تروى بماء خلط وتخدم بنظام الصرف المفتوح فى الرتبه الثالثه كأرض متوسطة $C_3$ (fair) للأرض التى زرعت عند مختلف فترات الأستزراع ٥ ، ١٥ ، ٣٠ ، ٥٠ سنة وكانت الاختلافات بينهم فى قيمة F.I.L.E داخل نفس الرتبه من مقدرة الأرض الإنتاجية وكانت معظم العوامل المحددة تتمثل فى نقص مستوى الماء الأرضى ، زيادة ملوحة الماء الأرضى ، زيادة ملوحة التربة ، نقص محتوى المادة العضوية والنيتروجين والفوسفور الميسر.

٩- صنفت الأرض المستخدمة كمزرعة سمكية لمدة ١٠ ، ١٥ سنة فى الرتبه الثالثه كأرض ذات درجة ملاءمة (fair) $C_3$. معظم العوامل المحددة لتلك الأرض كانت ارتفاع الماء الأرضى ــ نقص التوصيل الهيدروليكى ــ زيادة ملوحة الماء الأرضى ــ نقص المادة العضوية والفوسفور والنيتروجين الميسر.

وواضح أن معظم العوامل المحددة والسائدة فى منطقة الدراسة والواقعة فى شمال دلتا النيل تكون ارتفاع مستوى الماء الأرضى ، وزيادة ملوحة الماء الأرضى والتى تعود إلى عدم كفاءة نظام الصرف وملوحة وقلوية الأرض وانخفاض محتوى الأرض من المادة العضوية والنيتروجين والفوسفور الميسرين ونقص الماء العذب للرى حيث أن هذه الأراضى فى نهايات الترع.

**٧- ملاءمة الأرض للمحاصيل: Land Suitability for Crops**

الأرض محل الدراسة تكون عالية الملاءمة لبنجر السكر والقمح والشعير والبرسيم والكرنب كمحاصيل شتويه ، والأرز والقطن وعباد الشمس كمحاصيل صيفيه. ويمكن عمل تركيب محصولى مناسب باستخدام هذه المحاصيل.

**التوصيات:**

من الدراسة الحالية يمكن التوصية بالآتى:

١- يجب زراعة المحاصيل عالية التحمل للملوحة (الشعير ــ بنجر السكر ــ القطن) والمحاصيل المتحملة للملوحة مثل (القمح ــ الأرز ــ عباد الشمس).

٢- متابعة حالة الصرف وزيادة كفائتها من خلال الصيانة الدورية لنظام الصرف المغطى واستخدام بعض الوسائل المساعدة مثل الصرف المولى والحرث تحت التربة.

٣- عند توافر المياه العزبة يجب أن تستخدم فى الرى أثناء المراحل الحساسة فسيولوجيا من عمر النبات خصوصا مرحلة الانبات والحبوب.

٤- إنشاء المزارع السمكية فى الأرض المتأثرة بالأملاح أثناء مرحلة الغسيل لخفض ملوحة التربة وزيادة دخل المزارعين.

٥- يحظر استخدام الارض الزراعية المنتجة كمزارع سمكية للحفاظ على جودتها ومنع تدهور خواصها.

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(*) المقترح والمطور بواسطة Ismail وأخرون عام ١٩٩٤.

الملخص العربى

## "تقييم أراضى شمال الدلتا تحت أنواع مختلفة من الممارسات الزراعية"

أجريت هذه الدراسة لتقييم الأراضى المستصلحة تحت مختلف الممارسات الزراعية مثل فترات استخدام الأرض – مصادر مياه الرى – نظم الصرف والأستزراع السمكى. ولإنجاز هذا الهدف اختيرت منطقتين فى شمال الدلتا وهى: منطقة الزاوية ومنطقة غرب المنصور.

أختير واحد وعشرون قطاع أرضى فى كلا المنطقتين لتمثل الاختلافات فى الممارسات الزراعية حيث كانت مصادر مياه الرى ماء عذب وماء خلط ، وكانت نظم الصرف فى كلا المنطقتين هما الصرف المغطى والصرف المفتوح. وكانت فترات الأستزراع هى (٥ ، ١٥ ، ٣٠ ، ٥٠ عاما) بالإضافة إلى الأرض غير المستصلحة. وقد تم وصف القطاعات مورفولوجيا ، وأخذ العينات الممثلة لها لإجراء التحليلات المعملية للخواص الفيزيائية والكيميائية وكذلك حالة الخصوبة.

أخذت (٥) عينات ماء رى من مختلف مصادر الرى (ترعة الغابات – الحلافى – الدرمللى) فى منطقة الزاوية وكوم التين والمنصور فى منطقة غرب المنصور ، لمختلف التحليلات الكيميائية. وقيمت الأرض المدروسة باستخدام برنامج ASEL(*). النظام التطبيقى لتقييم الأراضى. وهو يناسب مختلف الظروف البيئيه فى مصر، والذى يعتمد على أربع عوامل رئيسية فى التقييم وهى: خواص التربة – نوعية مياه الرى – خصوبة التربة والظروف البيئية ويحسب من هذه العوامل الدليل النهائى لتقييم الأراضى F.I.L.E.

**ويمكن تلخيص النتائج المتحصل عليها فى الآتى:**

**أ- تأثير الممارسات الزراعية على مختلف خواص التربة:**

- **الخواص الفيزيائية:** حدث تحسن فى خواص التربة الفيزيائية نتيجة زيادة فترة الأستزراع واستخدام مياه عذبة فى الرى واستخدام الصرف المغطى. حيث انخفضت قيم الكثافة الظاهرية وإزدادت قيم عوامل التحبب والتوصيل الهيدروليكى.
- **خواص الأرض الكيميائية:** تحسنت الخواص الكيميائية للأرض المدروسة كنتيجة لزيادة فترة الأستزراع. وأيضا استخدام الماء العذب فى الرى واستخدام الصرف المغطى حيث انخفضت قيم كل من ملوحة التربة (ECe) والقلوية (ESP) ونسبة الصوديوم المدمص (SAR) وأيضا كربونات الكالسيوم.

(*) المقترح والمطور بواسطة Ismail وأخرون عام ١٩٩٤.

ب- تأثير الممارسات الزراعية على حالة الخصوبة:

- **المادة العضوية:** ازدادت المادة العضوية بزيادة فترة الأستزراع وبخاصة فى الطبقات السطحية وكان محتوى المادة العضوية أعلى فى الأراضى المنزرعة عن الأرض غير المستصلحة. مع ملاحظه عدم وجود تأثير واضح لكل من نوع نظام الصرف ونوعية ماء الرى على محتوى الأرض من المادة العضوية.
- **العناصر الغذائية الكبرى الميسرة NPK:** وجد أن محتوى الأرض التى تروى بمياه خلط كانت أعلى عن تلك التى تروى بمياه عذبة ، ووجد أن الأرض التى تخدم بنظام الصرف المفتوح كان محتواها أعلى من تلك التى يوجد بها صرف مغطى عند مختلف فترات الأستزراع. وزاد محتوى الأرض من النتروجين والفوسفور الميسر بزيادة فترات الاستزراع بينما انخفض محتوى الأرض من البوتاسيوم الميسر.
- **العناصر الغذائية الصغرى الميسرة (Fe, Mn, Zn, Cu):** زاد محتوى الأرض من العناصر الغذائية الصغرى الميسرة بزيادة فترة الأستزراع فى الأرض التى تخدم بنظام الصرف المفتوح عن تلك الأرض التى تخدم بنظام الصرف المغطى. ومن جهة أخرى لم يكن هناك تأثير ملحوظ لنوعية مياه الرى على محتوى الأرض من العناصر الغذائية الصغرى الميسرة.

جـ- تأثير استخدام الأستزراع السمكى على خواص التربة:

- **خواص التربة الطبيعية:** أدى وضع الارض تحت الأستزراع السمكى الى تدهور فى خواص التربة الفيزيائية مقارنة بالأرض التى زرعت مباشرة. حيث تظهر النتائج زيادة فى الكثافة الظاهرية ، وانخفاض فى عوامل تحبب التربة والتوصيل الهيدروليكى فى الأرض المستخدمه كمزارع سمكيه.
- **خواص التربة الكيميائية:** يؤدى الأستزراع السمكى إلى غسيل الأملاح مقارنة بالأرض غير المستصلحة. حيث انخفضت قيم التوصيل الكهربى بنسبة ٦٧,٦٨، ٧٢,١٨% فى أرض المزارع السمكيه لمدة ١٥ ، ١٠ سنوات على الترتيب. وانخفضت القلوية بنسبة ٣٢,١٤ ، ٤٤,٠٩% بالنسبه لأرض المزارع السمكيه لمدة ١٥ ، ١٠ سنوات على الترتيب مقارنة بالأرض غير المستصلحة ، ولكن هذه القيم مازالت مرتفعة مقارنة بالأرض المنزرعة.

د- تقييم مقدرة الأرض الإنتاجة باستخدام برنامج ASEL:

تأثير الممارسات الزراعية المدروسة على الدليل النهائى لتقييم الأرض (F.I.L.E):

١- الأرض تحت نظام الصرف المغطى لها قيم (F.I.L.E) أعلى من الأرض تحت نظام الصرف المفتوح عند نفس الفترات الزراعية.

٢- الأرض التى تروى بمياه عذبة لها (F.I.L.E) أعلى مقارنة بالأرض التى تروى بمياه خلط عند نفس الفترات الزراعية.

٣- قيم الـ FILE زادت مع زيادة الفترات الزراعية.

٤- لم تحتوى مناطق الدراسه على ارض درجه اولى وكانت اعلى رتبه تم الحصول عليها هى الدرجة الثانيه والثالثه.

٥- تصنف الأرض غير المستصلحة فى منطقتى الدراسة فى الرتبه الخامسه (ضعيفة جدا) $C_5$ (very poor) ، وكانت معوقات تلك الأرض هى نقص التوصيل الهيدروليكى ، نقص عوامل تحبب التربة ، زيادة ملوحة التربة ، زيادة القلوية ، زيادة ملوحة الماء الأرضى ، نقص المادة العضوية ، نقص النيتروجين والفوسفور الميسر.

٦- تم تصنيف الأرض التى تروى بماء عذب تحت نظام الصرف المغطى فى الرتبه الثالثه كأرض متوسطة (fair) $C_3$ للأرض المنزرعة لمدة ٥ سنوات ، الرتبه الثانيه أرض جيدة (good) $C_2$ للأرض المنزرعة ١٥ ، ٣٠ ، ٥٠ سنة معظم العوامل المعوقه لهذه الأرض كانت زيادة ملوحة الماء الأرضى ــ نقص المادة العضوية ــ نقص النيتروجين والفوسفور الميسر.

٧- صنفت الأرض التى تروى بماء عذب وتحت نظام الصرف المفتوح فى الرتبه الثالثه كأرض متوسطة (fair) $C_3$ للأرض المنزرعة لمدة ٥ ، ١٥ سنة ثم الرتبه الثانيه $C_2$ (good) للأرض التى زرعت لمدة ٣٠ سنة وكانت معظم المحددات لتلك الأرض ارتفاع الماء الأرضى ، وزيادة ملوحة الماء الأرضى وزيادة ملوحة التربة ونقص المادة العضوية والفوسفور والنيتروجين الميسر.

٨- تم تصنيف الأرض التى تروى بماء خلط وتخدم بنظام الصرف المغطى فى الدرجه الثالثه كأرض متوسطة (fair) $C_3$ للأرض التى زرعت لمدة ٥ ، ١٥ سنة والرتبه الثانيه أرض جيدة (good) $C_2$ للأرض التى زرعت لمدة ٣٠ ، ٥٠ سنة. معظم العوامل المحددة لتلك الأرض كانت ارتفاع الماء الأرضى ــ نقص التوصيل الهيدروليكى ــ زيادة ملوحة الماء الأرضى ــ نقص المادة العضوية والفوسفور الميسر والنيتروجين.

٩- صنفت الأرض التى تروى بماء خلط وتخدم بنظام الصرف المفتوح فى الرتبه الثالثه كأرض متوسطة (fair) $C_3$ للأرض التى زرعت عند مختلف فترات الأستزراع ٥ ، ١٥ ، ٣٠ ، ٥٠ سنة وكانت الاختلافات بينهم فى قيمة F.I.L.E داخل نفس الرتبه من مقدرة الأرض الإنتاجية وكانت معظم العوامل المحددة تتمثل فى نقص مستوى الماء الأرضى ، زيادة ملوحة الماء الأرضى ، زيادة ملوحة التربة ، نقص محتوى المادة العضوية والنيتروجين والفوسفور الميسر.

١٠- صنفت الأرض المستخدمة كمزرعة سمكية لمدة ١٠ ، ١٥ سنة فى الرتبه الثالثه كأرض ذات درجة ملاءمة (fair) $C_3$. معظم العوامل المحددة لتلك الأرض كانت ارتفاع الماء الأرضى – نقص التوصيل الهيدروليكى – زيادة ملوحة الماء الأرضى – نقص المادة العضوية والفوسفور والنيتروجين الميسر.

وواضح أن معظم العوامل المحددة والسائدة فى منطقة الدراسة والواقعة فى شمال دلتا النيل تكون ارتفاع مستوى الماء الأرضى ، وزيادة ملوحة الماء الأرضى والتى تعود إلى عدم كفاءة نظام الصرف وملوحة وقلوية الأرض وانخفاض محتوى الأرض من المادة العضوية والنيتروجين والفوسفور الميسرين ونقص الماء العذب للرى حيث أن هذه الأراضى فى نهايات الترع.

**هـ- ملاءمة الأرض للمحاصيل: Land Suitability for Crops**

الأرض محل الدراسة تكون عالية الملاءمة لبنجر السكر والقمح والشعير والبرسيم والكرنب كمحاصيل شتويه ، والأرز والقطن وعباد الشمس كمحاصيل صيفيه. ويمكن عمل تركيب محصولى مناسب باستخدام هذه المحاصيل.

**التوصيات:**

من الدراسة الحالية يمكن التوصية بالآتى:

١- يجب زراعة المحاصيل عالية التحمل للملوحة (الشعير – بنجر السكر – القطن) والمحاصيل المتحملة للملوحة مثل (القمح – الأرز – عباد الشمس).
٢- متابعة حالة الصرف وزيادة كفائتها من خلال الصيانة الدورية لنظام الصرف المغطى واستخدام بعض الوسائل المساعدة مثل الصرف المولى والحرث تحت التربة.
٣- عند توافر المياه العزبة يجب أن تستخدم فى الرى أثناء المراحل الحساسة فسيولوجيا من عمر النبات خصوصا مرحلة الانبات والحبوب.
٤- إنشاء المزارع السمكية فى الأرض المتأثرة بالأملاح أثناء مرحلة الغسيل لخفض ملوحة التربة وزيادة دخل المزارعين.
٥- يحظر استخدام الارض الزراعية المنتجة كمزارع سمكية للحفاظ على جودتها ومنع تدهور خواصها.

# اهدى هذا العمل

الى روح والدى

الى والدتى الغالية

الى زوجتى الوفية

الى أبنائى الأعزاء

أحمد - إيمان - أمانى

الى أشقائى الكرام

الله

بسم الله الرحمن الرحيم

قالوا سبحانك لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم

صدق الله العظيم

(البقرة:٣٢)

# لجنة الإشـــــراف

**أ.د./ صابرعبده جاهين**

أستاذ الأراضي المتفرغ ـــ كلية الزراعة ـــ جامعة كفرالشيخ

**أ.د./ محمد السعيد أبو والى** **(المشرف الرئيسى)**

أستاذ الأراضي ـــ كلية الزراعة ـــ جامعة كفرالشيخ

**د./ إخلاص مبروك الوكيل**

أستاذ مساعد الأراضي ـــ كلية الزراعة ـــ جامعة كفرالشيخ

**أ.د./ محمد إسماعيل الشهاوى**

رئيس بحوث ـــ معهد بحوث الأراضي والمياه والبيئة ـــ مركز البحوث الزراعية

# لجنة الحكم والمناقشة

تقييم أراضى شمال الدلتا تحت أنواع مختلفة من الممارسات الزراعية

*رسالة مقدمة من*

**بهجت عبد القوى عبد الحميد زامل**

بكالوريوس العلوم الزراعية – قسم الأراضي – كلية الزراعة بكفرالشيخ – جامعة طنطا ١٩٨٠م
ماجستير العلوم الزراعية – قسم الأراضي – كلية الزراعة بكفرالشيخ – جامعة طنطا ٢٠٠٣م

**رسالة علمية مقدمة للحصول على درجة**

**الدكتوراه فى فلسفة العلوم الزراعية**

**(أراضى)**

**لجنة الحكم والمناقشة:**

**أ.د./ صابرعبده جاهين** ......................
أستاذ الأراضي المتفرغ – كلية الزراعة – جامعة كفرالشيخ

**أ.د./ رأفت عبد الفتاح على** ......................
أستاذ ورئيس قسم الأراضي – كلية الزراعة – جامعة كفرالشيخ

**أ.د./ حسن أحمد إسماعيل** ......................
أستاذ الأراضي – كلية الزراعة (الشاطبى) – جامعة الاسكندرية

**أ.د./ محمد السعيد أبو والى** ......................
أستاذ الأراضي – كلية الزراعة – جامعة كفرالشيخ

التاريخ: ٢٠/٨/٢٠٠٧م

جامعة كفرالشيخ
كلية الزراعة
قسم الاراضى

# تقييم اراضى شمال الدلتا تحت أنواع مختلفة من الممارسات الزراعية

رسالة مقدمة من

**بهجت عبد القوى عبد الحميد زامل**

بكالوريوس العلوم الزراعية – قسم الأراضي – كلية الزراعة بكفرالشيخ – جامعة طنطا ١٩٨٠م

ماجستير العلوم الزراعية – قسم الأراضي – كلية الزراعة بكفرالشيخ – جامعة طنطا ٢٠٠٣م

**رسالة علمية مقدمة للحصول على درجة**

**الدكتوراه فى فلسفة العلوم الزراعية**

**(أراضى)**

٢٠٠٧م