MONITORING SOIL PROPERTIES CHANGES ASSOCIATED WITH THE APPLIED AGRO-MANAGEMENT PRACTICES IN SOME NEWLY RECLAIMED AREAS OF EGYPT

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ABSTRACT:

This study was an attempt to identify the changes in soil physico-chemical properties and nutrients status as associated with agro-management practices in some newly reclaimed areas due to their utilization for agriculture under different land use periods and farming systems.

So, three areas that have different soil origins, *i.e.*, fluvio-lacustrine deposits at Sahl El Hussania, aeolian deposits at El Salhia area and marine-lacustrine deposits at Maryut area were selected, and in turn the soils developed on such origins should be differing in the pedo-chemical or physico-chemical characteristics. Furthermore, three soil profiles having an almost similar textural class and differed in land use periods (3-20 years) were selected to represent each one of the studied areas.

The obtained results reveal that the soils of the selected three areas differ in their characteristics, particularly soil texture that categorized in fine (clay), coarse (loamy sand) and medium (sandy clay loam) grades for Sahl El Hussania, El Salhia and Maryut areas. Consequently, the response of soil properties; *i.e.*, morphological features, bulk density, total porosity, hydraulic conductivity, available water range, pH, ECe, soluble ions, CEC, ESP, $CaCO_3$ and organic matter contents as well as nutrients status and parametric evaluation index soil productivity limitations; to the actual changes as a result of the applied agro-management practices was more related to many factors, *i.e.*, physiographic position, origin of soil materials (inherited soil features), period of agricultural utilization, characteristics of the grown plants, irrigation water quality, method of irrigation system, efficiency of soil drainage or field drainage system.

Also, it is noteworthy to mention that the positive effects due to the applied agro-management practices were differed from an area to another according to the soil nature and environmental conditions, *i.e.*, efficient open drainage system, gypsum application, leaching process and bio-organic fertilization at Sahl El Hussania; application of clayey shales and farmyard manure at El Salhia; accumulation of Ca-humus due to organic fertilization that alleviating the restrictive effect of $CaCO_3$ and efficient tile drainage system at Maryut. Such applied agro-management practices during the long-term land use for agricultural utilization reflected favourable signs on soil properties amelioration, *i.e.*, creating the conductive pores which enhancing the removal of excess soluble salts, modifying the deteriorated soil structure due to either sodicity in the fine texture (Sahl El Hussania area) or the skeletal nature of soil (El Salhia area), creating the suitable air-moisture regime which helped for releasing, mobility and biological activity of essential nutrients uptake mechanism. Such favourable conditions were positively reflected on the vegetative growth of the grown plants as well as their final products.

Key words: Newly reclaimed soils, agro-management practices, land use periods for agricultural utilization.

INTRODUCTION:

In the last decades, Egypt face gab exists between human needs and its consumption. This problem is more related with the crisis of inadequate agriculture production, which is intensified by increasing population and by natural disasters such as drought, limited cultivated areas in the Nile Valley or Delta and shortage in the fresh Nile water. From a global viewpoint, only few untouched fertile areas are remained by the end of this century, so almost all production needed must come from the existing spread of productive land **(Smith and Dumanski, 1994)**. So that, The Egyptian Government requires to pay an attention to conserve and sustain their productivity status, besides agriculture extension in the adjacent desert areas. To achieve this target, many efforts have been directed towards identifying limitations of soil productivity either in the ancient agricultural areas or in the newly reclaimed ones, hoping an execute the suitable agro-management practices for soil properties amelioration and maximizing the yields of the grown crops. The improvement of mismanagement practices of soils, which are more related to the changes in the natural environment such as over intensive cultivation, destructive irrigation and farming practices, may be due to human favourable agro-management of such natural resources **(FAO, 1983)**.

Moreover, that means that there is an urgent need for horizontal expansion for the barren solids adjacent to the northern lakes as well as the desert areas of Egypt, particularly those have less productive desert sandy or calcareous soils. The significance of either available arable land or fresh water resources for agricultural utilization in the draught front desert outskirts of Egypt is one of the most important factors limiting both horizontal and vertical expansions as well as maximizing crop yield and its quality. Such conditions are the result of a complex combination of soil, plant and atmosphere factors, which all interact to control the best use efficiency of water for crop production as well as to maximize the return of water unit for irrigation **(Bali *et al.*, 1996)**. The beneficial effects of the applied agro-management practices are mainly depended on the soil properties and water quality, beside the kinds of the crops grown. To formulate a responsible schedule for the proper use of the water and soil resources as well as the protection of the cultivated lands and crops, several attempts must be find out to recommend the superiority of these practices.

The promising areas of virgin desert soils, which occupy a large area of Egypt, are commonly known to have a poor soil structure, low water holding capacity and their limited fertility. The dominance of coarse mechanical constituents siliceous or carbonitic in nature is not partially capable to retain neither water nor nutrients for growing plants. Accordingly, these soils are poor not only in the nutrient-bearing minerals, but also in organic matter, which are storehouse for the essential plant nutrients. In addition, the occurrence of inadequate water retention under such severe conditions, in turn the productivity of different crops tends to decrease markedly **(Metwally and Khamis, 1998)**. As for soils calcareous in nature, active $CaCO_3$ affect distinctly different soil properties related to plant growth, *i.e.*, crusting, soil-water relations, availability of plant nutrients, etc. **(Ragab, 2001)**. Calcareous soils are of wide occurrence in the desert regions of Egypt, and most of the newly reclaimed areas in the western parts at the periphery of the Nile Valley. Thus, the reclamation of desert soils calcareous in nature to become agriculturally productive is a priority of the Egyptian agricultural policy.

In arid and semi-arid regions as in Egypt, where the rainfall is scarce and water resources are limited, the best use of water for crop production must be adapted. This requires a proper understanding of the crop response to water for maximizing the return of water used for irrigation. Irrigation requirements have a vital role in crop production and irrigation planning. The irrigation methods often need to be applied under climatic and agronomic conditions very different from those under which they were originally developed. It is very important to evaluate these methods to be adapted if needed for application under different conditions **(Amer, 1999)**. That was true, since using the available low water quality and yielding plant varieties under different conditions of water use efficiencies should be achieved **(Tanaka, 1989)**. The alternative practices are sought to made agriculture more sustainable, as such, it would be able to protect soil or water resources, and be environmentally safe and profitable **(Barrow, 1995)**. Therefore, the major policy of the Egyptian Government aims to attain self-dependence in water needs. To achieve this goal efforts have been directed towards both increasing the water use efficiency for all used aspects. The positive or negative effects of such water used for irrigation purposes depend mainly on their quality and attained specific elements as well as soil nature **(Rajesh and Bajwa, 1997)**.

Ibrahim (2004) reported that for a successful outcome, land use has to be well adapted according to the nature of soil characteristics, water resources and the ecological conditions, which are more related to the technical economic sense. So that, the current study is a trial for elucidate soil development as affected by the applied agro-management practices under different soil origins and environmental conditions as well as to asses their significance as a guide to correct the problems facing the future agricultural development projects in the area under investigation.

MATERIALS AND METHODS:

The present study was undertaken to evaluate soil development in different newly reclaimed areas of Egypt due to executing the agro-management practices throughout determining the associated changes in their soil characteristics during different periods of agricultural utilization that may be helpful for identifying the best land use in the future time. To achieve such target, three areas having different soil origins, *i.e*., fluvio-lacustrine deposits at Sahl El Hussania, fluvio--aeolian plain at El Salhia area and lacustrine deposits at Maryut area, were chosen. Furthermore, the soils developed on such different origins should be differing in their pedo-chemical or physico-chemical characteristics. To achieve the objective of the current study, three soil profiles having an almost similar textural class and differed in land use periods (3-20 years) were selected to represent, as possible, each one of the studied areas.

The studied soils are irrigated with fresh Nile water and marginal waters, *i.e.*, drainage water contaminated with sewage effluent (Sahl El hussania area), underground well water (El Salhia area) and a mixture of the Nile water and drainage water (Maryut area). The chemical characteristics and suitability criteria for irrigation of the available water resources, according to **Page *et al.* (1982) and Ayers and Westcot (1985)**, are shown in Table (1).

The representative soil profiles, *i.e.*, 1-3 at Sahl El Hussania area, 4-6 at El salhia area and 7-9 at Maryut area, were dug to a depth of 100 cm, exception of soil profiles No.1 due to shallow ground water table at 90 cm from soil surface. A morphological description was carried out for the selected soil profiles according to the guidelines undertaken by **FAO (1990)**, as illustrated in Table (2). Disturbed and undisturbed soil samples were collected from the surface and subsoil layers for physical, chemical and mineralogical determinations as well as nutrients status in the active root zone (0-60 cm).

Methods of analyses:

Physical properties (*i.e.*, particle size distribution, particle density, bulk density, total porosity, hydraulic conductivity and soil moisture content at available water range), and chemical ones (*i.e.*, pH in 1 : 2.5 soil water suspension, ECe & soluble ions in soil paste extract, CEC, ESP, $CaCO_3$ and organic matter contents) were determined according to the standard methods outlined by **Black *et al.* (1965)** and **Page *et at*. (1982)**.

Table (1): Chemical characteristics of the used irrigation resource.

Water Characteristics	Sahl El Hussania	El Salhia	Maryut
Water pH	7.05	7.56	7.82
ECiw (dS/m)	2.42	0.49	1.90
Soluble ions (mmolc L^{-1}):			
Ca^{++}	2.02	2.49	6.32
Mg^{++}	5.60	0.76	5.17
Na^{+}	16.27	1.52	7.28
K^{+}	0.37	0.13	0.23
CO_3^{--}	0.00	0.00	0.00
HCO_{3-}	2.99	2.93	2.78
Cl^{-}	15.36	1.26	9.42
SO_4^{--}	5.85	0.91	6.80
SAR	8.34	1.19	3.08
RSC	--	--	--
Suitability degree	C2S2	C1S1	C2S1

Table (2): The morphological features of soil profiles at the different studied soil sites.

Physiographic unit	Land use	Cultivation period (year)	Profile No.	Horizon	Depth (cm)	Soil colour: Hue	Soil colour: Value/chroma Dry	Soil colour: Value/chroma Moist	Soil texture grade	Soil structure	Consistence	Roots	Boundary
Sahl El Hussania area													
Fluvio-lacustrine plain	**Virgin**	0	1	Az	0-30	10YR	4/2	3/1	**c**	mas	vfir	--	--
				Cz1	30-60					pr	vfir	fw	ds
				Cz2	60-90					co	vfir		
	Alfalfa	3	2	Ap	0-30		4/2	3/2		abl	fir	co	
				C1	30-60		5/3	5/2			vfir	my	ds
				C2	60-100					co	vfir		
		7	3	Ap	0-30	2.5Y	5/2	4/2		sabl	fir	my	--
				C1	30-60					abl			ds
				C2	60-100						vfir		
El Salhia area													
Fluvio-aeolian plain	**Virgin**	0	4	C1	0-20	5YR	6/6	5/3	sl	mas	lo	--	--
				C2	20-50							fw	ds
				C3	50-100	7.5YR	6/6	5/6	ls	sg			gs
	Fruit trees (citrus)	7	5	Ap	0-20	7.5YR	6/6	6/4	scl	gr	vfr	co	--
				C1	20-50	2.5Y	7/4	7/6	sl	cr	lo	my	cs
				C2	50-100		7/4	6/4	ls	sg			
		15	6	Ap	0-20	10YR	6/4	4/5	scl	gr	fr	my	--
				C1	20-50	5YR	6/6	5/3	sl	cr	vfr		cs
				C2	50-100	10YR	7/7	6/6	ls	mas	lo		
Maryut area													
Lacustrine plain	**Virgin**	0	7	Akz	0-25	2.5Y	7/4	6/4	scl	mas	fr	co	--
				Ckz1	25-60	10YR	8/6	6/7			vfir	my	ds
				Ckz2	60-100				cl	sabl			cs
	Barley	8	8	Ap	0-25	2.5Y	6/4	5/2	scl	gr	fr	my	--
				Ck1	25-60	10YR	7/6	6/6			fir		ds
				Ck2	60-100		8/4	7/6	cl	sabl		co	cs
		20	9	Ap	0-25	10YR	5/3	4/2	scl	gr	fr	my	--
				Ck1	25-60		6/4	5/6		sabl			ds
				Ck2	60-100		6/4	6/6	cl		fir	co	cs

Soil texture: ls=loamy sand sl=sandy loam scl=sandy clay loam cl=clay loam c=clay.
Roots: co=common my=many fw=few.
Soil structure: sg=single grain mas=massive cr=crumb gr=granular sabl=subanglular blocky pr=prismatic co=columnar.
Soil consistence: Dry: lo=loose: Moist: fr=friable fir=firm vfir=very firm

The nutrients status in soil, *i.e.,* available nutrients of N, P and K were extracted by 1% potassium sulphate, 0.5 M sodium bicarbonate and 1.0 N ammonium acetate, respectively **(Chapman and Pratt, 1961; Black *et al.,* 1965 and Jackson, 1973)**. Also, the available micronutrient contents (*i.e.* Fe, Mn and Zn) were extracted with DTPA according to **Lindsay and Norvell (1978)** and measured by using the atomic absorption spectrophotometer (Berkin Elemer, 2380). In addition, semi-quantitative of clay minerals which was carried out on the basis of visual estimates of X-ray diffraction intensity from test samples and standard mixtures of clay fractions according to **Jackson (1969)**.

RESULTS AND DISCUSSION:

Soil physico-chemical properties as related to soil agro-management practices:

Soil as a complex system is reliable for several physic-chemical modifications through the effects of locality environmental conditions and soil-water management practices. So, it is expected that the different characteristics of the studied soil profiles are largely responsible for performing management practices, and in turn their nutrients supplying power. Results illustrated in Tables (3-6) showed the positive effects of the different agro-management practices, particularly at the effective root zone depth. The recorded changes in soil properties included soil texture, bulk density, total porosity, available water range, hydraulic conductivity, pH, salinity, alkalinity, cation exchange capacity, $CaCO_3$ and organic matter contents.

Soils of Sahl El Hussania area:

It is noticed that the considerable pedogenic changes are ascribed to the cultivation periods, however, soil development is more obvious in the relatively long-term use of agricultural utilization as compared to the virgin soils. Soil bulk density and porosity are often used as an indicator for soil structure, moisture behaviour and aeration condition.

Data illustrated in Tables (3 and 5) clearly show that soil bulk density exhibited an increase via a decrease in soil total porosity in the virgin soil at Sahl El Hussania area (profile No. 1) due to soil salinity stress. This trend could be attributed to the negative effects of Na-salts on deforming the soil aggregates, and in turn soil structure or soil aggregation tends to be less stable in the saline soils. Then it tends to decrease via a pronounced increase in soil total porosity as a result of removing the excess of soluble salts due to the applied agro-management practices, which including the application of gypsum requirement, deep ploughing, leaching process under an efficient drainage system, organic manure application, suitable agricultural procedures for the different cropping patterns and rotations through the long-term periods of cultivation. Such agro-management practices led to a parallel increase in each of soil available water and permeability (Ksa), which proportionally related to the alleviation of the negative effects of both osmotic and matrix potentials.

Also, it is quite noticeable that a decrease in soil pH as well as the increase in organic matter content due the reclamation process could be attributed to the occurrence of various organic and inorganic compounds, which directly or indirectly nourish the fish after different biochemical and chemical changes (**Nashy, 1995**).

Table (3): Some physical properties of the studied soils.

Profile No.	Depth (cm)	Particle size distribution %			Textural class	Bulk density (g/cm^3)	Total porosity %	Available water %	K sat. (cm/h)
		Sand	Silt	Clay					
Sahl El Hussania area									
1	0-30	18.80	38.05	43.15	Clay	1.20	58.57	21.69	1.32
	30-60	18.17	36.33	45.50		1.27	62.60	23.97	0.97
	60-90	6.89	38.61	54.50		1.30	67.85	26.94	0.71
2	0-30	10.26	44.70	45.04		1.17	62.23	23.81	1.85
	30-60	15.90	38.10	46.00		1.23	67.36	22.23	1.29
	60-100	16.05	38.84	45.11		1.29	68.87	21.97	0.90
3	0-30	22.23	35.51	42.26		1.15	59.41	24.54	2.16
	30-60	17.64	37.22	45.14		1.18	57.00	23.60	1.75
	60-100	19.76	36.89	43.35		1.21	59.30	21.93	1.09
El Salhia area									
4	0-20	63.88	21.96	14.16	Sandy loam	1.55	49.05	13.95	7.85
	20-50	70.85	17.65	11.50		1.65	47.10	11.48	9.90
	50-100	82.64	11.95	5.41	Loamy sand	1.67	45.16	7.69	12.20
5	0-20	55.63	20.15	24.22	Sandy clay loam	1.45	51.02	14.49	6.86
	20-50	58.64	24.87	16.49	Sandy loam	1.47	48.27	12.65	8.24
	50-100	79.03	13.47	7.50	Loamy sand	1.56	47.15	9.27	11.05
6	0-20	46.05	26.45	27.50	Sandy clay loam	1.30	53.08	15.91	6.18
	20-50	64.47	19.76	15.77	Sandy loam	1.41	49.41	13.02	7.34
	50-100	76.24	13.85	9.91	Loamy sand	1.48	48.25	10.43	10.53
Maryut area									
7	0-25	61.30	17.20	21.50	Sandy clay loam	1.35	48.83	10.69	6.39
	25-60	55.85	15.70	28.45		1.37	51.14	14.92	4.72
	60-100	41.90	20.60	37.50	Clay loam	1.39	55.70	17.25	3.48
8	0-25	54.20	19.30	26.50	Sandy clay loam	1.27	49.22	15.33	4.79
	25-60	53.95	16.05	30.00		1.29	52.10	19.32	3.80
	60-100	39.70	22.30	38.00	Clay loam	1.32	56.50	21.60	2.82
9	0-25	51.25	20.34	28.41	Sandy clay loam	1.22	51.32	19.21	3.07
	25-60	47.50	18.70	33.80		1.25	53.60	22.19	2.11
	60-100	29.35	31.34	39.31	Clay loam	1.27	57.30	24.21	2.28

On the other hand, the pronounced decreases in soil $CaCO_3$ content in soil profile Nos. 2 and 3, that characterized by the occurrence of various fish-ponds organic and inorganic compounds and relatively low soil pH, may be directly or indirectly related to the dissolution effect of these constituents on soil $CaCO_3$. Finally, results of field-work and laboratory analyses showed wide variations between the studied soils which were mainly related to the different agro-management practices. Cultivated soils under drainage systems have very deep root zone depth, lacking features of soil development. These features included Ap friable horizon and firm subsoil ones, matrix colour of dark yellowish brown, slightly ECe & calcareous ($CaCO_3$ < 3 %) and non-alkaline soils (ESP < 15).

Soils of El Salhia area:

Data in Tables (3-5) indicate that the original phase of the desert sediments, which are represented by the virgin soil profiles 4-6, have almost uniform loose sandy loam underlain loamy sand in the virgin profile layers. On the other hand, the cultivated soils within the same origin of these units, in general, are characterized by relatively medium textured soil (sandy clay loam) in the surface layers that are more subjected to the agro-management practices. The response of soil characteristics to the positively changes as a result of land management practices was more related to the uppermost layer, may be due to the man made of adding clayey shales and farmyard manure as shown in soil sites 5 and 6 and 12 as well as the accumulated of suspended fine colloids during the long-term use.

Table (4): Chemical analysis of soil paste extract for the studied soils.

Profile No.	Depth (cm)	Soil pH*	ECe (dS/m)	Soluble cations in meq/l				Soluble anions in meq/l			
				Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}
Sahl El Hussania area											
1	0-30	8.31	30.00	48.30	47.20	200.50	3.00	0.00	2.40	200.40	96.20
	30-60	8.40	24.00	11.70	58.70	166.80	2.74	0.00	2.14	204.66	33.14
	60-90	8.65	20.40	11.70	35.60	154.10	2.54	0.00	3.20	153.60	47.14
2	0-30	7.75	6.50	9.50	20.10	33.71	1.69	0.00	3.20	11.52	50.28
	30-60	7.80	7.90	15.40	24.90	36.53	2.17	0.00	2.40	22.90	53.70
	60-100	7.89	9.10	15.70	25.10	47.40	2.80	0.00	2.14	26.70	62.16
3	0-30	7.45	4.90	19.05	11.80	17.01	1.14	0.00	2.67	26.90	19.43
	30-60	7.60	5.30	11.70	13.46	26.84	1.00	0.00	2.78	27.72	22.50
	60-100	7.75	5.90	13.30	23.50	21.20	1.00	0.00	2.97	28.80	27.23
El Salhia area											
4	0-20	7.95	7.00	11.60	8.90	48.50	1.00	0.00	2.80	39.70	27.50
	20-50	8.15	5.00	8.70	2.00	38.45	0.85	0.00	1.87	34.56	13.57
	50-100	8.25	2.95	7.36	1.00	20.88	0.26	0.00	2.35	17.20	9.95
5	0-20	7.85	3.00	12.24	5.00	12.40	0.36	0.00	2.81	17.76	9.43
	20-50	7.90	2.30	8.46	4.55	9.64	0.35	0.00	2.74	11.76	8.50
	50-100	8.05	1.85	6.97	3.61	7.57	0.35	0.00	2.20	8.28	8.02
6	0-20	7.65	2.09	8.92	1.66	9.76	0.56	0.00	2.74	10.60	7.56
	20-50	7.75	1.10	4.64	1.90	4.01	0.45	0.00	2.67	4.84	3.49
	50-100	7.90	0.90	3.68	1.24	3.63	0.45	0.00	2.67	3.84	2.49
Maryut area											
7	0-25	8.00	16.80	50.70	36.80	89.33	1.17	0.00	2.40	74.20	101.40
	25-60	7.95	18.65	36.48	36.66	122.14	1.23	0.00	2.54	121.84	72.13
	60-100	7.95	20.60	33.26	41.52	139.94	1.28	0.00	2.67	164.48	48.85
8	0-25	7.80	4.30	15.28	16.12	10.60	1.00	0.00	2.35	21.96	18.69
	25-60	7.90	5.20	14.82	12.04	24.58	0.56	0.00	2.40	26.88	22.72
	60-100	7.90	5.85	13.26	20.04	24.75	0.45	0.00	2.67	35.36	20.47
9	0-25	7.50	3.80	14.30	7.36	15.34	1.00	0.00	2.74	18.60	16.66
	25-60	7.50	4.60	15.06	11.72	17.65	1.57	0.00	2.47	24.80	18.73
	60-100	7.55	4.20	12.48	12.68	16.28	0.56	0.00	2.47	19.20	20.33

Soil bulk density is a function of soil structure, which is more related to various physical properties, especially water movement in soil **(Lawrence, 1977)**. Therefore, improvement of soil structure plays an important role for modifying the other physical properties in soil**.** So, the application of organic manure (FYM) or green manuring as well as the inorganic clayey shales caused a pronounced reduction in soil bulk density values, as shown in soil profile 6 (old alluvial river terraces). These findings are in agreement with those obtained by **Batey (1990)** who reported that soil bulk density was closely related to the properties of solid and pore space, which depended upon the changes in soil texture, moisture content and other factors such as soil salinity and alkalinity. Also, the obtained data showed a parallel increment in soil available water range vs a pronounced reduce in soil permeability (Ksa), which are proportionally related to the relative increase of fine soil mechanical fractions, organic matter content. The relatively increase in soil moisture retained at the field capacity may be ascribed to the effect of both s-matrix and capillary potentials which increasing ability of the reclaimed soils to retain a more moisture content.

Table (5): Some chemical properties of the studied soils.

Profile No.	Depth (cm)	CEC (meq/100 g soil)	SAR	ESP	$CaCO_3$ %	Organic matter %
Sahl El Hussania						
1	0-30	37.60	28.84	29.22	4.20	0.86
	30-60	38.95	28.12	28.68	3.63	0.65
	60-90	39.17	31.70	31.27	3.27	0.39
2	0-30	39.02	8.76	14.64	2.62	1.79
	30-60	39.83	8.14	15.71	2.91	1.04
	60-100	38.75	10.49	17.00	2.01	0.62
3	0-30	40.90	6.54	7.74	2.33	2.63
	30-60	39.71	7.56	11.00	2.02	1.30
	60-100	34.89	4.94	15.69	1.91	0.89
El Salhia area						
4	0-20	15.61	15.16	13.42	7.60	0.25
	20-50	9.85	16.65	14.90	4.40	0.18
	50-100	4.72	10.24	12.16	4.40	0.07
5	0-20	21.10	4.22	9.73	5.80	0.32
	20-50	12.95	3.78	11.14	4.20	0.26
	50-100	6.05	2.22	8.97	3.90	0.11
6	0-20	23.20	3.09	6.19	4.40	0.68
	20-50	13.79	1.19	9.50	3.90	0.37
	50-100	8.65	1.54	7.00	3.20	0.16
Maryut area						
7	0-25	12.85	6.61	17.50	38.30	0.27
	25-60	14.09	6.05	19.17	39.05	0.20
	60-100	15.32	6.11	20.08	40.76	0.12
8	0-25	13.78	3.96	5.91	35.20	0.95
	25-60	14.65	3.66	8.40	37.40	0.56
	60-100	16.01	4.08	9.16	39.15	0.22
9	0-25	15.11	3.29	5.13	29.43	1.67
	25-60	15.32	3.66	7.22	30.40	0.95
	60-100	16.95	3.55	8.90	32.52	0.30

The positive effects of different agro-management practices led to reduce soil salinity on the long-term use as compared to the virgin soils developed on the same soil sediments, probably due to the sufficient soil drainage that enhanced the removal of the excess salts. The noticeable decrease in soil pH in soil profiles 6 (fluvio-aeolian plain) as compared to the virgin state, may be attributed to the occurrence of organic acids that derived from added organic manures as well as the release CO_2 during organic matter decomposition which dissolves in water forming carbonic acid that lowering soil pH (**Mohamed, 1998**). In spite of the prevailing arid condition, soil organic matter content tended to increase from 0.25 % (virgin soil) up to 0.68 % in soils cultivated for a period of 15 years (profile No. 6). It is most probably due to organic fertilization and the accumulation of plant residues on soil surface. Soil $CaCO_3$ content is generally at a low range of 3.20 in soil profiles 6 of the old alluvial river terraces, which are mainly developed on a siliceous origin. It is quite noticeable that there was an increase for the CEC value in soil surface layer of profiles 6, due to the long-term use of cultivation that led to an accumulation of charged organic and inorganic colloids.

Soils of Maryut area:

The obtained results, Tables (3-5), show that a reduction in each of soil bulk density and permeability was associated with increasing the period of agricultural utilization. It is most probably due to lowering the values of soil salinity, sodicity and compaction phenomena. This trend could be contributed with the increment of total porosity and available water range. With respect to the studied soil chemical properties, data indicate that soil organic matter and $CaCO_3$ contents are relatively low and high, respectively. There was a dual relationship between $CaCO_3$ and organic matter contents, where the latter exhibited a gradual decrease as the increase in $CaCO_3$ towards topsoil may be due to the upward movement of $Ca(HCO_3)_2$ and its precipitated as a secondary $CaCO_3$ under the hot conditions. Soil salinity levels of the studied virgin soils (profile 7) are classified as saline and alkaline soils (ECe >4 dS/m and ESP of >15), while the cultivated ones are slight saline to non-saline and non-alkaline soils.

It is noteworthy to mention that lacking features of development in the Miocene limestone formations at Maryut are represented by dark yellowish brown matrix colour, especially in the surface layer of the more cultivated soil profiles (20 years land use), due to the coagulation of humus by soluble Ca^{2+} in the form of accumulations of Ca-humus. Moreover, these environmental conditions create a suitable air-moisture regime for biological activity, which enhance the organic matter decomposition. Also, applied leaching processes under an efficient open or tile drainage system reflected the signs of soil management practices, which led to remove a relatively high content of soluble salts throughout soil profile. Also, the perennial irrigation and bio-organic fertilization and cropping patterns played an important role for increasing soil depth as a result of soil moisture regime cycles.

Soil taxonomy:

Based on the detected soil morphological features and physico-chemical properties, the soils under investigation could be classified up to the family level into five taxonomic units according to **Soil Survey Staff (1999)**, as shown in Table (6).

It is most probably the studied soils are developed on different parent materials and occupy scattered portions of Egypt. Also, the investigated areas lie within the climatic conditions characterized by alternative pattern of a long hot rainless summer and short mild winter with a pronounced amount of rainfall. Some of the studied soil profiles are enriched with secondary $CaCO_3$ accumulations, which satisfy the requirement of calcic horizon in some profiles such as Nos. 7, 8 and 9.

Soil evaluation:

The physical parametric land evaluation system undertaken by **Sys and Verheye (1978)**, which is considered a favourable system under the conditions prevailing in the soils of Egypt **(Moussa, 1991)**, was applied to determine the soil limitations and their intensities as well as land suitability classes according to the current suitability ratings. The obtained data in Table (7) reveal that all the studied soils have no limitations for their topography, wetness (w), exception for profile 1, and the effective soil depth (s_2). On the other hand, most of the representative soil profiles are suffering from soil texture (s_1), $CaCO_3$ (s_3) content, gypsum (s_4) content and salinity/alkalinity (n) as limitations for soil productivity, which are put into variable intensity degrees of (75-95, moderate-slight), (80-90, moderate-slight), (90, slight) and (40-98 very severe-slight), respectively.

Table (6): Soil taxonomic units of the studied soil profiles.

Order	Sub-order	Great group	Sub-group	Family	Representative soil profiles
Vertisols	Torrerts	Haplotorrerts	Sodic Haplo-Torrerts	Sodic Haplotorrerts, fine clayey, smectitic, hyperthermic	1
			Typic Haplo-Torrerts	Typic Haplotorrerts, fine clayey, smectitic, hyperthermic	2 & 3
Entisols	Orthents	Torri-orthents	Typic torri-orthents	Typic Torriorthents, sandy, mixed, hyperthermic	4, 5 & 6
Aridisols	Calcids	Haplo-calcids	Sodic Haplo-calcids	Sodic Haplocalcids, fine loamy, mixed, thermic	7
			Typic Haplo-calcids	Typic Haplocalcids, fine loamy, mixed, thermic	8 & 9

Table (7): Soil limitations and rating indices for the evaluation of the studied soil profiles.

Profile No.	Suitability condition	Topography (t)	Wetness (w)	S				Soil salinity/ Alkalinity (n)	Rating (Ci)	Suitability class	Suitability subclass
				Soil texture (s1)	Soil depth (s2)	$CaCO_3$ (s3)	Gypsum (s4)				
1	Current	100	50	85	100	100	90	50	19.13	N	Nws1s4n
	Potential	100	100	85	100	100	90	100	76.50	S1	S1s1s4
2	Current	100	100	85	100	100	90	80	61.20	S2	S2s1s4n
	Potential	100	100	85	100	100	90	100	76.50	S1	S1s1s4
3	Current	100	100	85	100	100	90	80	61.20	S2	S2s1s4n
	Potential	100	100	85	100	100	90	100	76.50	S1	S1s1s4
4	Current	100	100	75	100	100	90	90	60.75	S2	S2s1s4n
	Potential	100	100	75	100	100	90	100	67.50	S2	S2s1s4
5	Current	100	100	80	100	100	90	96	69.12	S2	S2s1s4n
	Potential	100	100	80	100	100	90	100	72.00	S2	S2s1s4
6	Current	100	100	100	100	100	90	100	69.12	S2	S2s1s4n
	Potential	100	100	100	100	100	90	100	72.00	S2	S2s1s4
7	Current	100	100	90	100	80	90	75	54.00	S2	S2s1s3s4n
	Potential	100	100	90	100	80	90	100	64.80	S2	S2s1s3s4
8	Current	100	100	95	100	80	90	90	61.56	S2	S2s1s3s4n
	Potential	100	100	95	100	80	90	100	68.40	S2	S2s1s3s4
9	Current	100	100	95	100	80	90	98	67.03	S2	S2s1s3s4n
	Potential	100	100	95	100	80	90	100	68.40	S2	S2s1s3s4

According to the model of **Sys and Verheye (1978)** and the estimated data of soil criteria, the suitability indices (Ci) for the studied nine profiles for current and potential classes are assessed and recorded in Table (7). The obtained results show that the estimated current ratings of the studied soil profiles ranged between 19.13 and 69.26, indicate that the soils of the studied areas could be categorized into three classes, as follows.

a. Not suitable soils (N):

The rating of this class is < 25, and represented by soil profile No. 1.

b. Moderately suitable soils (S2):

The rating of this class is 50-<75, and represented by soil profile Nos. 2, 3, 4, 5, 6, 7, 8 and 9.

For ameliorating the suitability of these soils, major improvement practices should be carried out such as removing the excess of soluble salts and sodicity through applying the gypsum and leaching requirements under an efficient drainage ditches, in addition to organic fertilization and other soil and water managements. Such agro-management practices will correct the ratings of soil potential suitability classes to be ranged 64.56-76.95, and potential soil suitability becomes as follows.

a. Moderately suitable soils (S2):

The rating of this class is 50-<75, and represented by soil profile Nos. 4, 5, 6, 7, 8 and 9.

b. Highly suitable soils (S1):

The rating of this class is 75<, and represented by soil profile Nos. 1, 2, and 3.

Nutrients status in the studied soils:

Data in Table (8) indicate that the soils of Maryut and El Salhia areas were developed in calcareous parent material under sand encroachment, which threaten their fertile status due to coarser in texture, weak in soil structure, attained very low organic matter content and low soil potentiality for plant nutrients supplying power that inherited from their origin sediments. In addition, the relatively high $CaCO_3$, which is dominated in soils of Maryut areas, that restrictive the nutrients availability in the soil, where the relatively high values of soluble Ca^{2+} derived from carbonation process of $CaCO_3$ and soil pH and led to restrict nutrients availability, especially phosphorus and micronutrients. On the other hand, the fluvio-lacustrine soils at Sahl El Hussania area are distinctly rich in the plant nutrients, especially the micronutrients due to their enrichment in nutrient-bearing minerals as compared to the aforementioned studied desert soils.

Due to the agro-management practices by farmer's activity throughout long-term use of agricultural utilization under different cropping patterns, some soils of the studied units had adequate nutrients, especially in the micronutrients at the surface layers. The beneficial effect of both soil physical and chemical properties on nutrients availability could be achieved through maintaining a suitable air-moisture regime and improving the range of available water, which showed a pronounced positive effect on biological activity in soil. Also, the changes in frequency and intensity of land management practices altered the soil properties that are more related to soil potentiality for nutrients, which were not only tended to increase with increasing the nutrient-bearing minerals content, but also with the increment of charged silicate clays of specific active surface reactions.

Mineralogy of clay fraction:

Data of semi-quantitative measurements of the clay fraction obtained from the selected soil sediments, Table (9), reveal that, with exception of soils of Sahl El Hussania which exhibited a relatively high smectites content due to their previously subjected to intensive chemical weathering under the water-logged condition (pre-aquic condition), the mineralogical composition of clay fraction for the other studied soil sediments is dominated with kaolinite minerals, followed by palygorskite or feldspars in the cases of calcareous in nature (Maryut area) or aeolian sediments (El Salhia area), respectively.

Table (8): Total and available contents of some nutrients in the studied soils.

Profile No.	Depth (cm)	Macronutrients (mg/kg)							Micronutrients (mg/kg)						
		Total			Available				Total			Available			
		N	P	K	N	P	K	Cu	Mn	Zn	Fe	Cu	Mn	Zn	Fe
Sahl El Hussania area															
1	0-30	330	219	21427	35.35	11.25	425	50	145	112	23387	1.89	5.14	2.60	16.94
	30-60	270	186	22069	31.52	8.40	407	45	137	119	24075	1.52	4.92	2.08	15.68
2	0-30	480	383	23592	46.62	13.84	532	57	150	115	23363	2.36	7.02	3.24	17.20
	30-60	340	279	22332	41.55	9.28	434	48	143	107	22852	1.61	5.49	2.16	16.44
3	0-30	810	491	20431	58.15	15.02	616	61	157	95	19513	2.15	8.85	4.27	19.88
	30-60	430	289	21515	47.97	11.85	514	51	149	92	21425	2.72	6.42	3.02	17.11
El Salhia area															
4	0-20	460	267	1659	18.90	4.20	128	35	71	44	9412	0.76	1.30	0.88	3.10
	20-50	250	184	995	17.50	3.40	119	25	50	31	7276	0.60	1.00	0.70	1.28
5	0-20	550	285	1924	24.50	5.00	156	50	80	50	10225	0.83	0.50	0.92	4.08
	20-50	380	198	1024	19.80	3.90	123	35	60	38	8425	0.74	1.09	0.84	2.36
6	0-20	640	375	2098	42.20	5.80	177	75	95	63	10513	0.96	1.80	0.98	7.30
	20-50	520	238	1119	34.00	4.20	138	50	70	45	8475	0.80	1.15	0.92	5.68
Maryut area															
7	0-25	580	333	2508	20.20	4.45	280	45	55	87	13350	0.92	1.15	1.06	4.50
	25-60	470	285	2507	19.10	3.32	231	43	65	78	14375	0.72	1.18	1.09	4.08
8	0-25	740	663	2753	48.00	6.80	227	55	100	90	16625	0.98	1.25	1.35	5.90
	25-60	520	407	2885	32.25	4.40	310	50	100	75	17057	0.62	1.38	1.14	6.08
9	0-25	880	774	3431	55.75	7.40	298	65	150	95	16856	1.02	1.50	1.63	6.80
	25-60	640	506	2994	40.25	6.60	375	55	125	82	17313	0.74	1.37	1.21	5.42

Table (9): Semi quantitative analysis of the clay fractions separated from the studied soils at the last period of cultivation.

Soil unit	Soil site No.	Depth (cm)	Clay minerals							Accessory minerals		
			Smectite	Kaolinite	Hydrous mica (illite)	Vermiculite	Palygorskite	Chlorite	Interstratified minerals	Quartz	Feldspars	Calcite
El Hussania	3	30-60	51.24	16.91	8.67	6.76	--	4.72	--	3.60	8.10	--
El Salhia	6	20-50	--	49.71	6.43	--	7.00	--	--	15.72	21.14	--
Maryut	9	25-60	1.25	34.97	8.28	10.15	21.65	3.20	7.80	--	--	12.70

The well assembling of kaolinite in the clay fractions of the majority of the studied soil sediments suggests the presence of an appreciable amount of coarse crystallized type, which is derived mainly from the weathering products of basic parent materials that attain low Si-content and favourable conditions to form 1:1 clay minerals. The physical breakdown weathering process under the dry and hot desert climate at El Salhia and Maryut areas may emphasize the occurrence of pronounced amounts of feldspars. The occurrence of calcite, palygorskite, vermiculite and interstratified minerals in some soil sediments of Maryut area are more related to soil origin that characterized by calcareous lithology and obviously cleared the importance of Ca^{2+} and Mg^{2+} ions in the formation of the interstratified and vermiculite minerals.

It is worthy to mention that the distinct assemblages of clay kinds for the studied soil units are not only controlled by soil origins but also by the prevailing environmental conditions. The pre-aquic condition prevailed the sediments of Sahl El Hussania may be encourage the alteration of the mica particles to form other minerals and causes the presence of an appreciable amount of smectites. Also, it can be inferred that feldspars are of primary origin ones and are derived mainly from the parent rock at El Salhia area, these results are supported by the fact that these soils are still young. Also, the occurrence of relatively high amount of quartz at El Salhia area confirms the primarily weathering stages in the source of sediments. Finally, it could be concluded that the clay kinds in the studied soil areas are still not affected by the dominant agro-management practices during the agricultural utilization periods, which are not enough for modifying the clay mineral assemblages.

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متابعة التغيرات فى خصائص التربة المصاحبة لعمليات الخدمة الزراعية فى بعض المناطق المستصلحة حديثا فى مصر

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تعتبر هذه الدراسة محاولة لتحديد التغيرات فى خصائص التربة الفيزيوكيميائية وكذلك حالة المغذيات النباتية المصاحبة لعمليات الخدمة الزراعية فى بعض المناطق المستصلحة حديثا لإستخدامها فى مجال التنمية الزراعية تحت ظروف متغيرة من مدد الإستزراع والنظم المزرعية. وقد تم إختيار ثلاث مناطق تختلف فى مادة أصلها ممثلة فى الرسوبيات البحيرية-النهرية لمنطقة سهل الحسنية، رسوبيات نهرية-هوائية المنشأ لمنطقة الصالحية، رسوبيات بحيرية لمنطقة مريوط، ومن ثم فان الأراضى المتكونة على مثل هذه الرسوبيات لابد وأن تختلف فى خصائصها البيدوكيميائية أو الفيزيوكيميائية. علاوة على ذلك فقد تم إختيار ثلاث قطاعات أرضية متشابهة فى درجة قوام التربة ومختلفة فى مدد الإستزراع (٣-٢٠ سنة) لتمثل كل من المناطق المختارة.

وتشير النتائج المتحصل عليها إلى أن أراضى الثلاث مناطق المختارة تختلف فى خصائص تربتها خاصة قوام التربة - والذى يمكن حصره فى ناعم (طينى)، خشن (رملى طميى)، متوسط (طميى طينى رملى) ممثلا لكل منها على الترتيب مناطق سهل الحسنية، الصالحية، مريوط. ونتيجة لهذا الإختلاف الواضح، فان إستجابة خصائص التربة ممثلة فى الملامح المورفولوجية، الكثافة الظاهرية، المسامية الكلية، التوصيل الهيدروليكى، الماء الميسر، الرقم الهيدروجينى، التوصيل الكهربى، الأيونات الذائبة، السعة التبادلية الكاتيونية، الصوديوم المتبادل، المحتوى من كربونات الكالسيوم والمادة العضوية وكذلك حالة المغذيات ودليل التقييم الباروميترى لمعوقات الإنتاجية فى التربة – للتغيرات الحقيقية كنتيجة لعمليات الخدمة المطبقة ترتبط لحد كبير بكثير من العوامل ممثلة فى الموقع الفيزيوجرافى، مادة الأصل التى تكونت منها التربة (الملامح الوراثية)، مدة الإستزراع، خصائص النباتات النامية، نوعية مياه الرى، طرق الرى، كفاءة صرف التربة أو نظام الصرف الحقلى.

ومن الجدير بالذكر الإشارة إلى أن التأثيرات الإيجابية لعمليات الخدمة الزراعية المطبقة تختلف من منطقة إلى أخرى تبعا لطبيعة التربة والظروف البيئية، حيث تم إجراء عمليات إصلاح شملت إنشاء شبكة مصارف مفتوحة فعالة، إضافة جبس زراعى، وغسيل جوفى، وتسميد عضوى-حيوى فى منطقة سهل الحسنية مقابل إضافة طفلة طينية وتسميد عضوى فى منطقة الصالحية، وبالنسبة لمنطقة مريوط

فان التسميد العضوى قد أدى إلى تراكم الدوبال الكالسى الذى يحد من التأثير السلبى لكربونات الكالسيوم على تيسر المغذيات فى التربة بالإضافة إلى شبكة الصرف الفعالة للحد من تراكم الأملاح الذائبة وإزالة الزائد منها.

وتنعكس تلك التأثرات الإيجابية الناجمة عن إجراء عمليات الخدمة الزراعية على المدى الطويل من إستخدام التربة فى مجال التنمية الزراعية على تحسين خصائص التربة والتى أدت إلى وجود مسام موصلة تساعد على التخلص من الأملاح الذائبة الزائدة، تحسين حالة البناء الأرضى المتدهورة كنتيجة لسيادة الصودية (منطقة سهل الحسنية) أو الطبيعة الهيكلية للتربة (منطقة الصالحية) مما يساعد على حدوث ميزان هوائى-رطوبى مناسب يشجع عملية إنطلاق وحركة وميكانيكية الإمتصاص الحيوى النشط للمغذيات الضرورية للنبات. ومثل هذه الظروف الجيدة تنعكس بصورة إيجابية على حالة نمو النباتات النامية ومن ثم إنتاجيتها النهائية.