RESULTS AND DISCUSSION

4*.RESULTS AND DISCUSSION

4.1.Soils of the studied area:

4.1.1. Soil classification:

In the current study, soil classification was performed according to the "Soil Taxonomy" **system (USDA 1975 and USDA 1999)** defining and naming soil taxa to the family level. Whenever possible, families were differentiated to the series level. In this regard, the USDA Soil Taxonomy System which aims at classifying soils in an up–to-date system resembling the Plant Taxonomy System was worked out by the United States Soil Survey Division of the United States Department of Agriculture (USDA) since the early sixties of the last century (20^{th} century).It was finally published under its current name of "**Soil Taxonomy**" in 1975 **(USDA 1975)**.Since then a number of related publications were issued concerning this system. One series of such publications is the "**Keys to Soil Taxonomy** "which " provides the taxononic keys necessary for the classification of soils according to **Soil Taxonomy**" This series acquaints soilscientists with recent changes in the system Six editions of the "**Keys to Soil Taxonomy"** publications were issued up to the mid mineties of the 20^{th} century (up to 1994). There were a

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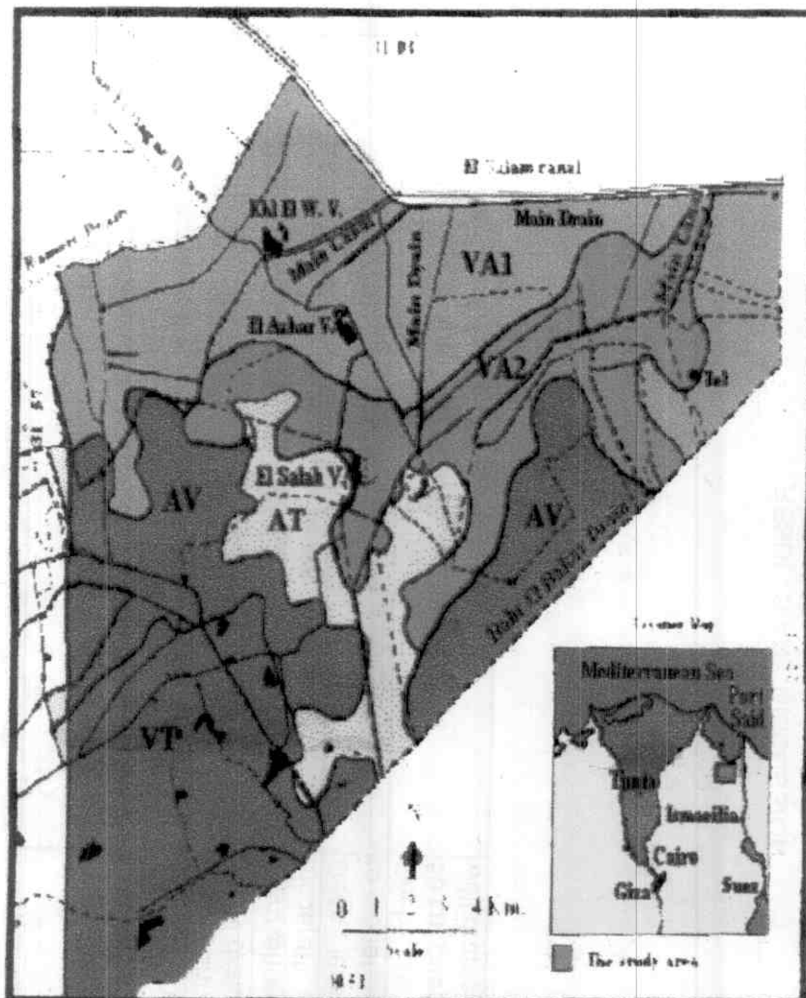
*number of changes aimed at imporoving and up-dating efforts as issues contenued to appear . Morover , the Soil Taxonomy " system itself was issued in a second edition in 1999; where it included a number of changes and revisions concerning a number of aspects. For example , the 1999 version included two orders not mentioned in the 1975 version (the Andisols and Gellisols). Another example is the widening of the difintion of vertisols. In the 1999-edition vertisols included a suborder "cryert" which was not mentioned in the original 1975 System. This suborder was first introduced in the "keys" issue of 1994 and lattr on in the Taxonomy system of 1999.

The field study base map was prepared by recording all available soil information on a recent cadestal map of scal 1 :50,000. The map was carfully checked in the field, and the bounderies between various mapping units were examined , corrected and demarcated on a map (Fig .8) .

The morphological description of the soil profiles (see appendix) and the laboratory analysis of the soil samples were used to define the dominant soil taxonomic unit in each mapping unit. Then, the legend was written and the mapping units were expressed (Table 2).

Table2 Taxa and description of soils of El-Hasainiya plain North east of Delta , Egypt

Soil mapping unit	Taxonomic unit	Description
VA1	Very fine , montmorillonitic , thermic Family of the *Halic Endoaquerts subgroup*	Deep, shrinking -swelling very fine clay soils , poorly to very poorly drained
VA2	Fine, montmorillonitic, thermic Family of the *Halic Endoaquerts subgroup*	Deep, shrinking -swelling fine clay soils poorly drained
VT	Fine, montmorillonitic, thermic family of the *Typic Haplotorrerts subgroup*	Deep ,shrinking-swelling clay soils, moderatly well drained
AV	Clayey, montmorillonitic ,thermic Family of the *Vertic Fluvaquents subgroup*	Deep , less homogeneous clay soils,poorly to moderately well drained
AT	Loamy over clayey ,mixed ,thermic Family of the *Typic Fluvaquents subgroup*	Deep , loam and /or clay loam till about 50 cm over clay soils , poorly to moderately well drained



VA1	Very fine, montmorillonitic, thermic; Halic Endoaquerts.
VA2	Fine, montmorillonitic, thermic; Halic Endoaquerts.
VT	Fine, montmorillonitic, thermic ; Typic Haplotorrerts.
AV	Clayey, montmorillonitic, thermic; Vertic Fluvaquents.
AT	Loamy over clayey, mixed, thermic; Typic Fluvaquents.

Fig (9) : Soil classification map of the studied area

- *The soil taxa were identified and named to the family level, then the soil families were differentiated to the series level.

Based on the obtained climatological normals given in Table 1 , the mean annual soil temperature could be considered as less than 22 ^{0}C and the differences between mean summer and mean winter is more than 5 ^{0}C. The soil temperature regime of most of the studied area could be difined according to Soil Taxonomy nomenclature (USDA 1975) as "thermic" and soil moisture regime as "torric" . In soils which have high water table levels, the soil moisture regime could be defined as "aquic". In the light of relevant soil properties, the examined soils display common features , but differ in one or more of their characteristics such as soil texture, sequence of soil profile layers, drainage conditions , slickensides and soil structure. According to the Soil Taxonomy system (USDA 1975), the soils would belong to the *Vertisols* and *Entisols* orders.

By defination , soils of the *Vertisol* order have 30 % or more clay (dominant 2:1 expanding clay) in all horizons above lithic or paralithic contact or to a depth of 1 meter , which ever is shallower, and have cracks at least 1 cm wide at a depth of 50 cm during part of most years.. In addition these soils usually have gilgai microrelief and

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*slickensides on wedge–shaped or parallelipiped natural structural aggregates at some depth below the surface.

4.1.1.1.1 *Vertisols:*

Vertisols identified in the current study were in two suborders : *Aquerts* and *Torrerts.*The Aquerts contain Endoaquerts and the Terrerts contain Haplotrrerts groups . The Endoacquerte include Halic Endoaquerts sub-group. The Haplotorrerts include Typic Haplotorrerts subgroup

The Aquerts occupy a considerable portion of the study area occurred as Halic Endoaquerts subgroup. According to Soil Taxonomy (USDA 1975 ,and USDA 1999). Aquerts are seasonally wet (saturated) and even if artifically drained , They display bluish grey (gleyed) or very mottled horizons throught 50 cm from the soil surface. HalicEndoaquerts do not salic or calcic horizons , duripan within 100 cm of the soil surface ; do not have , an electrical conductivity of the saturation extract below 4.0 dS/m in the saturation extract and also do not have pH of 5.0 or less (in 1:1 soil : water suspension) . They are commonly wet with moisture deficiency for a short period during the year,Halic Endoaquersts are highly saline (EC of 15 dS/m or more in their saturated paste.extract. Based on particle size analysis of the active soil depth representing the "control section", two soil families were differentiated within the Halic Endoaquerts sub-group;

*they are (1) very fine montmorillonitic , thermic Halic Endoaquerts and 2) fine montmorellonitic thermic Halic Endoaquerts (Table 2).

The *Torrets* occupy a sizable part (about one-sixth of the area) of the study area ; they include soils of the Typic Haplotorrerts subgroup.According to the Soil Taxonomy system Torrerts are vertsols which –if not irrigated during the year –have cracks in 6 or more out of 10 years that remain closed for less than 60 consecutive days. Happlotorrerts do not, salic , gypsic or calcic. Their colour value is (moist) is , of less than 4. *Typic Haplotorrerts* are not highly saline , non-sodic , with no dense pans .One soil family represents the characteristic of one soil series was identified in this subgroup, i.e. fine montmorellonitic thermic Typic Haplotorrerts (Table 2).

4.1.1.2. Entisols :

Entisols identified in the current study were in , one suborder *Aquents* According to Soil Taxonmy (USDA 1975 and USDA 1999 Aquents are soils that have acquic conditions (water saturation) permanent or seasonal.

Aquents of the current study occupy about one third of the study area ; and contain Fluvaquents great group , branching in two subgroups vertic Fluvaquents and Typic Fluvaquents. According to the Soil Taxonomy system (USDA 1994 and USDA 1999) Fluvaquents are aquents that have “either 0.2 % or more organic carbon at a depth of 125 cm below the mineral soil surface or an irrigular decrease in organic carbon from a depth of 25 cm to a depth of 125 cm , or to a lithic or paralithic contact if shallower. Vertic Fluvaquents are Fluvaquents which "have cracks within 125 cm of soil surface that are 5 mm or more wide" ; and /or a linear extensibility of 6.0cm or more between the mineral soil surface and either a depth of 100 cm or a lithic or paralithic contact whichever is shallower"

Typic Fluvaquents are Fluvaquents which do not have buried horizons , or a bulk density over 1.0 g/cm^3 , or a difference of < 5 ^0C between summer and winter soil temperature. Each of the two subgroups have one family and one series (Table 2)

4.1.2. Description of the soil mapping units (Soil Taxonomic units:-

The soil mapping units which are shown in Table 2, and Fig. 9 are identified to the family level and are described and discussed below. Morphological characteristics of soil profiles are shown in Appendix ,1 and soil analyses are shown in Table 3.

4.1.2.1- Very fine , montmorillonitic , thermic Halic Endoaquerts , (mapping unit VAI):

These soils are relatively low in elevation being below 1 m a.s.l. They are nearly level clay swamps frequently flooded by sea water. They occupy the northern and north eastern part of the studied area (Fig.9). Soils of this unit consist of a deep heavy clay -textured soils and are represented by profiles 3,5,6 and 7

The soils seemed rather homogeneous in colour and texture. The typical profile is characterized mainly by very dark grayish brown (10YR3/2) (moist) down to the 45-50 cm layer, with common to many dark gray to black mottles in the 20-50 cm layer . Soil colour was darker with depth and varied from dark grey (10 YR4/1) to very dark gray (10 YR3 /1) . The darkness of soil colour indicates bad drainage conditions of these soils and fluctuation of water table level which varied from 45 to 100 cm . The relatively deep water table observed in some locations (profiles 6 and 7) must have been a result of artificial drainage executed in this area Moisture deficiency is indicated by deep wide surface cracks. Soil texture is clayey throughtout the soil profile with a consistency (in moist soil) ranging from "firm" to "very sticky" with depth . The soil structure is weak subangular blocky in the surface layer and develops with depth to "strong medium" and "coarse" angular blocky. Slickensides were observed in the subsurface layer reaching a thickness of 25 cm or more. Salt accumulations were obsorved on the surface as brown accumulations and a few soft lime segregations were shown in the upper part of the soil profile with no evidence of secondary gypsum formation.

The analytical data of soil profiles 3,5,6 and 7 representing this unit (Table 3) reflect the main characteristics of such soils. Ranges of contents of clay , silt and sand were 47.5 to 67.68 % , 14.70 to 37.50 % and 1.00 to 24.62 % for each fraction, respectively. There was no specific pattern with depth for clay or silt contents. The highest sand contents were in the surface layers. The calcium carbonate contents ranged from 0.27 to 7.60 % with a tendency to decrease with depth, while gypsum being almost nil. The content of total soluble salts ranged from 0.43 to 1.88 %

4.1.2.2. Fine , montmorillonitic ,thermic Halic Endoaquerts, (mapping unit (VA2)

These soils represent the clay flats of the fluvio-marine marshes and occupy , the lowest laying land which must had been frequently flooded by sea water in the very past history. The soils are located along the southern boundaries of the VA1 soils (Fig,9) and are represented by soil profiles 1,2,4 and 18.

The soils of this unit are rather similar to those of the VA1 unit but lighter in texture and of relatively higher elevation. Morphologically (Appendix,1) it has the same colour .They showed gley phenomenon (mottling) with firm sticky with a blocky structure and clear slickensides in the subsurface layer. The soil texture is homogeneous clayey throughout the soil profile , and with deep cracks extending from surface when soil is dry (profile 1). Soft lime segregations were observed in the surface layer with few gypsum accumulations in the subsoil. In soil profile 4 sandy veins were observed in the surface and subsurface layers, occupying few patches , (as inclusion soils) : a possible indication of the remains of an old beach line of Manzala lake .

With exception of profile 4 ranges of the contents of clay ,silt and sand fractions are 45.25 % to 57.0 % , 5.25 to 42.05 and 14.25 to 23.75 % for each fraction, respectively. The calcium carbonate content varied from 0.48 to 7.68 % with a tendancy to decrease with depth. Gypsum content ranged from traces to 2.77 % ,and total soluble salts ranged from 0.10 to 1.61 %.

4.1.2.3. Fine, montmorillonitic , thermic

Typic Haplotorrerts (mapping unit VT)

These soils represent the old reclaimed lands of the fluvio-marine soils in the area. They have a relatively higher elevation ; generally about 2m. a.s.l., and occupy most of the south–western part of the studied area (Fig.9) . The soils of this unit are craked deep clayey and are represented by soil profile 11.

*The soil colour (moist) is very dark grayish brown (10YR3/2) in the surface and subsurface layers with no evidence of mottles. The subsoil (below 50 cm. depth) seemed dark dominated by very dark gray (10 YR 3/1) with common gley, indicating relatively good drainage conditions. Texture is clayey and less homogeneous than VA2 soils especially in the subsoil. The consistency is firm and sticky by depth, with blocky structure and clear slickensides in the subsurface layer. Few soft and hard lime accumulations occured in the surface and subsurface layers.

The analytical data of soil profile 11 which represents this unit is given in Table (3) . The particle size distribution indicates the less homogenity of the clayey soil texture by depth . Clay, silt and sand fractions varied widely, being 44.83 to 60.20 %, 17.60 to 42.95 % and 12.22 to 28.70 %, for each fraction, respectively . The highest clay content was observed in the 25-50 cm. layer, and the highest silt contents was in the 50-95 cm layer. The sand fraction content shows a gradual dcreaase with depth. Calcium carbonate ranged from , 0.64 to 1.60 % ; gypsum ranged from 0.73 to 2.00 % with tendency of decrease with depth. The total soluble salts ranged from 0.15 to 0.21 %.

4.1.2.4- Clayey ,montmorillonitic ,thermic Vertic Fluvaquents mapping unit (AV)

These soils represent the relatively higher parts of the fluvio-marine clay flats, which are subject annual flooding by *sea water for a short period, and occupy most of the southern and western parts of the studied area (Fig 9). The soils are predominantly deep clayey , and represented by the characteristics of soil profiles 10,13,14,15 and 16.

Soil colour (moist) is almost the same as the VA1 soils and ranges from very dark grayish brown in the surface layer to very dark gray in the subsurface layers. Dark coloured mottles are common in the subsurface due to bad drainage conditions . The soil texture is mainly clay throughout the profile with firm and sticky consistency. Some , clay loam layers were observed in the surface and the subsurface.The soil structure is mainly weak to moderate blocky (subangular and angular) with mainly weak slickensides phenomena. Some lime accumulations were observed in the upper layers and few gypsum viens were found in some subsurface layers.

Analytical data of profiles 10,13,14, 15 , and 16 representing soils of this unit (Table 3) show that clay ranged from 35.63 to 57.18 %.. with considerable variations particulary in the surface layer and also in the deepest one.Ranges of silt and sand where 8.88 to 54.05 % for silt and 7.72 to 39.82 % for sand, with no specific pattern with depth. Calcium carbonate ranged from 0.64 to 10.00 % , Gypsum contents were generally low and ranged from nil to 1.61 %; but mostly under 1 % .The total soluble salts ranged widely from 0.16 to 2.25 % w/w.

4.1.2.5.: Loamy over clayey , mixed ,thermic Typic Fluvaquents, mapping unit (AT)

These soils are fluvio-marine clay flats covered by wind blown fluffy clay dunes. The relief was irregular with an elevation of 1 to 3 m. asl. in the central part of the study area , (Fig 9). The soils were deep loamy over clayey,and are represented by soil profiles 8,9,12 and 17.

Soil colour indicated darkness (moist) with a gley varied appearance , in the subsurface layers. The surface layers varied from sandy clay loam to clay. Some profiles showed clayey texture in the deep subsoil. Soil consistency was fraible to firm, sticky to very sticky and soil structure was generally weak blocky (subangular and angular) with no evidence of slickensides . Few lime and gypsum accumulations were observed in some subsurface layers.

The analytical data of the soil profiles representing soils of this unit (Table 3) show that clay, silt and sand contents varied widely from 22.55 to 61.68 % clay , 3.25 to 46.38 % silt and 20.47 to 45.47 % sand, with no specific pattern with depth for silt and sand fractions. Regarding clay , the upper subsurface layers showed the lowest contents and the deepest layers showed the highest contents. Calcium carbonate contents varied from 0.40 to 2.50 % .Gypsum varied from nil to 0.65 % except in the subsurface of profile 9 where it was 1.3 %. The content of total soluble salts ranged from 0.25 to 0.91 %.

Table 3 Particle size distribution, texture clas, $CaCO_3$ %,soluble salts %, and gypsum % for soils of Hasainiya plain North -east of Delta, Egypt.

Soil mappin unit	prof. No.	Depth cm	Particle size distribution			Texture class	CaCO3 %	Gyp. %	TSS %
			Sand %	Silt %	Clay %				
VA1	3	0-20	13.00	29.50	57.50	Clay	7.60	0.00	0.76
		20-45	5.50	29.25	65.25	Clay	4.00	0.01	0.43
		45-65	7.00	30.25	62.75	Clay	1.20	0.00	0.55
	5	0-20	11.75	22.75	65.25	Clay	2.00	0.00	1.35
		20-40	9.00	25.50	65.50	Clay	0.80	0.00	1.88
	6	0-20	16.50	21.00	62.50	Clay	0.27	0.00	0.61
		20-45	5.00	37.25	57.25	Clay	5.60	0.00	0.90
		45-90	1.00	35.50	63.50	Clay	0.40	0.00	1.23
	7	0-20	17.50	35.00	47.50	Clay	1.44	0.00	1.7.6
		20-50	7.50	37.50	55.00	Clay	1.80	0.00	1.44
		50-80	7.32	25.00	67.68	Clay	0.64	0.00	1.61
		80-10	24.62	14.70	60.68	Clay	0.64	0.00	1.12
VA2	1	0-15	23.50	20.50	56.00	Clay	1.76	2.77	0.96
		15-45	23.75	21.25	55.00	Clay	0.72	0.00	1.36
		45-60	22.50	21.50	56.00	Clay	0.48	0.20	1.27
	2	0-20	14.25	28.75	57.00	Clay	7.68	0.34	0.95
		20-60	20.75	26.75	52.50	Clay	4.80	1.39	1.43
		60-75	20.25	34.50	45.25	Silty clay	2.40	1.33	1.61
	4	0-25	64.50	5.25	30.25	Sandy C.L.	2.40	0.00	0.42
		25-65	80.75	9.50	9.75	loamy sand	1.20	0.14	0.10
		65-85	48.75	7.00	44.25	sandy clay	0.64	0.07	0.44
	18	0-25	22.20	25.62	52.18	Clay	1.60	2.00	0.67
		25-65	18.85	25.25	55.90	Clay	1.04	0.83	0.86
		65-10	21.02	22.13	56.85	Clay	0.64	0.73	1.36
VT	11	0-25	28.70	21.00	50.30	Clay	1.60	2.00	0.15
		25-50	22.20	17.60	60.20	Clay	1.04	0.83	0.15
		50-95	12.22	42.95	44.83	Silty clay	0.64	0.73	0.21

Sandy C.L. : Sandy clay loam prof.=profile

TSS :total salts % Gyp.=gypsum

Table 3 Con.

Soil mappin unit	prof. No.	Depth cm	Particle size distribution Sand %	Silt %	Clay %	Texture class	CaCO3 %	Gyp. %	TSS %
AV	10	0-25	25.69	25.78	48.53	Clay	2.16	0.15	0.77
		25-55	39.82	12.63	47.55	Clay	1.20	0.45	0.69
		55-10	26.19	38.18	35.63	Clay loam	1.44	1.04	1.01
	13	0-30	32.42	28.10	39.48	Clay loam	2.00	0.03	0.21
		30-60	18.07	24.75	57.18	Clay	2.56	0.07	0.22
		60-80	20.14	41.83	38.03	Clay loam	1.60	0.02	0.16
	14	0-25	7.72	54.05	38.23	Silty C. L	1.44	0.48	0.68
		25-60	20.00	36.53	43.47	Clay	1.04	1.61	0.42
		60-11	23.57	33.88	42.55	Clay	2.00	1.15	0.92
	15	0-25	39.63	14.54	45.83	Clay	10.00	0.88	0.55
		25-55	38.82	15.15	46.83	Clay	3.20	0.00	0.36
		55-95	33.25	17.67	49.08	Clay	2.00	0.00	0.48
	16	0-25	37.22	8.88	53.40	Clay	3.44	0.00	1.06
		25-60	29.57	27.03	43.03	Clay	2.00	0.29	1.92
		60-10	20.95	23.92	55.13	Clay	0.64	0.62	2.25
AT	8	0-20	22.39	46.38	31.21	Clay loam	2.40	0.65	0.62
		20-40	32.92	36.48	30.60	Clay loam	0.80	0.60	0.68
		40-90	40.50	3.25	56.25	Clay	2.00	0.00	0.91
	9	0-20	45.47	20.05	34.48	Sandy C.L.	0.40	0.00	0.64
		20-50	40.15	37.30	22.55	Loam	0.40	1.29	0.37
		50-10	42.92	9.03	48.05	Clay	2.24	1.35	0.59
	12	0-30	38.59	20.58	40.83	Clay	2.50	0.00	0.66
		30-55	34.70	32.85	32.45	Clay loam	1.76	0.00	0.29
	17	0-20	20.47	23.85	55.68	Clay	0.64	0.05	0.30
		20-60	28.60	36.70	34.70	Clay loam	1.20	0.07	0.34
		60-10	21.00	17.32	61.68	Clay	0.64	0.00	0.25

Silty . C.L. : Silty clay loam

Sandy C.L. : Sandy clay loam

TSS :total salts %

prof.=profile

Gyp.=gypsum

*4-1-3 Soil salinity

In the arid and semi-arid regions, when evaporation exceeds precipitation , problems of soil salinity and alkalinity are widespread. In areas laying near the sea or lakes, the sea water influences directly or indirectly the soils and ground water. The ground water depth and its salinity form the major factors which affect soil salinity and sodicity.

The saturation extract analytical data of the samples representing the soils of the area are shown in Table 4 .Soil salinity , is expressed in terms of electrical conductivity (EC) of the saturation extract .Results show values varying from 3.19 to as high as 46.30 dS/m , indicating wide variation ranging from no salinty to extremely high salinity . These reflect variations in soil conditions and management practices. Soils of profiles 3 and 11 represent lands which had been reclaimed for about fifty years or more. They are non-saline to slightly saline soils. Most of their EC values range from 3.19 to 7.22 dS/m.

Soils of profiles 12,13 and 14 represent lands of have been reclaimed which have been under agriculture for the past 12 to less than 15 year. They are mainly slightly saline to moderatly saline and most of their EC values range from 4.47 to 15. dS/m.Soils of profiles 1,5,15,16 and 17 represent lands which are recently reclaimed as well as lands which are still under reclamation with EC ranging from 4.85 to 46.30 dS/m. They are saline to extremely saline and most of them are over 16 dS/m .

*Abd El-Hady ,(1998)** recorded values of 30.90 to 145.6 dS/m in virgin soils of this area. Sea water intrusion, may have contributed to the high salinity of these soils. Fluctuation of water table, and salt accumulation by prevailling arid conditions, are most certainly some of the factors causing high salinity.

The distribution of soluble ions is shown in Table 4 . The cationic composition is dominated by Na^{+} , followed by Mg^{++} in all profiles of VA1 and VA2 soils. In the VT soils, sodium is the predominant cation followed by Mg then Ca and K, (except layer 25-50 cm of profile 11 where appears Ca preceded Mg). Soluble cations in the AV soils were : Na >Ca > Mg >K except profile 10 and layer 20-60 of profile 16 where the pattern was Na > Mg > Ca >K. Distruibution of soluble cation in the AT soils was as follows : Na> Mg >Ca > K in some layers of profiles 9, 12 and 17 where Ca preceded Mg..

The distribution of soluble anions is shown in Table 4 . The anionic composition of VA1 , VT and AV soils and most of AV2 and AT soil showed Cl $>SO_4>HCO_3$. In some layers of AV2 and AT soils, SO_4 preceded Cl . There was no CO_3 ions in all soils

4.1.4. Soil fertility:

Fertility of soil may be assessed by "potential fertility" and "actual fertility"; the former relates to the soil weathering , base saturation , exchangeable ions , organic matter, and the

Table 4 Chemical composition of the soil saturation extract in the studied soils

Soil mapp. unit	prof. No.	Depth cm	SP	EC dS/m	Cations (m mol c/L)				Anions (m mol /L)				SAR
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3	Cl^{-}	$SO_4^{=}$	$CO_3^{=}$	
VA1	3	0-20	77.5	15.40	25.00	30.08	125.50	15.00	4.80	100.00	90.78	0.00	16.09
		20-45	122.5	5.47	5.00	8.62	42.00	3.20	3.20	36.00	19.62	0.00	17.85
		45-65	117.5	7.22	8.00	10.31	54.00	3.80	3.00	65.00	8.11	0.00	18.07
	5	0-20	120.0	17.52	25.00	42.69	160.00	15.00	3.20	140.00	99.49	0.00	27.50
		20-40	100.0	29.40	25.00	35.08	225.50	16.00	2.80	250.00	48.78	0.00	41.14
	6	0-20	85.0	11.20	24.00	25.27	86.00	14.00	4.00	90.00	55.27	0.00	17.33
		20-45	100.0	14.10	28.00	30.08	122.50	15.00	4.80	100.00	90.78	0.00	22.73
		45-90	95.0	20.20	25.00	30.88	190.00	16.50	3.20	135.00	124.18	0.00	38.34
	7	0-20	112.5	24.40	30.00	81.33	220.50	16.00	4.80	240.00	103.03	0.00	25.78
		20-50	100.0	22.50	29.00	65.23	200.00	25.00	3.20	260.00	56.03	0.00	36.75
		50-80	100.0	35.10	25.00	30.23	196.50	18.00	4.00	225.00	40.73	0.00	35.81
		80-100	62.5	28.50	35.00	91.42	240.00	15.00	3.20	235.00	143.22	0.00	28.60
VA2	1	0-15	66.0	22.70	45.00	75.19	195.00	21.00	2.80	190.00	143.39	0.00	25.16
		15-45	110.0	19.30	25.00	30.08	210.50	18.00	2.40	99.00	182.18	0.00	40.11
		45-60	93.0	21.30	25.00	42.31	217.50	18.00	2.00	110.00	190.81	0.00	37.49
	2	0-20	85.0	17.52	30.00	37.63	160.00	15.00	3.20	140.00	99.43	0.00	27.50
		20-60	110.0	20.30	35.00	72.77	190.50	8.00	2.47	150.00	153.80	0.00	25.95
		60-75	100.0	25.20	40.00	65.96	227.30	14.00	2.20	210.00	135.06	0.00	31.23
	4	0-25	46.0	14.10	40.00	48.92	120.50	12.00	3.80	90.00	127.62	0.00	18.07
		25-65	33.3	4.80	4.00	5.69	38.00	2.40	3.00	40.00	7.09	0.00	17.26
		65-85	107.5	6.42	4.09	9.60	50.00	1.60	3.60	52.00	9.69	0.00	19.11
	18	0-25	60.0	17.50	41.00	45.54	210.50	21.00	3.60	190.00	124.44	0.00	32.00
		25-65	63.0	21.20	50.00	64.99	227.50	19.00	2.80	190.00	168.69	0.00	30.00
		65-100	73.0	29.20	23.00	25.08	237.50	15.00	2.80	240.00	57.78	0.00	48.44
VT	11	0-25	60.0	3.77	8.00	9.31	22.00	1.20	6.40	22.00	12.11	0.00	7.48
		25-50	72.5	3.19	6.00	3.62	25.00	1.20	3.20	28.00	4.62	0.00	11.40
		50-95	77.0	4.17	6.00	7.46	30.00	2.00	2.80	32.00	10.66	0.00	11.56

Table 4 Cont.

Soil mapp. unit	prof. No.	Depth cm	SP	EC dS/m	Cations (m mol c/L)				Anions (m mol /L)				SAR
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3	Cl^{-}	$SO_4^{=}$	$CO_3^{=}$	
AV	10	0-25	20.0	19.36	41.00	45.54	192.50	16.00	3.20	160.00	131.84	0.00	29.26
		25-55	60.0	17.85	40.00	48.54	215.50	14.00	3.60	190.00	124.44	0.00	32.39
		55-100	72.0	21.90	50.00	74.99	217.50	19.00	2.80	190.00	168.69	0.00	27.51
	13	0-30	67.5	4.86	12.00	7.23	30.00	1.20	4.40	32.00	14.03	0.00	9.67
		30-60	75.0	4.47	10.00	5.38	36.00	1.20	4.80	36.00	11.78	0.00	12.98
		60-80	70.0	3.65	10.00	9.23	25.40	1.20	2.40	30.00	13.43	0.00	8.19
	14	0-25	67.5	15.72	52.00	26.92	132.50	8.00	2.80	140.00	76.62	0.00	21.09
		25-60	62.5	10.60	23.00	8.31	80.00	6.00	4.00	96.00	17.31	0.00	20.22
		60-110	56.0	25.70	80.00	55.80	226.50	18.00	3.60	250.00	136.70	0.00	28.70
	15	0-25	81.0	10.60	12.00	9.31	90.00	8.00	4.00	96.00	19.31	0.00	27.57
		25-55	70.0	8.00	14.00	12.92	63.00	2.00	3.60	58.00	30.32	0.00	17.17
		55-95	89.0	8.46	20.00	12.69	58.00	2.40	4.00	60.00	29.09	0.00	14.35
	16	0-25	89.0	18.57	65.00	45.57	192.50	17.00	3.20	160.00	156.87	0.00	25.89
		25-60	82.5	36.40	75.00	93.26	385.00	22.00	3.60	350.00	221.66	0.00	41.97
		60-100	76.0	46.30	65.00	53.15	395.00	37.50	3.20	360.00	187.45	0.00	50.96
AT	8	0-20	55.0	17.54	35.00	40.70	150.00	16.00	3.22	138.00	101.37	0.00	24.39
		20-40	55.0	19.20	38.01	65.11	165.01	16.03	3.63	89.87	190.66	0.00	22.98
		40-90	70.0	20.40	33.20	72.71	193.01	7.98	3.53	149.58	153.79	0.00	26.51
	9	0-20	62.5	15.90	4.00	42.49	150.00	10.00	2.00	130.00	74.49	0.00	23.36
		20-50	67.5	8.56	25.00	27.99	40.00	20.00	2.80	48.00	62.69	0.00	7.77
		50-100	65.0	14.11	40.00	38.92	130.50	12.00	2.00	110.00	108.62	0.00	20.78
	12	0-30	65.0	15.90	45.00	17.49	140.00	10.00	2.00	110.00	100.49	0.00	25.05
		30-55	62.5	7.25	12.00	1.08	53.00	3.20	3.60	48.00	17.68	0.00	15.60
	17	0-20	80.0	5.84	4.00	5.62	52.00	3.20	3.20	36.00	25.62	0.00	23.71
		20-60	76.0	6.94	4.00	5.50	58.10	3.22	3.60	40.00	27.22	0.00	26.66
		60-100	81.0	4.85	4.00	3.69	40.10	2.40	3.20	40.00	6.99	0.00	20.39

mapp.=mapping

*latter relates to pH , CEC , and available P **(FAO,1976 and Sys,1980).**

4.1.4.1. Soil reaction (pH)

Data in Table 5 show that soil reaction in the soils is slightly alkaline to strongly alkaline. The pH values in the soil saturation paste ranged from 7.38 to 8.53. Most of the slightly alkaline soils are those of the VA, At and AV units, and most of the strongly alkaline values are in soils of the VA units.

4.1.4.2.Organic matter content:

The data of organic matter content of the investigated soils are shown in Table 5. Soil organic matter ranged between 0.51 and 2.80 %. The surface layers are characterized by high values which tend to decrease with depth. Most of the investigated soils had been used as fish ponds for long periods before they were dried out and used for agriculture **Sadek (1978)** reported relatively high content of organic matter in saline soils and attributed this to its low decompositition due to soil salinity.

4.1.4.3. Cation exchange capacity and exchangeable cations:

The ion exchange properties of soil are , generally , related to soil colloids, **(Wiklander 1964)** . The results of cation exchange capacity (CEC) and the exchangeable cations of the studied soils are given in Table 5. The lowest two values of CEC were 9. 4 and 25.10 cmolc/kg were in profile 4 in layers 25-65 cm and 0-25 cm, respectively . Values for the other soils of the study ranged from 23.50 to 54.80 cmolc/kg . The high values

Table 5 Soil pH, organic matter ,cation exchange capacity and exchangeable cations in soils of El-Hasainiya plain , North Delta , Egypt.

Soil mapp. unit	prof. No.	Depth cm	*p H soil Paste	OM %	CEC and exchangeable cations (E.Cat.)								
					CEC	(E.Cat.) in cmolc/kg soil				E.Cat. Distribution			
						Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
VA1	3	0-20	8.37	2.30	48.70	10.51	27.19	8.90	2.10	21.60	55.80	18.30	4.30
		20-45	8.17	1.40	54.70	14.10	27.90	10.30	2.40	25.80	51.00	18.80	4.40
		45-65	8.32	0.90	53.80	12.60	26.47	12.03	2.80	23.40	49.20	22.40	5.20
	5	0-20	8.31	2.60	51.50	10.90	23.76	14.04	2.80	21.20	46.10	27.30	5.40
		20-40	8.53	1.40	50.90	10.20	19.50	18.90	2.30	20.00	38.30	37.10	4.50
	6	0-20	7.60	2.20	49.00	11.90	24.65	9.85	2.60	24.30	50.30	20.10	5.30
		20-45	7.70	1.30	48.00	12.20	20.89	12.41	2.50	25.40	43.50	25.90	5.20
		45-90	7.71	0.95	51.30	13.30	20.57	15.83	1.60	25.90	40.10	30.90	3.10
	7	0-20	8.06	2.01	46.25	10.08	21.10	11.93	3.14	20.20	45.60	25.80	6.80
		20-50	8.09	1.32	49.90	7.40	23.21	16.79	2.50	14.80	46.50	33.60	5.00
		50-80	7.86	0.89	53.50	8.50	24.62	17.68	2.70	15.90	46.00	33.00	5.00
		80-100	8.12	0.51	50.90	9.14	25.60	13.76	2.40	18.00	50.30	27.00	4.70
VA2	1	0-15	8.06	2.20	53.60	12.90	24.55	13.15	3.00	24.07	45.80	24.53	5.60
		15-45	7.59	1.50	50.30	10.15	20.50	16.65	3.20	20.18	40.76	33.10	6.36
		45-60	7.43	0.90	54.50	8.90	25.30	17.90	2.40	16.33	46.42	32.84	4.40
	2	0-20	7.87	2.40	54.80	11.50	26.00	14.80	2.50	20.99	47.45	27.01	4.56
		20-60	7.99	1.60	52.00	12.10	23.80	14.10	2.00	23.30	45.80	27.10	3.80
		60-75	8.27	0.85	44.70	10.40	18.11	14.09	2.10	23.30	40.50	31.50	4.70
	4	0-25	8.26	2.30	25.10	7.40	10.20	5.10	2.40	29.50	40.60	20.30	9.60
		25-65	8.37	1.50	9.40	1.10	5.00	2.10	1.20	11.70	53.20	22.30	12.80
		65-85	8.40	0.85	42.30	10.23	21.50	7.97	2.60	24.20	51.80	18.80	6.10
	18	0-25	8.03	2.20	48.20	14.30	20.06	11.24	2.60	29.70	41.60	23.30	5.40
		25-65	7.96	1.40	47.00	13.90	20.20	10.30	2.70	29.60	43.00	21.90	5.70
		65-100	7.92	0.60	46.30	10.10	18.20	15.50	2.50	21.80	39.30	33.50	5.40
VT	11	0-25	7.92	2.20	49.30	25.50	18.00	3.90	1.90	51.70	36.50	7.90	3.90
		25-50	7.85	1.80	51.20	25.62	17.00	6.38	2.20	50.00	33.20	12.50	4.30
		50-95	7.93	0.90	42.90	25.00	10.38	5.42	2.10	58.30	24.20	12.60	4.90

*in the paste mapp=mapping OM=organic matter

Table 5 cont.

Soil mapp. unit	prof. No.	Depth cm	*p H soil Paste	OM %	CEC and exchangeable cations (E.Cat.)								
					CEC	(E.Cat.) in cmolc/kg soil				E.Cat. Distribution			
						Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Ca^{++}	Mg^{++}	Na^{+}	K^{+}
AV	10	0-25	7.52	2.20	50.30	20.5	14.35	12.85	2.6	40.80	28.50	25.50	5.20
		25-55	7.47	1.20	50.90	17.06	17.20	15.14	2.50	33.60	33.70	29.70	4.90
		55-100	7.47	0.65	42.50	13.00	15.66	11.14	2.70	30.60	36.80	26.20	6.40
	13	0-30	7.64	2.20	45.10	20.70	17.00	5.10	3.20	45.90	37.70	11.30	5.10
		30-60	7.44	1.60	52.30	25.40	19.00	7.50	2.40	48.60	36.30	14.30	4.60
		60-80	7.59	0.90	44.10	16.30	15.20	10.10	2.50	37.00	34.50	22.90	5.70
	14	0-25	7.70	2.10	47.60	22.30	13.10	9.90	2.30	46.80	27.50	20.80	4.80
		25-60	7.59	1.40	49.40	23.10	13.80	9.10	2.70	46.80	27.90	18.40	5.50
		60-110	7.65	0.85	47.30	22.50	12.30	10.10	2.40	47.60	26.00	21.40	5.10
	15	0-25	7.72	2.10	38.20	10.50	17.10	8.50	2.10	27.50	44.80	22.30	5.50
		25-55	8.21	1.20	43.10	12.10	19.40	8.90	2.60	28.10	45.00	20.60	6.00
		55-95	8.28	0.60	36.90	11.40	15.20	8.20	2.10	30.90	41.20	22.20	5.70
	16	0-25	8.09	2.80	42.80	10.40	19.20	11.70	1.50	24.30	44.90	27.30	3.50
		25-60	8.07	2.00	43.90	8.30	17.90	15.10	2.60	18.90	40.80	34.40	5.90
		60-100	7.99	0.85	40.30	6.60	14.20	16.80	2.70	16.40	35.20	41.70	6.70
AT	8	0-20	7.43	2.20	35.40	9.50	16.15	7.15	2.60	26.84	45.62	20.20	7.35
		20-40	7.46	1.20	38.40	8.59	20.43	6.98	2.40	22.40	53.20	18.18	6.25
		40-90	7.38	0.95	49.00	9.63	25.16	11.66	2.50	19.65	51.35	23.80	5.10
	9	0-20	7.44	2.10	34.40	11.39	11.20	9.71	2.00	33.20	32.70	28.30	5.80
		20-50	7.52	1.80	32.50	13.45	13.52	3.33	2.20	41.40	41.60	10.20	6.40
		50-100	7.49	0.70	40.90	14.00	16.03	8.27	2.60	39.20	34.20	20.20	5.90
AT	12	0-30	7.53	2.10	45.40	20.10	11.50	11.12	2.70	44.20	25.30	24.50	5.90
		30-55	7.88	1.66	41.70	19.07	13.00	7.03	2.60	45.70	31.20	16.90	6.20
	17	0-20	8.40	1.95	42.00	10.23	19.40	10.17	2.20	24.40	46.20	24.20	5.20
		20-60	8.29	1.30	42.90	11.00	17.90	11.30	2.70	25.60	41.70	26.30	6.30
		60-100	8.36	0.80	41.50	11.02	19.00	9.18	2.30	26.60	45.80	22.10	5.50

*in the paste mapp=mapping OM=organic matter characterize soils of the VT unit. The low ones characterize soils of the AV and AT unit. In general , CEC is related to clay content and organic matter content, These results are in close agreement with those of El-Toukhy (1995),who reported that the values of CEC were high in somefluvio-marine soils than in recent Nile alluvial soils giving averages of 48.80 , and 35.08 cmolc/kg for each of the two groups of soil respectively. In most soils, exchangeable Mg was the highest followed by Ca then Na and exchangeable K was the Exchangeable Mg^{++} ranged from 10.20 to 27.90 Ca^{++} ranged from 10.10 to 25.62 , Na^{+} ranged from 2.10 to 18.90 , and K ranged from 1.20 to 3.20 cmolc/kg. The order $Ca^{++} > Mg^{++} > Na^{+}$ characterized soils of the AV and AT units. Dominance of exchangeable Mg^{++} in most of the studied soils was in line with domenance of Mg for soluble cations where there was more Mg^{++} than Ca^{++} in the saturation extracts (Table 4) . The dominance of exchangeable magnesium is a main feature of most of the soils surrounding the coasts of seas and lakes (**FAO 1963 and El-Naggar 1986).**

4.1.4.4 Available nutrients .

Macronutrients :

The data of available nitrogen $(NH_4+NO_3)N$ "i.e.mineral N" , available phosphorus (P) and available potassium (K) of the studied soils are given in Table 6 .

Table 6 Available macronutrients of El-Hasainiya plain soils.

Soil mapping unit	prof. No.	Depth cm	Available macro nutrients mg/kg soil		
			N (NO3+NH4) N	P	K
VA1	3	0-20	98	3	426
		20-45	70	10	327
		45-65	14	4	486
	5	0-20	15	4	638
		20-40	15	5	671
	6	0-20	65	3	365
		20-45	56	6	502
		45-90	23	5	525
	7	0-20	70	4	592
		20-50	54	5	555
		50-80	54	5	571
		80-100	49	4	540
VA2	1	0-15	74	2	577
		15-45	66	5	633
		45-60	44	5	606
	2	0-20	61	4	601
		20-60	61	5	608
		60-75	54	4	647
	4	0-25	86	6	297
		25-65	61	5	163
		65-85	58	6	508
	18	0-25	78	3	266
		25-65	67	1	282
		65-100	52	3	327
VT	11	0-25	65	1	221
		25-50	33	2	160
		50-95	26	1	163

Table 6 Cont.

Soil mapping unit	profile No.	Depth cm	Available macro nutrients mg/kg soil		
			N (NO3+NH4) N	P	K
AV	10	0-25	61	3	183
		25-55	49	4	221
		55-100	44	2	282
	13	0-30	61	3	190
		30-60	54	3	178
		60-80	37	2	198
	14	0-25	53	3	266
		25-60	49	2	251
		60-110	47	2	208
	15	0-25	65	5	441
		25-55	56	3	539
		55-95	40	3	592
	16	0-25	71	6	684
		25-60	52	11	718
		60-100	37	2	733
AT	8	0-20	54	2	206
		20-40	49	2	236
		40-90	42	1	137
	9	0-20	74	1	223
		20-50	49	1	213
		50-100	33	3	163
	12	0-30	115	4	404
		30-55	49	2	304
	17	0-20	80	1	198
		20-60	81	1	182
		60-100	67	2	213

*The results indicate that available N ranged from 14 to 115. The lowest contents are found in 3 (the deepest layer)and profile 5

Concerning available P, the data reveal that it ranged from 1 to 11 mg/kg soil. The great majority of soil layers showed less the 6 mg P/kg. In layer 25-45 cm of profile 3 and layer 25-60 cm of profile 16 contents were 10 and 11 mg P/kg respectively. In a few number of cases, the subsurface layer containted greater P contents than the surface one. El-**Toukhy (1995)** reported that available P ranged from 5 to 28 mg/kg in the soils of the fluviomarine deposits .

The values of available K (ammonium acetate – extractable) in the studied soils ranged from 137 –733 mg/kg soil. The highest value was in profile 16 and the lowest one was in profile 8. In twelve profiles out of eighteen profiles of the study , available K tended to accumulate in the subsoil . This reflects the arid nature of the soils

Micronutrients:

The amounts of available "DTPA-extractable" iron (Fe) ,manganese (Mn), copper (Cu) , and zinc (Zn) of the studied soils are given in Table 7 .

Table 7 DTPA -extractable micronutrients of El-Hasainiya plain soils.

Soil mapping unit	profile No.	Depth cm	Available micro elements (mg/kg.soil)			
			Fe	Mn	Zn	Cu
VA1	3	0-20	9.40	10.82	2.21	5.83
		20-45	9.80	8.80	2.25	5.13
		45-65	8.70	7.90	2.50	4.64
	5	0-20	10.70	8.01	3.38	5.88
		20-40	10.20	7.81	2.36	4.89
	6	0-20	15.40	9.96	1.90	5.29
		20-45	8.30	8.01	1.40	5.36
		45-90	8.20	9.84	2.60	5.07
	7	0-20	10.20	7.32	2.17	5.64
		20-50	9.30	6.02	2.32	5.34
		50-80	6.40	6.71	2.42	4.41
		80-100	6.10	7.82	2.45	2.30
VA2	1	0-15	12.20	10.93	3.30	5.07
		15-45	9.40	5.31	2.80	4.42
		45-60	9.00	3.75	2.30	3.79
	2	0-20	10.30	8.07	4.28	5.87
		20-60	10.20	7.55	1.46	4.82
		60-75	6.80	7.26	2.52	4.41
	4	0-25	7.40	9.25	2.82	3.45
		25-65	4.50	4.05	1.74	2.39
		65-85	7.10	12.00	2.24	2.52
	18	0-25	12.60	7.42	3.50	5.32
		25-65	9.40	3.05	3.10	4.54
		65-100	5.50	3.37	2.70	3.66
VT	11	0-25	8.40	4.86	3.80	4.20
		25-50	12.20	4.02	1.90	4.76
		50-95	6.90	4.22	1.90	4.61

Table 7 Cont.

Soil mapping unit	profile No.	Depth cm	Available micro elements (mg/kg.soil)			
			Fe	Mn	Zn	Cu
AV	10	0-25	10.12	9.95	3.54	2.61
		25-55	8.30	4.69	3.15	5.23
		55-100	7.50	3.52	2.00	3.32
	13	0-30	5.50	6.18	2.00	4.69
		30-60	9.40	5.20	1.32	5.15
		60-80	6.20	4.47	2.20	4.80
	14	0-25	7.30	4.98	2.50	4.76
		25-60	9.56	5.82	2.00	6.78
		60-110	8.90	2.17	1.36	5.03
	15	0-25	11.50	6.53	2.82	4.49
		25-55	9.00	1.62	2.54	4.30
		55-95	9.20	5.56	2.50	3.47
	16	0-25	10.20	11.12	1.20	3.08
		25-60	9.10	6.66	0.80	4.80
		60-100	9.20	3.75	2.22	4.96
AT	8	0-20	10.20	10.37	3.82	3.14
		20-40	9.80	10.85	2.53	6.16
		40-90	9.80	3.16	2.28	4.49
	9	0-20	8.50	8.10	4.10	2.68
		20-50	7.40	2.20	3.20	4.38
		50-100	6.90	3.67	2.80	4.86
	12	0-30	15.10	9.77	2.80	6.10
		30-55	8.50	5.13	2.10	4.57
	17	0-20	17.60	6.99	2.50	4.90
		20-60	11.20	3.47	2.00	4.72
		60-100	8.00	6.51	1.30	3.64

*Available Fe ranged from 5.5 to 17.6 mg/kg. The highest value was in the surface layer of profile 17 while the lowest one was in the deepest layers of profile 18 and the surface layer of profile 13. Generally , the surface layer in all soil profiles contained higher values (7.4-17.6 mg/Kg.) than the subsurface or the deepest layers (5.5-10.2 mg/Kg soil). El-Toukhy, (1995) and Naeem (1996) reported available Fe ranges of 1.4 to 36.2 mg/kg in some soils south of El-Manazala lake, north –east Delta , Egypt..

Available Mn in the studied soils varied from 1.6 to 12.0 mg /Kg. Most of the surface layers contained relatively higher values and tended to be decrease with depth.Also, **El –Shazly et al .,1991** found that DTPA extractabler of 2-5 mg Mn/kg in some soils adjacent to El-Manzala lake.

Available Zn varied from 0.8 to 4.3 mg Zn /kg soil. The lowest value was in the 25-60 cm layer of profile and the highest in the surface layer of profile 2. Most of the values were between 2 and 3 mg /kg soil with a minor variation between and within the studied soil profiles.

Available Cu , varied from 2.3 to 6.8 mg/kg soil . The lowest was in the deepest layer of profile 7 and the highest was in the subsurface 25-60 cm layer of profile 14. Most of the values were around 4 mg/Kg soil. (El-Toukhy 1995 , Naeem 1996 and Ibrahim 1998) reported values of available Cu between 2.0-16.5 mg/kg in some soils south El-Manzala lake.

*According to Soltanpour and Schwab (1977) , the index values of DTPA- extractable elements are as follows :

Class	Fe	Mn	Zn	Cu
	-mg/kg			
Adequate	> 4.0	> 1.8	>1.5	> 0.5
Marginal	2.1-4.0	Not mentioned	1-1.5	Not mentioned
Low	< 2.0	1.8 or less	0.9 or less	0.5 or less

According to such ratings contents of available micronutrentes Fe, Mn , Zn and Cu in the studied soils would be considered adequate for crops.

4.1.5. Soil physical properties :

4.1.5.1. Bulk density

Bulk density depends on number of factors including soil texture packing , organic matter content, soluble salts , exchangeable cations , and soil depth, (Baver 1963).

Values of bulk density ranged from 1.20 to 1.58 g /cm^3 (Table 8), . reflecting variabilty in texture and structure and other properties. Bulk density tended to increase from the surface layers to the subsurface ones, a pattern associated a decrease in organic matter content with depth effect, (Higgy 1983).

4.1.5.2 Total Porosity and pore size distribution

Total porosity is an index of the relative volume of pores in the soil. Data presented in Table 8 reveal that the values of total soil porosity for the soils under study ranged between 39.2 and 74.1 %. According to De Leenhee and De Boodt, (1965) and Kohnke ,(1968) soil pores may be divided in the following four main classes :

1-Quickly drainable pores QDP. of ϕ > 28.8 μ m ,

2- Slowly drainable pores SDP. of ϕ 8.62 to 28.8 μ m

3- Water holding pores WHP.of ϕ 0.19 to 8.62 μ m

4- Fine capillary pores FCP. of . ϕ < 0.19 μ m

Quickly and slowly drainable pores are responsible for the downward movement of water into the soil. From the data of Table 8, there is a marked variation for all classes . The range of variation for each class was as follows quickly drainable pores 3.9 – 16.9 %, slowly drainable pores 0.4 - 7.5 %, water holding pores 9.9 – 24.7 % and fine capillary pores 12.6-37.9 %.

The fine capillary pores occurred mostly in the clayey soils in sizable contents . Low proportion of fine capillary pores were in the light textureed soils.It is clear from the previous data that the studied soils are mainly characteristic by fine particle fraction , that because the high adsaptive capacity of these soil to water.

Table 8 Soil bulk density , total porosity and pore size distribution of El-Hasainiya plain soils.

Soil mapping unit	prof. No.	Depth cm	Bulk density g/cm^3	Total Por.	Pore size distribution u			
					Q.D.P. O> 28.8	S.D.P 28.8-8.62	W.H.P. 28.62-0.19	F.C.P < 0.19
VA1	3	0-20	1.20	60.3	5.6	6.9	21.0	26.9
		20-45	1.25	64.0	3.9	6.5	21.3	32 4
		45-65	1.32	69.5	8.9	5.4	22.6	32.9
	5	0-20	1.31	65.6	10.6	0.4	23.0	31.7
		20-40	1.38	70.3	12.0	1.2	24.7	32.5
	6	0-20	1.24	61.6	9.4	4.7	21.5	26.0
		20-45	1.30	65.5	12.1	4.2	22.3	27.0
		45-90	1.38	69.2	11.6	5.0	24.2	29.2
	7	0-20	1.30	57.4	9.0	2.8	20.4	25.1
		20-50	1.35	62.6	9.9	3.9	22.0	26.9
		50-80	1.40	64.1	12.9	3.2	21.7	26.2
		80-100	1.42	67.2	7.8	3.0	24.2	32.2
VA2	1	0-15	1.26	63.9	12.3	6.2	20.4	25.0
		15-45	1.30	61.7	11.3	4.2	21.8	25.4
		45-60	1.35	65.0	12.0	3.8	22.2	27.1
	2	0-20	1.24	65.4	7.3	6.3	21.7	30.0
		20-60	1.30	68.5	10.5	4.2	23.2	30.6
		60-75	1.42	74.1	13.2	3.2	24.7	32.7
	4	0-25	1.42	39.2	12.7	2.8	9.9	13.9
		25-65	1.58	44.5	16.8	4.9	10.3	12.6
		65-85	1.27	63.3	10.3	4.6	21.9	26.5
	18	0-25	1.29	59.6	11.2	4.2	18.1	25.3
		25-65	1.33	44.3	9.5	1.0	16.6	17.1
		65-100	1.42	56.9	11.6	4.3	18.0	23.1
VT	11	0-25	1.25	44.3	6.8	3.3	14.9	19.2
		25-50	1.32	57.2	13.6	4.2	17.4	22.0
		50-95	1.40	60.0	13.9	3.7	18.9	23.6

QDP :quickly drainable pores SDP:slowly drainable pores prof.=profile

WHP: water holding pores FCP :fine capillary pores por.=porosity

Table 8 Cont.

Soil mapping unit	prof. No.	Depth cm	Bulk density g/cm^3	Total Por.	Pore size distribution u			
					Q.D.P. O> 28.8	S.D.P 28.8-8.62	W.H.P. 28.62-0.19	F.C.P < 0.19
AV	10	0-25	1.3	53.7	10.2	3.2	18.4	21.9
		25-55	1.38	58.4	9.5	3.5	18.9	26.5
		55-100	1.4	57.5	11.9	3.2	20.1	22.3
	13	0-30	1.28	54.0	9.1	3.1	16.9	25.0
		30-60	1.35	55.4	11.9	0.4	21.4	21.7
		60-80	1.42	69.9	16.2	7.4	21.2	25.2
	14	0-25	1.23	59.4	13.5	5.5	17.7	22.6
		25-60	1.32	58.0	11.7	4.4	19.3	22.7
		60-110	1.38	57.6	11.5	2.9	20.8	22.4
	15	0-25	1.2	55.0	7.1	6.1	16.3	25.4
		25-55	1.25	51.1	7.6	6.8	17.4	19.3
		55-95	1.27	52.1	10.5	3.2	17.4	20.6
	16	0-25	1.32	63.0	13.1	6.6	18.0	25.3
		25-60	1.35	64.1	15.0	5.3	18.8	25.1
		60-100	1.41	69.8	16.9	8.6	19.7	24.5
AT	8	0-20	1.3	50.1	11.9	3.0	14.5	20.6
		20-40	1.35	52.4	13.9	3.6	15.1	19.9
		40-90	1.42	60.7	8.5	4.1	21.5	26.6
	9	0-20	1.3	56.9	14.8	3.9	16.6	21.7
		20-50	1.38	55.4	12.7	2.5	17.7	22.5
		50-100	1.48	64.4	8.5	4.0	23.3	28.6
	12	0-30	1.25	55.6	12.0	4.4	10.1	23.2
		30-55	1.38	56.4	13.5	3.9	17.9	21.1
	17	0-20	1.22	56.7	13.7	7.5	15.5	20.1
		20-60	1.26	55.6	13.9	7.2	16.3	18.3
		60-100	1.31	64.5	16.0	6.8	18.6	23.2

QDP :quickly drainable pores SDP:slowly drainable pores prof.=profile

WHP: water holding pores FCP :fine capillary pores por.=porosity

*4.1.5.3. Soil moisture characteristic curves:

The shape of soil moisture curves depends mainly on some properties of the soil as texture , structure, soluble salts, and exchangeable cations. The effect of soil texture is mainly related to the specific surface of the particles which affects the adhesion force and , this appears within the high tension range of 1.0 Mpa (i.e., 10 bar); and also depends on water retained by the soil at low tension . (below 0.1 Mpa (i.e. 10 bar) which relates to the structure pattern of the soil. (Hillel 1971).

Data on moisture retention are presented in Tables 10 and 11 and illustrated in Figures 10-27. There are differences in the shape as well as the magnitude of curves . In profiles of light textured soils , the curves show a sharp decrease in moisture as tension increases . In profiles of heavy textured soils the effect of clay content on the shape of curves show gradual decrease moisture as tension increases.

4.1.5.4.Soil moisture content:

Field capacity (FC),wilting point (WP) and available water (AW) are shown in Table 9. Field capacity ranged from 19.8 to 42.9 %, . with high values being in clayey soils,and low ones sandy soils. Averages of field capacity were 38.9 ,32.9 ,29.0, 31.7 and 29.95 for units of VA1 , VA2 , VT , AV and AT respectively. In most profiles, the value of soil moisture at field capacity coincided in most cases with increased contents of clay with depth

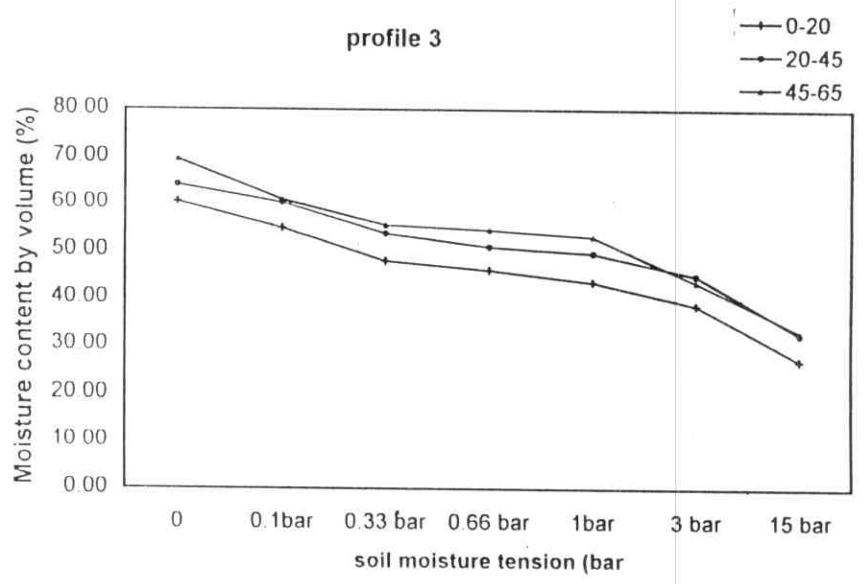


Fig (10) Moisture characteristic curvesof profile (3) at VA1 soil mapping unit ,El-Hasainiya plain soils

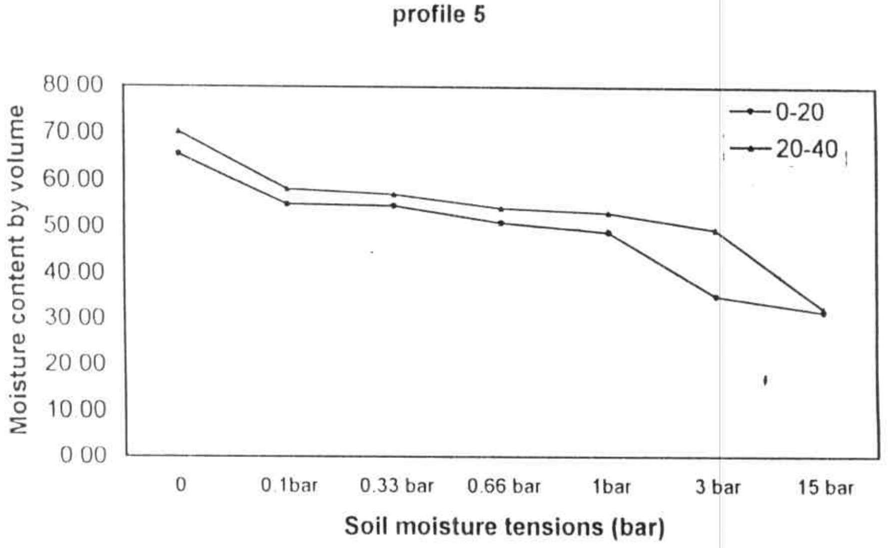


Fig (11) Moisture characteristic curves profile (5) at VA1 soil mapping unit El-Hasainiya plain soils

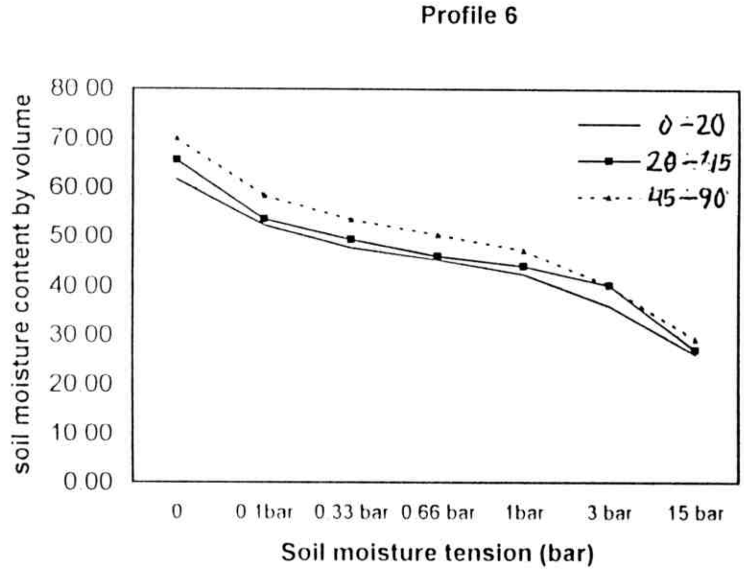


Fig (12) Moisture characteristic curves of profile (6) at VA1 soil mapping unit,El-Hasainiya plain soils

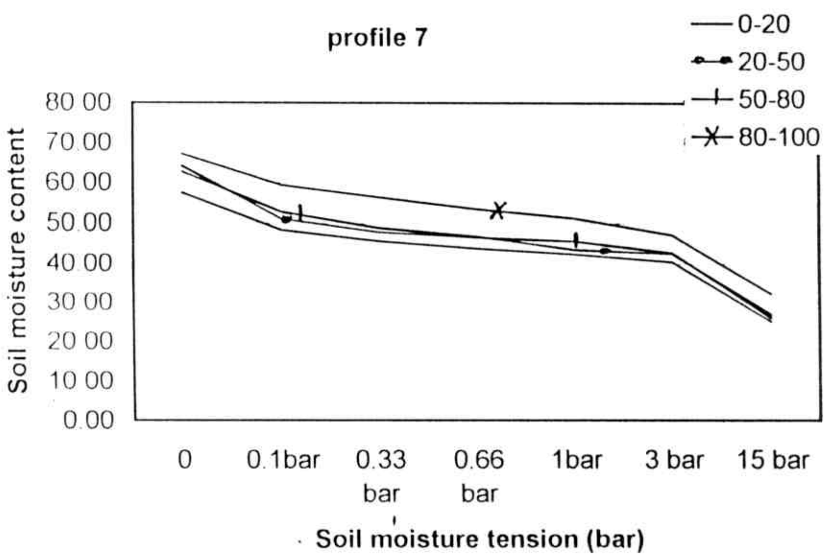


Fig (13) Moisture characteristic curves of profile (7) at VA1 soil mapping unit,El-Hasainiya plain soils

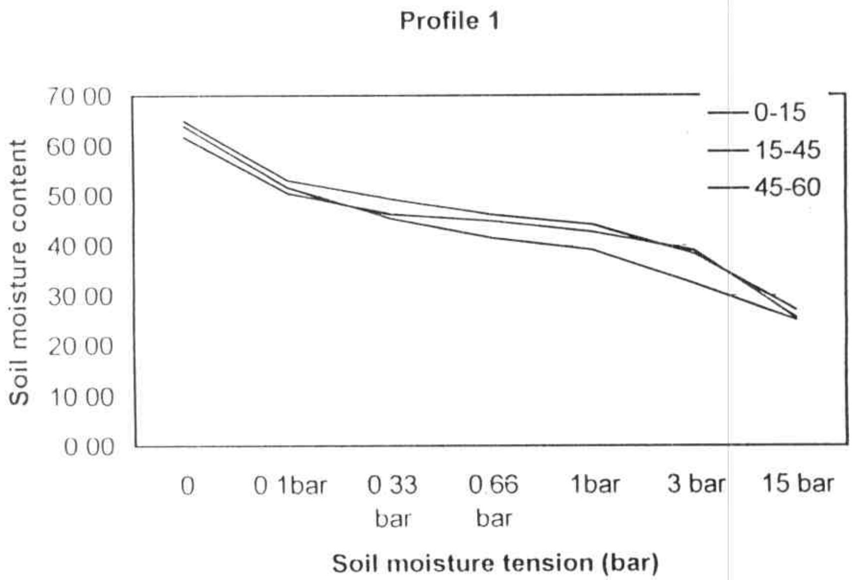


Fig (14) Moisture characteristic , curves of profile (1) at VA2 soil mapping unit,El-Hasainiya plain soils

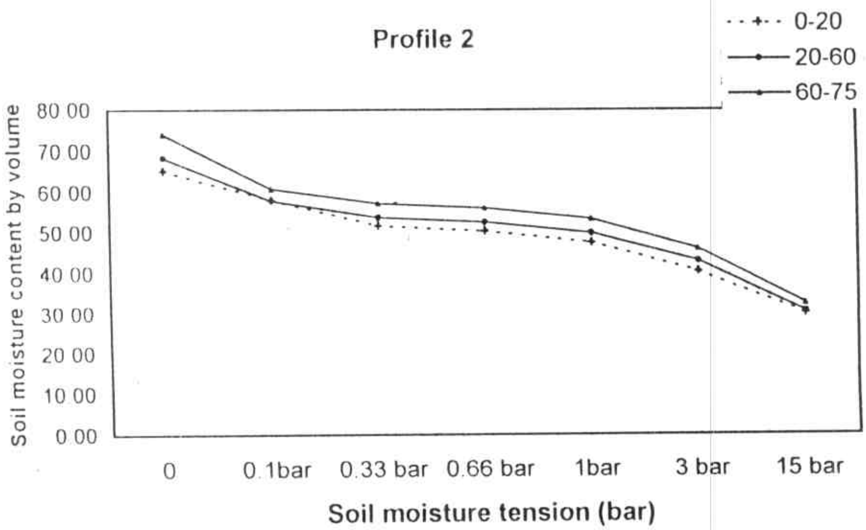


Fig (15) Moisture characteristic curves of profile (2) at VA2soil mapping unit,El-Hasainiya plain soils

Profile 4

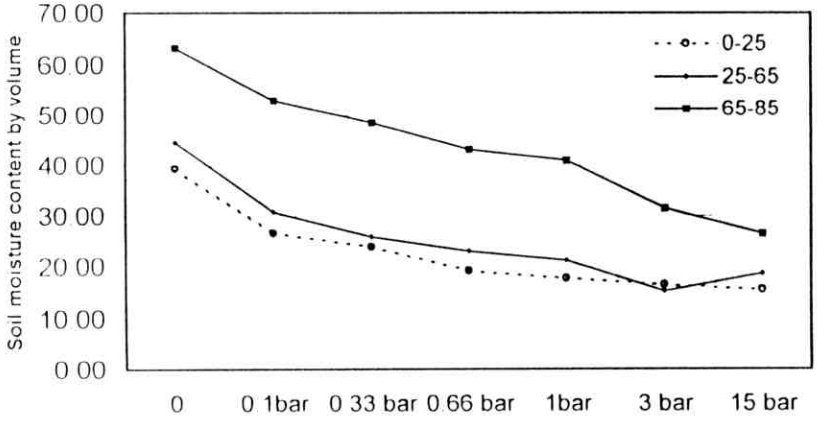


Fig (16) Moisture characteristic curves of profile (4) at VA2 soil mapping unit ,El-Hasainiya plain soils

Profile 18

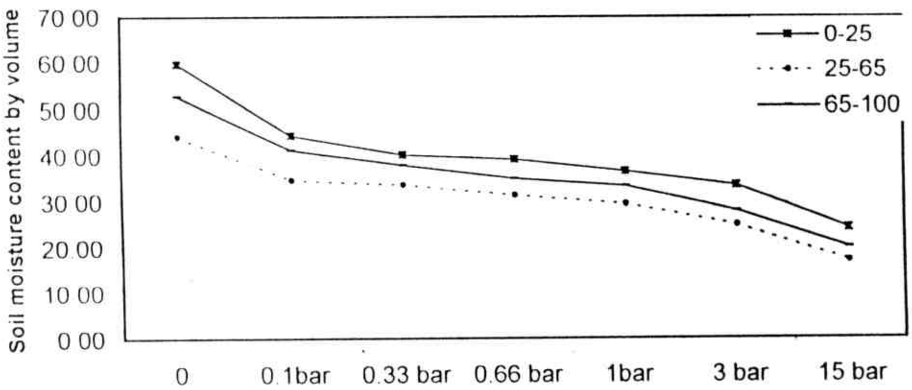


Fig (17) Moisture characteristic curves of profile (18) at VA2soil mapping unit, El-Hasainiya plain soils

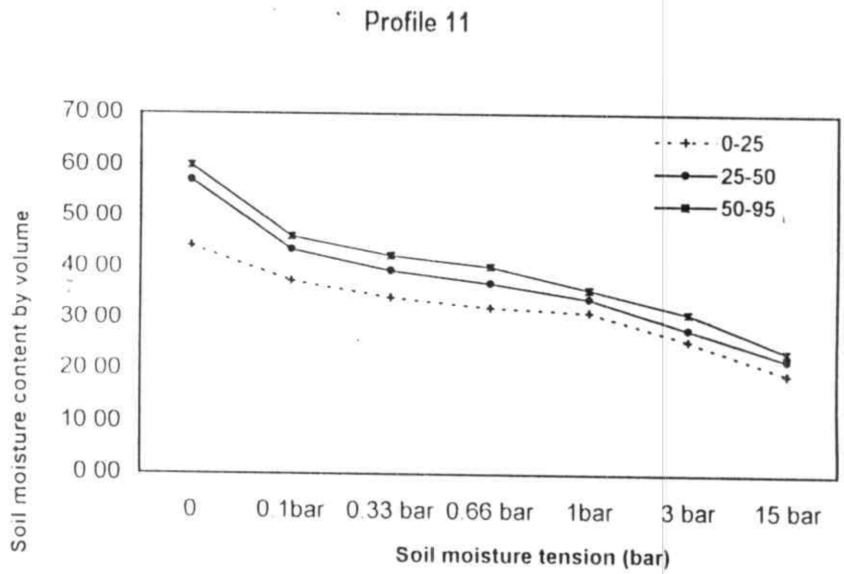


Fig (18) Moisture characteristic curves of profile (11) at VT soil mapping unit, El-Hasainiya plain soils

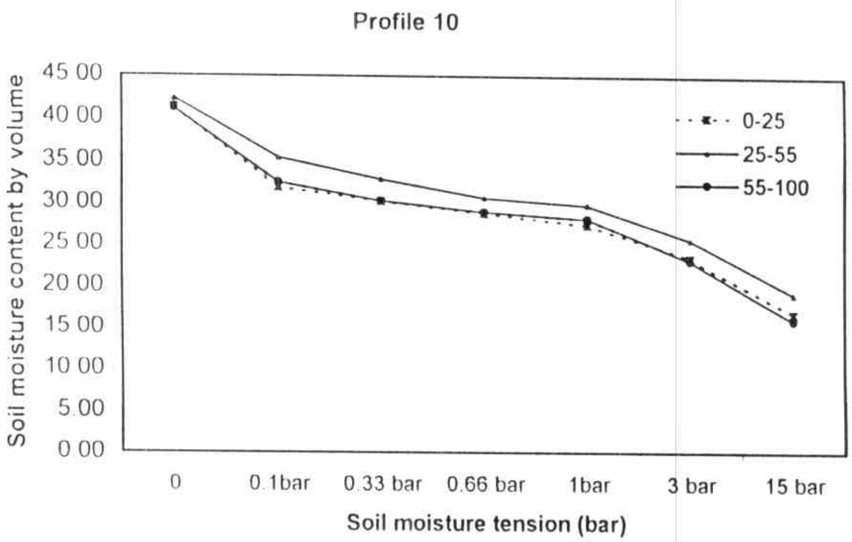


Fig (19) Moisture characteristic curves of profile (10) at AV soil mapping unit, El-Hasainiya plain soils

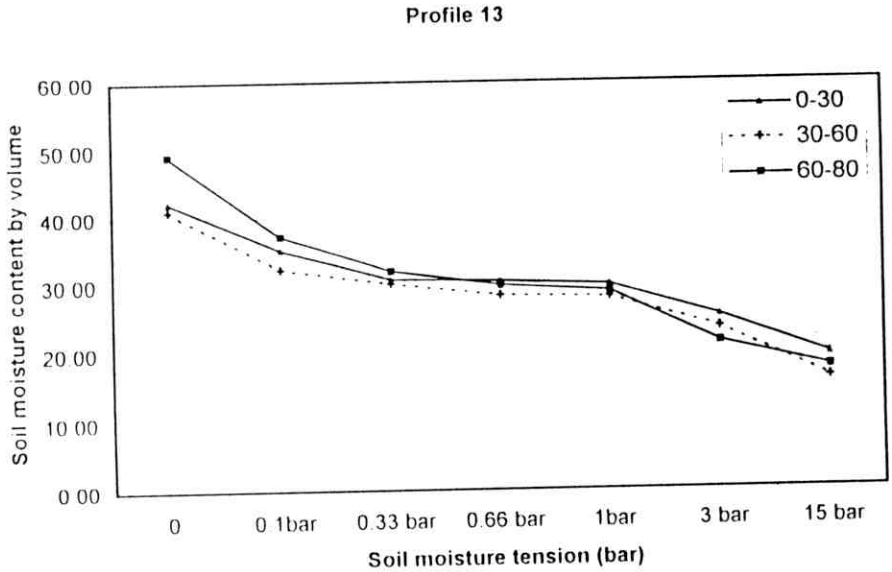


Fig (20) Moisture characteristic curves of profile (13) at AV soil mapping unit ,El-Hasainiya plain soils

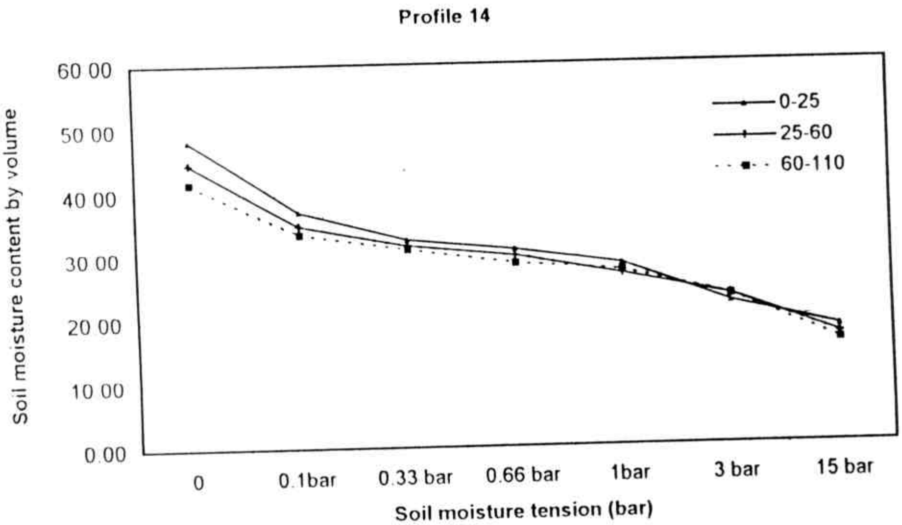


Fig (21) Moisture characteristic curves of profile (14) at AV soil mapping unit ,El-Hasainiya plain soils

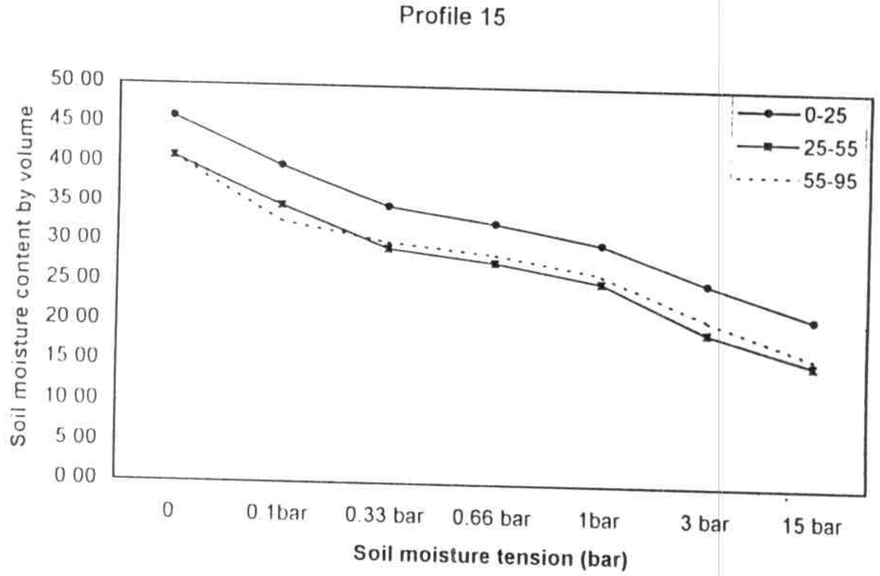


Fig (22) Moisture characteristic curves of profile (15) at AV soil mapping unit , El-Hasainiya plain soils

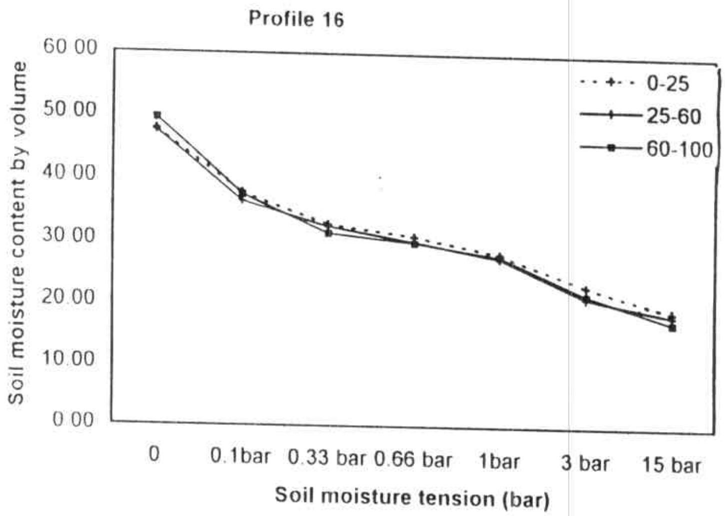


Fig (23) Moisture characteristic curves of profile (16 at AV soil mapping) unit, El-Hasainiya plain soils

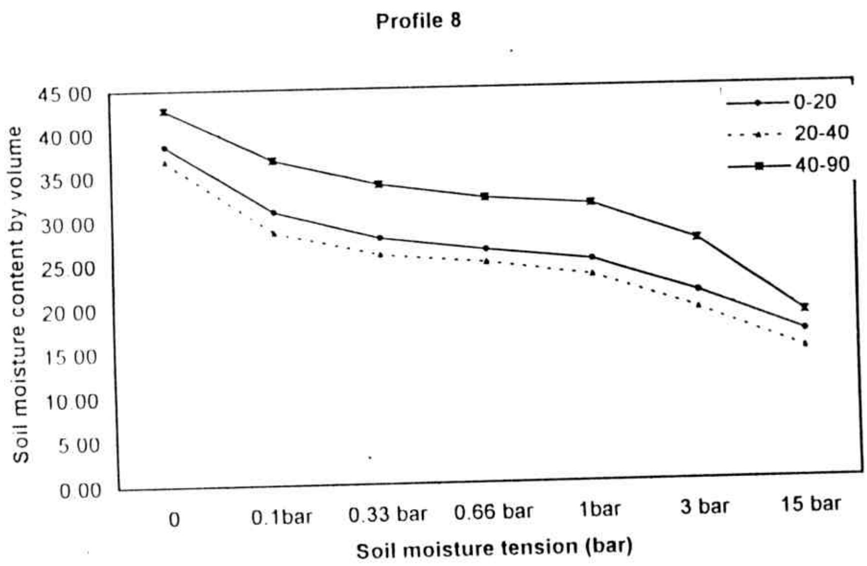


Fig (24) Moisture characteristic curvesof at AT soil mapping profile (8) unit, El-Hasainiya plain soils

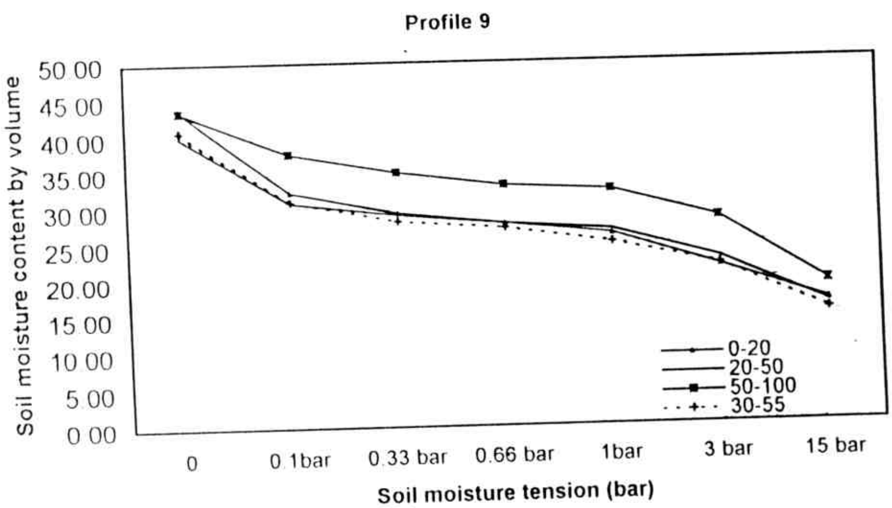


Fig (25) Moisture characteristic curvesof profile (9 at AT soil mapping) unit , El-Hasainiya plain soils

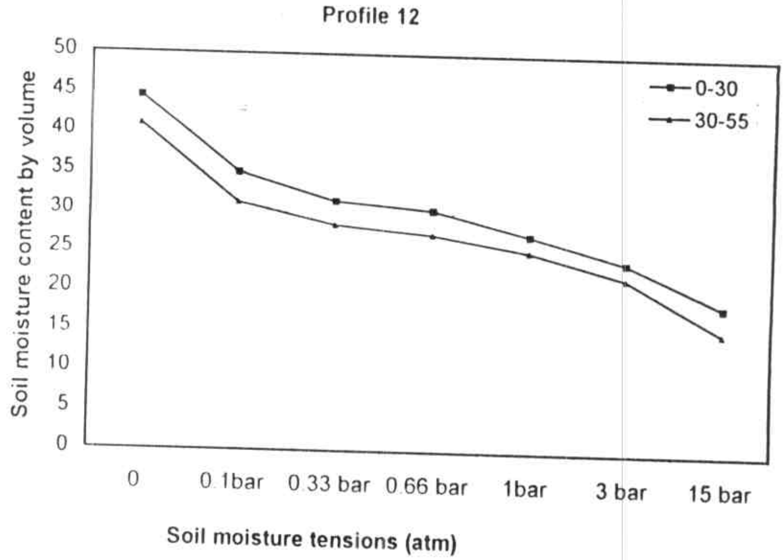


Fig (26) Moisture characteristic curvesof the studied soils profile (12) at AT soil mapping unit

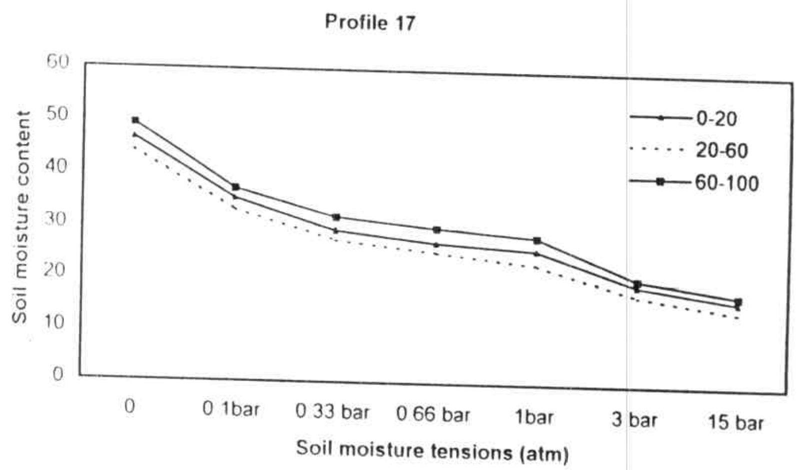


Fig (27) Moisture characteristic curvesof the studied soils profile (17) at AT soil mapping unit

Table 9 Soil moisture % by weight retained at different levels of moisture tension of El-Hasainiya plain soils.

Soil mapp. unit	prof. No.	Depth cm	Saturated soil samples	Moisture tensions (Mpa.)					
				0.01	0.033	0.066	0.1	0.3	1.5
VA1	3	0-20	50.3	45.6	39.9	38.3	36.2	32.1	22.4
		20-45	51.2	48.1	42.9	40.7	39.6	35.9	25.9
		45-65	52.6	46.1	42.0	41.2	40.1	32.9	24.9
	5	0-20	50.1	42.0	41.7	38.9	37.4	26.9	24.2
		20-40	51.0	42.3	41.4	39.3	38.6	35.9	23.5
	6	0-20	49.7	42.1	38.3	36.4	34.1	29.0	21.0
		20-45	50.4	41.1	37.9	35.3	33.7	30.8	20.8
		45-90	50.7	42.3	38.7	36.4	34.1	29.0	21.2
	7	0-20	44.1	37.2	35.0	33.7	32.5	31.1	19.3
		20-50	46.4	39.1	36.2	34.6	32.2	31.4	19.9
		50-80	45.8	36.5	34.2	33.2	32.6	30.5	18.7
		80-100	47.3	41.8	39.7	37.7	36.1	33.2	22.7
VA2	1	0-15	50.7	41.0	36.0	32.9	31.0	25.6	19.8
		15-45	47.5	38.8	35.5	34.5	32.8	30.0	19.6
		45-60	48.1	39.3	36.5	34.2	32.7	28.4	20.0
	2	0-20	52.0	46.8	41.7	40.7	38.4	32.6	24.2
		20-60	52.1	44.6	41.4	40.5	38.4	33.1	23.5
		60-75	52.2	42.9	40.4	39.5	37.6	32.4	23.0
	4	0-25	31.0	22.1	19.8	15.9	14.7	12.9	11.6
		25-65	35.6	24.6	22.3	18.4	16.9	13.8	14.9
		65-85	49.8	41.7	38.1	33.9	32.2	24.8	20.9
	18	0-25	46.2	34.5	31.2	30.4	28.5	26.0	18.8
		25-65	33.3	26.1	25.3	23.6	22.2	18.8	12.9
		65-100	40.1	29.1	26.8	24.7	23.6	19.7	14.1
VT	11	0-25	35.4	30.0	27.3	25.8	25.0	20.6	15.4
		25-50	43.4	33.0	29.9	28.0	25.8	21.2	16.7
		50-95	42.3	32.5	29.9	28.4	25.2	21.9	16.6

Mega pascal "Mpa"=10 bar mapp.=mapping prof.=profile

Table 9 Cont.

Soil mapp. unit	prof. No.	Depth cm	Saturated soil samples	Moisture tensions (Mpa.)					
				0.01	0.033	0.066	0.1	0.3	1.5
AV	10	0-25	53.7	41.5	39.3	37.4	35.6	30.5	21.9
		25-55	58.4	48.9	45.4	42.4	41.1	35.3	26.5
		55-100	57.5	45.5	42.4	40.6	39.4	32.4	22.3
	13	0-30	54.0	44.9	41.9	38.9	38.1	32.3	25.0
		30-60	55.4	43.5	43.1	38.2	37.8	31.7	21.7
		60-80	69.9	52.8	45.3	42.3	40.9	30.3	25.2
	14	0-25	59.4	45.8	40.3	30.2	35.3	27.5	22.6
		25-60	58.0	46.3	42.0	39.7	35.6	31.0	22.7
		60-110	57.6	46.1	43.1	39.8	38.1	32.3	22.4
	15	0-25	55.0	47.9	41.8	39.2	36.2	30.5	25.4
		25-55	51.1	43.5	36.8	34.8	31.8	24.1	19.3
		55-95	52.1	41.5	38.4	36.6	33.5	26.5	20.6
	16	0-25	63.0	49.9	43.3	40.8	37.2	30.5	25.3
		25-60	64.1	49.1	43.9	52.8	50.5	42.1	25.1
		60-100	69.8	52.9	44.3	42.2	39.2	30.6	24.5
AT	8	0-20	50.1	40.2	36.1	34.2	32.6	27.6	21.6
		20-40	52.4	38.6	35.0	33.6	31.5	26.1	19.8
		40-90	60.7	52.3	48.1	45.7	44.6	38.6	26.6
	9	0-20	56.9	42.2	38.3	36.2	34.2	28.2	21.7
		20-50	55.4	42.7	40.2	38.5	37.0	31.5	22.5
		50-100	64.4	55.9	52.0	49.1	48.0	42.0	28.6
	12	0-30	55.6	43.6	39.3	37.9	33.9	29.8	23.2
		30-55	56.4	42.9	39.1	37.5	34.6	30.2	21.1
	17	0-20	56.7	43.1	35.6	33.1	31.6	23.6	20.1
		20-60	55.6	41.7	34.5	31.8	29.1	21.9	18.3
		60-100	64.6	48.6	41.8	39.3	37.2	27.0	23.2

Mega pascal "Mpa"=10 bar   mapp.=mapping   prof.=profile

Table 10 Soil moisture % by volume retained at different levels of moisture tension of El-Hasainiya plain soils.

Soil mapp. unit	prof. No.	Depth cm	Saturated soil samples	Moisture tensions (Mpa.)					
				0.01	0.033	0.066	0.1	0.3	1.5
VA1	3	0-20	60.3	54.8	47.9	46.0	43.4	38.5	26.9
		20-45	64.0	60.1	53.6	50.9	49.5	44.9	32.4
		45-65	69.5	60.8	55.4	54.4	52.9	43.4	32.9
	5	0-20	65.6	55.0	54.7	51.0	49.0	35.2	31.7
		20-40	70.3	58.4	57.1	54.2	53.2	49.6	32.5
	6	0-20	61.6	52.2	47.5	45.1	42.3	35.9	26.0
		20-45	65.5	53.4	49.3	45.9	43.8	40.0	27.0
		45-90	70.0	58.4	53.4	50.2	47.1	40.0	29.2
	7	0-20	57.4	48.4	45.5	43.8	42.2	40.4	25.1
		20-50	62.6	52.8	48.9	46.7	43.5	42.4	26.9
		50-80	64.1	51.1	47.9	46.5	45.6	42.7	26.2
		80-100	67.2	59.4	56.4	53.5	51.3	47.1	32.2
VA2	1	0-15	63.9	51.6	45.4	41.5	39.1	32.3	25.0
		15-45	61.7	50.4	46.2	44.8	42.6	39.0	25.4
		45-60	65.0	53.0	49.3	46.1	44.1	38.3	27.1
	2	0-20	65.4	58.0	51.8	50.5	47.6	40.5	30.0
		20-60	68.5	58.0	53.8	52.7	49.9	43.0	30.6
		60-75	74.1	60.9	57.4	56.1	53.4	46.0	32.7
	4	0-25	39.2	26.5	23.8	19.1	17.6	16.5	15.6
		25-65	44.5	30.8	25.9	23.0	21.1	15.3	18.6
		65-85	63.3	53.0	48.4	43.1	40.9	31.5	26.5
	18	0-25	59.6	44.5	40.3	39.3	36.7	33.5	24.3
		25-65	44.2	34.7	33.7	31.4	29.5	25.0	17.1
		65-100	52.9	41.3	38.1	35.1	33.5	28.0	20.1
VT	11	0-25	44.3	37.4	34.1	32.3	31.3	25.7	19.2
		25-50	57.2	43.6	39.5	37.0	34.0	28.0	22.0
		50-95	60.0	46.2	42.5	40.3	35.8	31.1	23.6

Mega pascal "Mpa"=10 bar   mapp=mapping   prof.=profile

Table10 Cont.

Soil mapp. unit	prof. No.	Depth cm	Saturated soil samples	Moisture tensions (Mpa.)					
				0.01	0.033	0.066	0.1	0.3	1.5
AV	10	0-25	41.3	31.9	30.2	28.8	27.4	23.5	16.9
		25-55	42.3	35.4	32.9	30.7	29.8	25.6	19.2
		55-100	41.0	32.5	30.3	29.0	28.1	23.2	16.0
	13	0-30	42.2	35.1	30.7	30.4	29.8	25.2	19.5
		30-60	41.0	32.2	30.1	28.3	28.0	23.5	16.1
		60-80	49.3	37.2	31.9	29.8	28.8	21.4	17.7
	14	0-25	48.3	37.3	32.8	31.1	28.7	22.4	18.4
		25-60	44.6	35.1	31.8	30.1	27.0	23.5	17.2
		60-110	41.7	33.7	31.3	28.9	27.6	23.4	16.2
	15	0-25	45.8	39.9	34.8	32.7	30.2	25.4	21.2
		25-55	40.9	34.8	29.4	27.8	25.4	19.3	15.5
		55-95	41.0	32.7	30.2	28.8	26.4	20.9	16.2
	16	0-25	47.7	37.8	32.8	30.9	28.2	23.1	19.2
		25-60	47.5	36.4	32.5	39.1	37.4	31.2	18.6
		60-100	49.5	37.5	31.4	29.9	27.8	21.7	17.4
AT	8	0-20	38.5	30.9	27.8	26.3	25.1	21.2	16.6
		20-40	36.8	28.6	25.9	24.9	23.3	19.3	14.7
		40-90	42.8	36.8	33.9	32.2	31.4	27.2	18.7
	9	0-20	43.8	32.4	29.5	27.8	26.3	21.7	16.7
		20-50	40.1	31.0	29.1	27.9	26.8	22.8	16.3
		50-100	43.5	37.8	35.1	33.2	32.4	28.4	19.3
	12	0-30	44.5	34.9	31.4	30.3	27.2	23.8	18.6
		30-55	40.9	31.1	28.3	27.2	25.1	21.9	15.3
	17	0-20	46.5	35.3	29.2	27.1	25.9	19.3	16.5
		20-60	44.2	33.1	27.4	25.2	23.1	17.4	14.5
		60-100	49.3	37.1	31.9	30.0	28.4	20.6	17.7

Mega pascal "Mpa"=10 bar mapp=mapping prof.=profile

Table 11 Hydraulic conductivity and soil moisture constants (field capacit FC wilting point ,WP and available water AW of El-Hasainiya plain so

Soil mapping unit	profile No.	Depth cm	Hydraulic conductivity cm/h.	Soil moisture constants %		
				F.C.	W.P.	A.W.
VA1	3	0-20	0.53	38.9	22.4	16.5
		20-45		42.9	25.9	17.0
		45-65		42.0	24.9	17.1
	5	0-20	0.15	41.7	24.2	17.5
		20-40		41.4	23.5	17.9
	6	0-20	0.57	38.3	21.0	17.4
		20-45		37.9	20.8	17.1
		45-90		38.7	21.2	17.5
	7	0-20	0.23	35.0	19.3	15.7
		20-50		36.2	19.9	16.3
		50-80		34.2	18.7	15.5
		80-100		39.7	22.7	17.0
VA2	1	0-15	0.26	36.0	19.8	16.2
		15-45		35.5	19.6	16.0
		45-60		36.5	20.0	16.5
	2	0-20	0.43	41.7	24.2	17.5
		20-60		41.4	23.5	17.9
		60-75		40.4	23.0	17.4
	4	0-25	1.09	19.8	11.6	8.2
		25-65		22.3	14.9	7.5
		65-85		38.1	20.9	17.2
	18	0-25	1.83	31.2	18.8	12.4
		25-65		25.3	12.9	12.5
		65-100		26.8	14.1	12.7
VT	11	0-25	1.90	27.3	15.4	11.9
		25-50		29.9	16.7	13.2
		50-95		29.9	16.6	13.3

Table 11 Cont.

Soil mapping unit	profile No.	Depth cm	Hydraulic conductivity cm/h.	Soil moisture constants %		
				F.C.	W.P.	A.W.
AV	10	0-25	1.09	30.2	16.9	13.3
		25-55		32.9	19.2	13.7
		55-100		30.3	15.9	14.4
	13	0-30	1.00	32.7	19.5	13.2
		30-60		30.1	16.1	14.0
		60-80		31.9	17.7	14.2
	14	0-25	2.99	32.8	18.4	14.4
		25-60		31.8	17.2	14.6
		60-110		31.3	16.2	15.1
	15	0-25	1.79	34.8	21.2	13.6
		25-55		29.4	15.5	14.0
		55-95		30.2	16.2	14.0
	16	0-25	1.92	32.8	19.2	13.6
		25-60		32.5	18.6	13.9
		60-100		31.4	17.4	14.0
AT	8	0-20	0.76	27.8	16.6	11.2
		20-40		25.9	14.7	11.2
		40-90		33.9	18.7	12.2
	9	0-20	4.46	29.5	16.7	12.8
		20-50		29.1	16.3	12.8
		50-100		35.1	19.3	15.7
	12	0-30	0.35	31.4	18.6	12.8
		30-55		28.3	15.3	13.0
	17	0-20	0.69	29.2	16.5	12.7
		20-60		27.4	14.5	12.9
		60-100		31.9	17.7	14.2

*Wilting point ranged from 11.6 to 25.9 % . High values were associated with high contents of clay in soils. The average values of wilting point were 22.4 , 18.6 , 16.2 17.66 and 16.81 for soil units of VA1 , VA2 , VT , AV and AT respectively

Available water varied from 7.5 to 17.9 % . High values were recorded in VA1,unit and in most profiles of VA2 unit, Low one were recorded in VA2 unit which has low contents of clay particles. The average values of available water were 16.88,14.33,12.8 , 13.99 and 12.86 for soil units of VA1 , VA2 , VT , AV and AT respectively

4.1.5.5. Hydraulic conductivity

Hydraulic conductivity is an important parmeter in planning for irrigation , drainage of soils , and leaching operations of saline and sodic soils .It measures the rate of downward movement of water by gravity .Values of hydraulic conductivity ranged from 0.15 to 4.46 cm/hour.Values of hydraulic conductivity in this study are comparable to those obtained by (El-Toukhy , 1995) who reported values from 0.025 to 0.61 cm/h for soils of southern border of El-Manzala lake. The average values of hydraulic conductivity were (0.37 , 0.90 , 1.9 1.76 and 1.57 cm/h) for the soil units of VA1 , VA2 , VT , AV and AT respectively .

According to the Guidelines (FAO 1990) , soils of the VA1 unit and some soils of the VA2 unit may be termed as having between very slow to slow hydraulic conductivity. Soils *of VT , AV , and AT units having between slow to moderately slow hydraulic conductivity except soils of profiles 9 (AT unit) and 14 (AV unit) which have moderately rapid hydraulic conductivity.

4.1.6. Mineralogical analysis of the clay fraction:

The data of semi-quantitative analysis of clay minerals in seven representative soil samples are given in Table 12, and Figures 28 to 34

Smectite was the dominat mineral , kaolinite is the second dominant mineral. Traces of illite mineral are identified , they showed increases with depth in profiles 7 and 11 .

Palygroskites were few in the 50-80 cm layer of profile 7 and subsurface layer of profile 11. Interstratified minerals were in traces in the 20-50 cm layer of profile 7 and were not existent in the other layers and all profiles in all the studied samples.

Quartz , feldspars , dolomite and gypsum minerals were in traces to few amounts. Calcite was in traces in subsurface layers of profiles 7 and 11.

The obtained results are in agreement with those obtained by Omar et al. 1992 , El –Gindy et al 1996 and Ibrahim 1998 and Abd El-Salam 2001, who reported that fertile non-sodic and non-fertile sodic soils of some fluvio- marine plains showed dominance of smectite minerals with small amounts of koalinite and illite minerals with interstratified minerals, being very few .

Table 12 Semi quantitative analysis for mineralogical compasition of the clay fraction (<0.002 mm) separated the studied soils

Prof. No	Depth cm	Inerstrati-fied minerals	Clay minerals				Accessory minerals				
			Kaolinte onite	Montmorill-onite	Illite	Palygros kite	Quartz	Feldspars	Dolomite	Calcite	Gypsum
4	65-80	-	Mod	Dom.	Tra.	-	Tra.	Tra.	Few	-	Mod
7	20-50	Tra	Few	Dom.	Few	-	Tra.	Tra.	Tra.	Tra	Tra
	50-80		Few	Dom.	Tra.	Few	Tra.	Tra.	Tra.	-	Tra
8	20-40	-	Few	Dom.	Tra.	-	Tra.	Few	-	-	Tra
	40-90	-	Few	Dom.	Tra.	-	Tra.	Tra.	Few	-	Tra
11	25-50	-	Tra	Dom.	Tra.	Few	Tra.	Tra.	Few	Tra	Few
	50-90	-	Mod	Dom.	Few	-	Tra.	Tra.	Tra.	-	Few

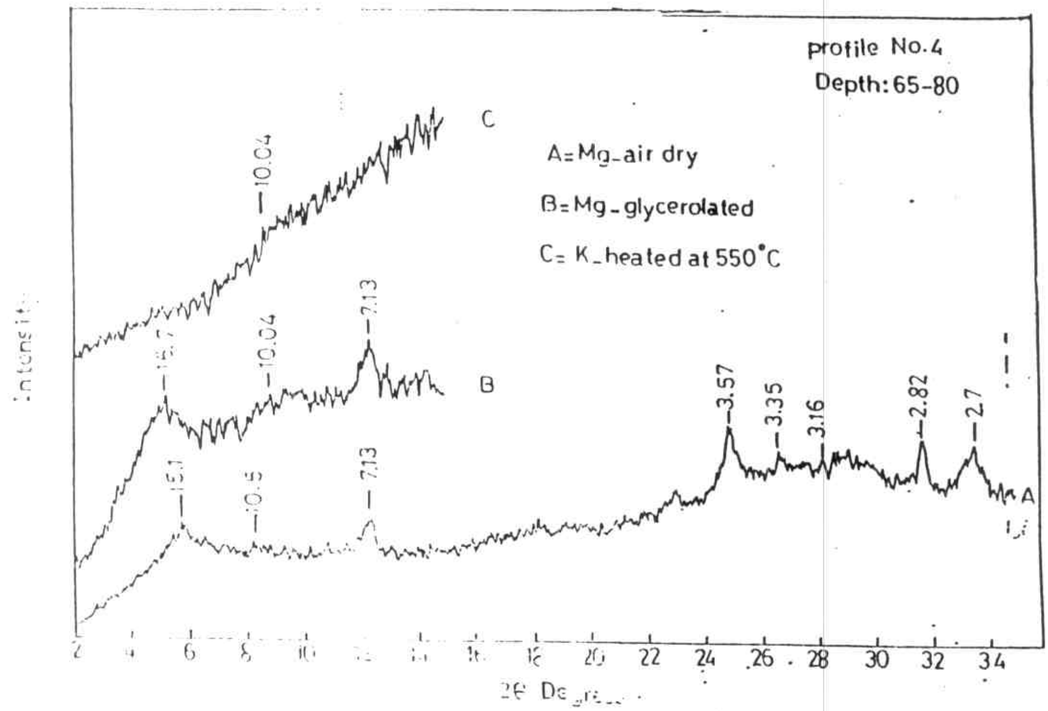
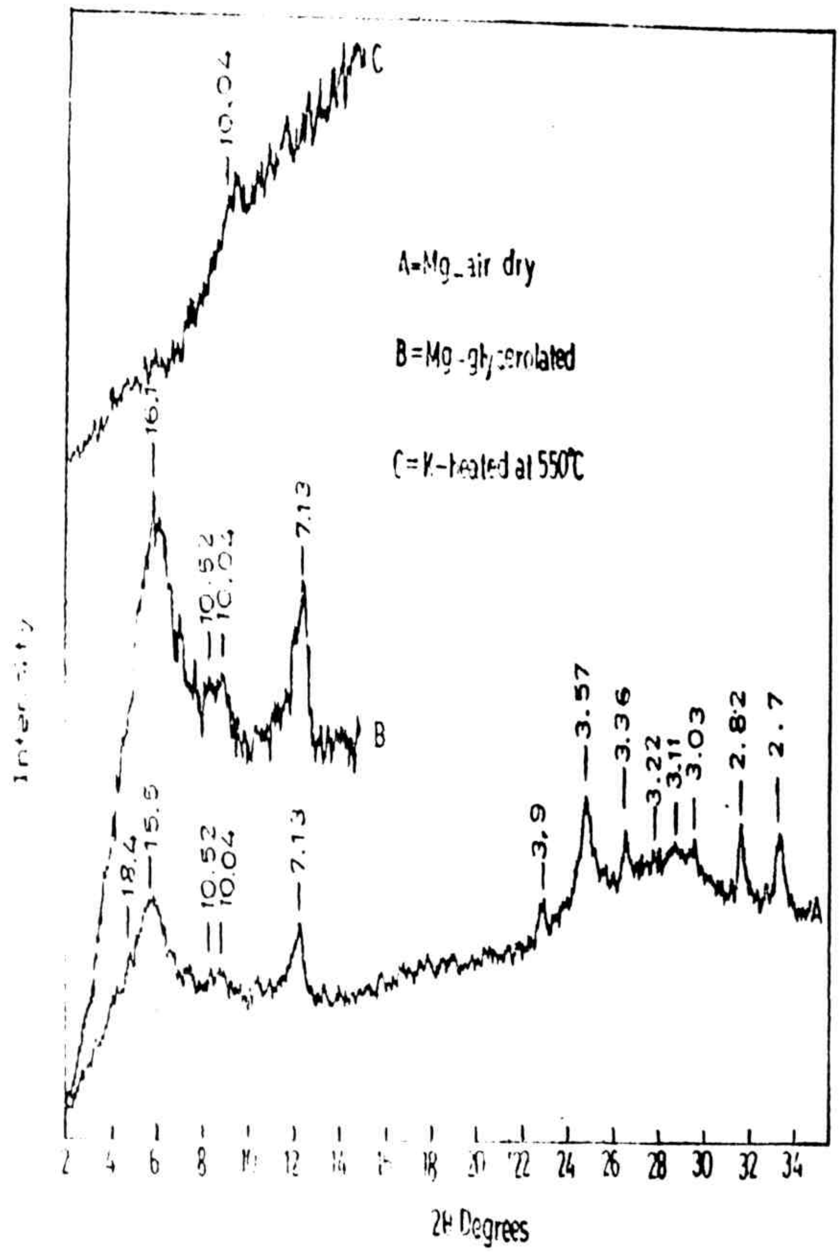
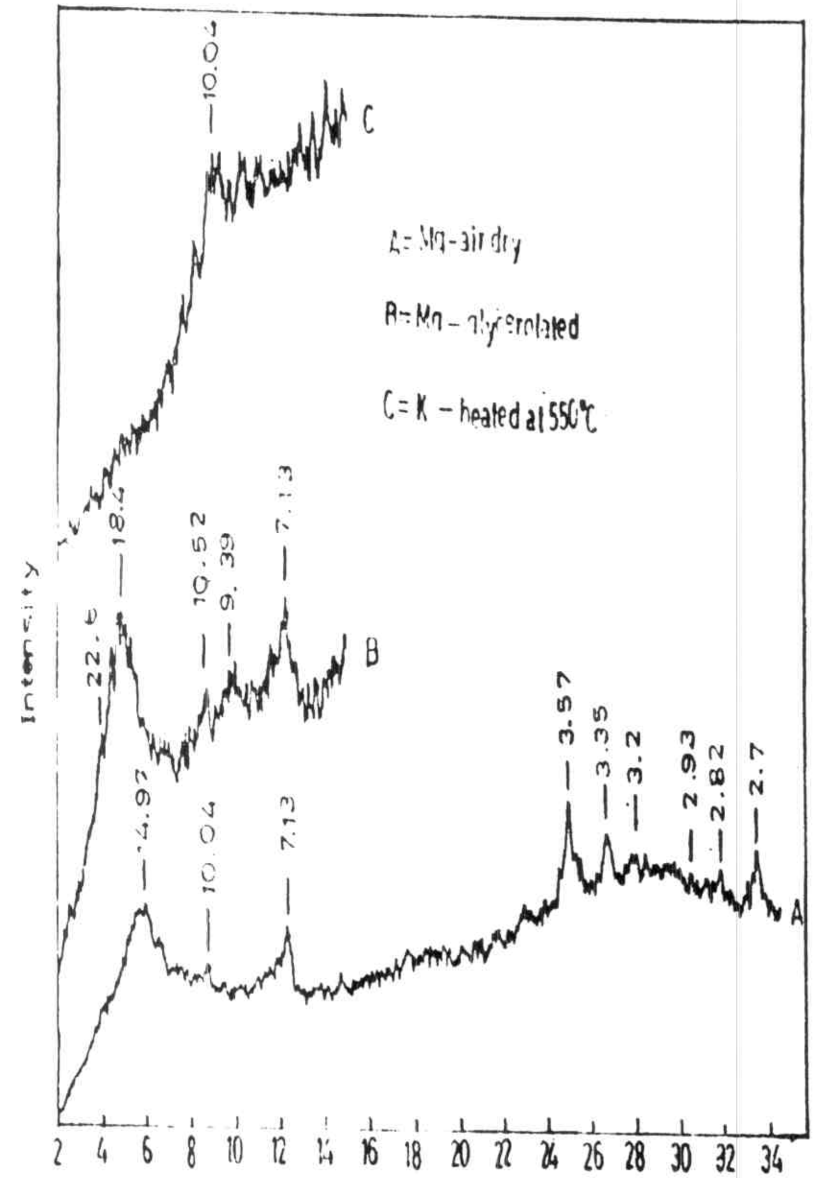


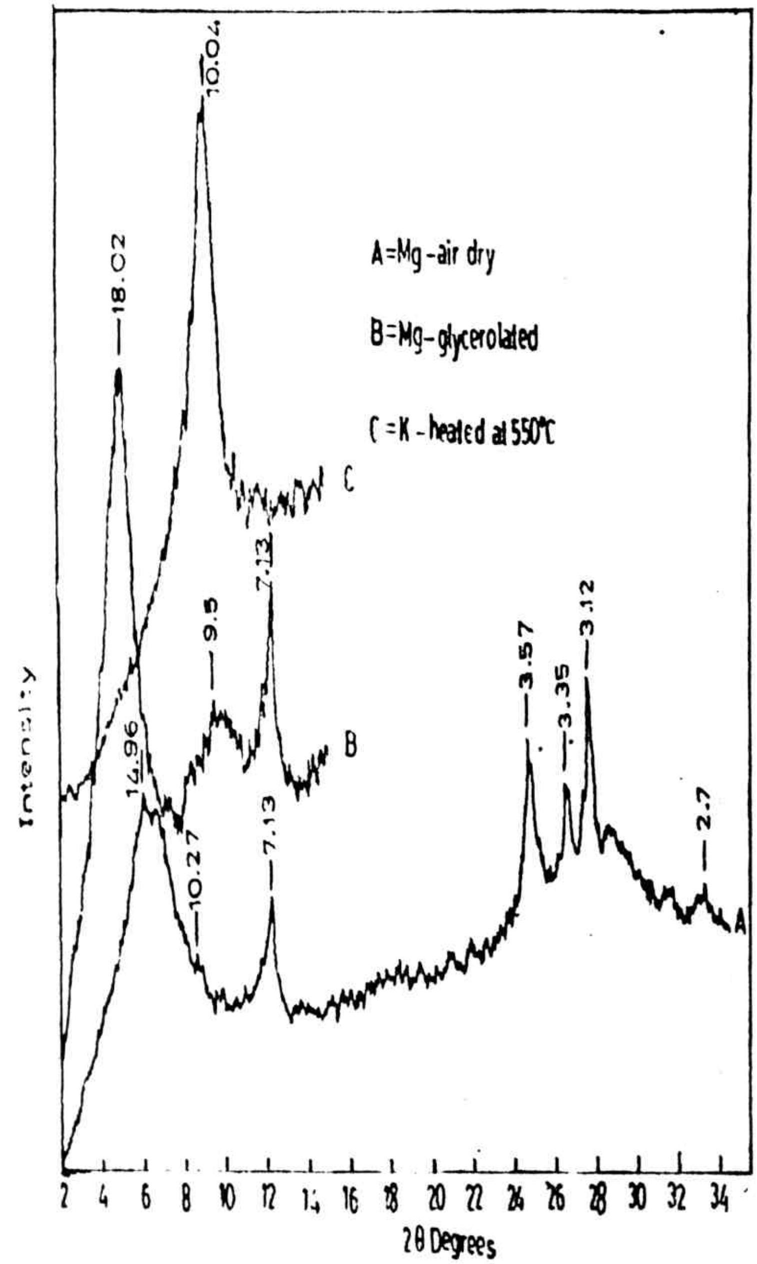
Fig (28): X-ray diffraction pattern of clay fraction separated from the (65-80cm) layer of profile (4).



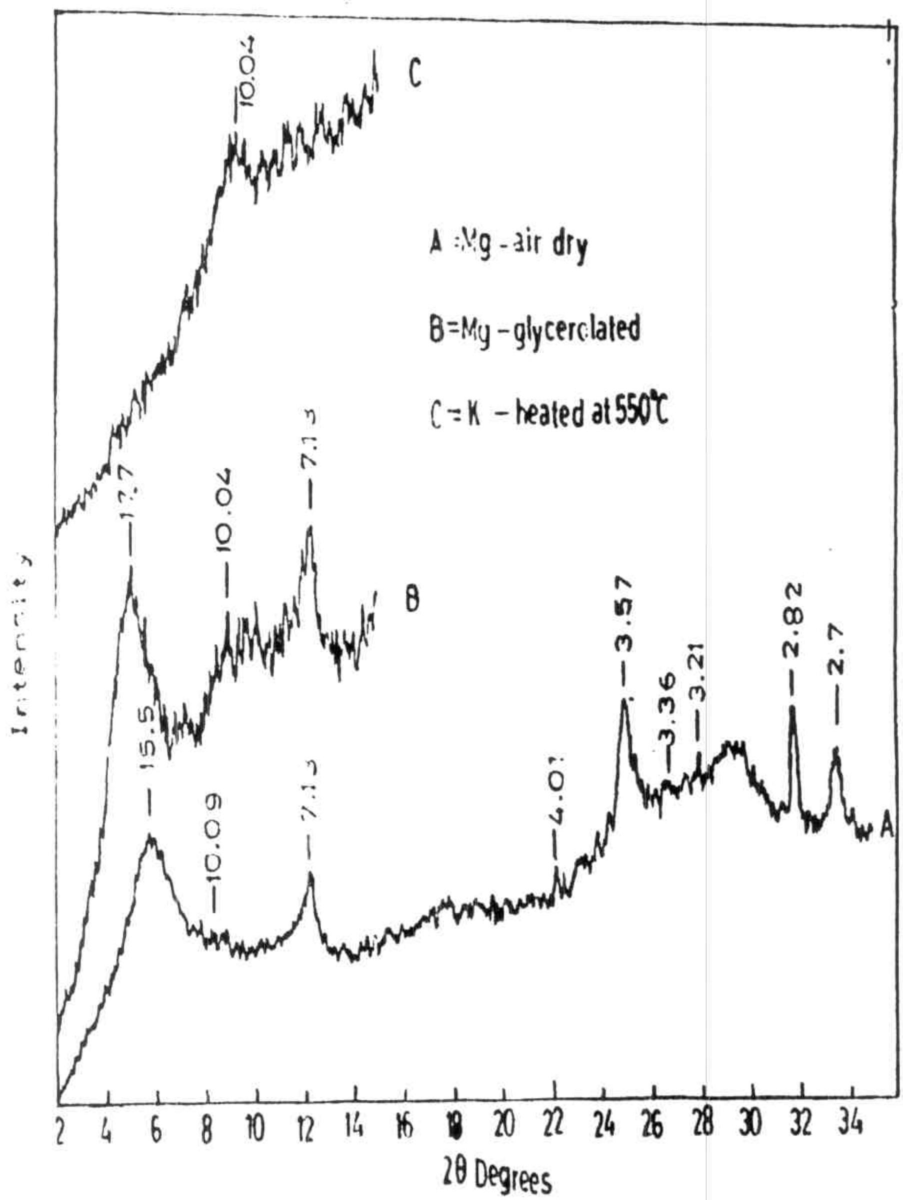
Fig(29)x-rag diffraction pattern of clay fraction profile No.7 depth 20-50 cm



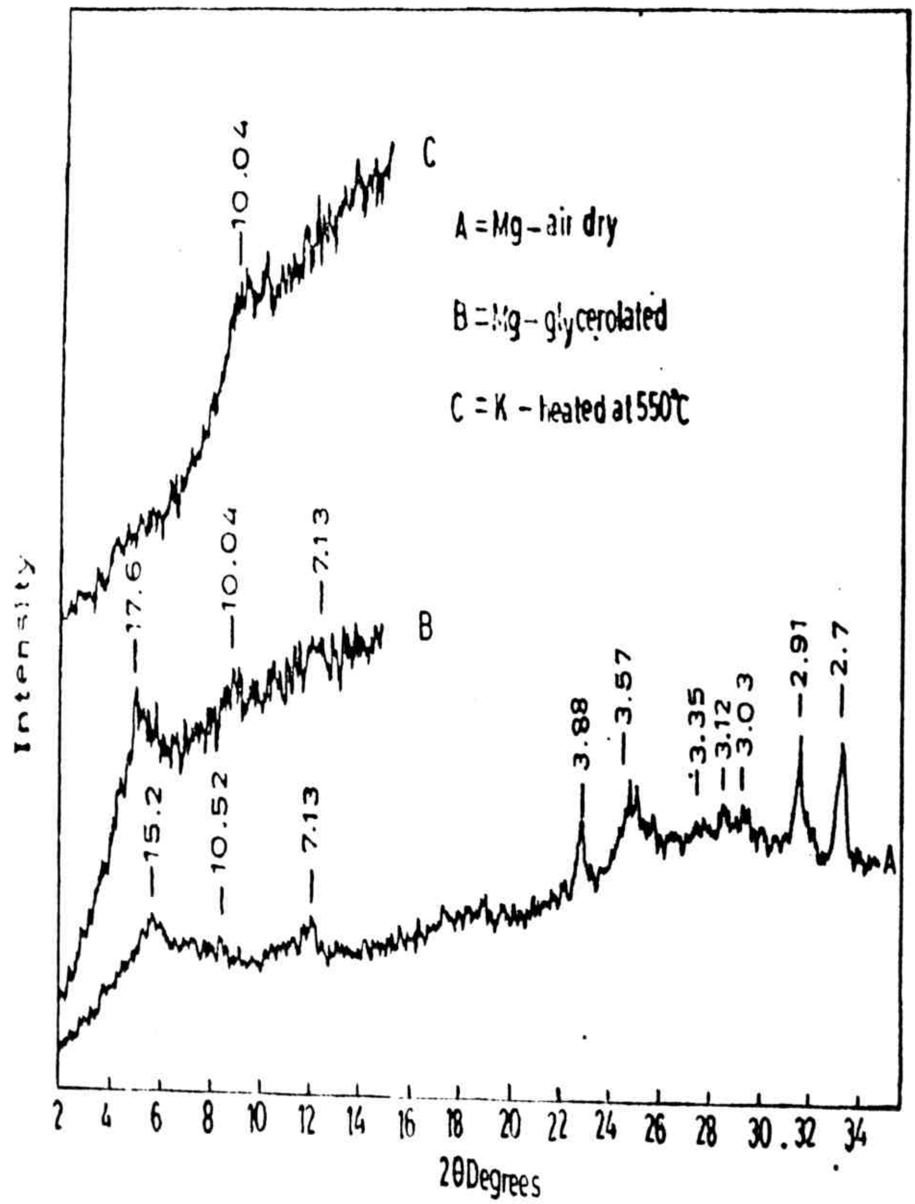
Fig(30)x-ray diffraction pattern of clay fraction profile No7 - depth 50-80 cm



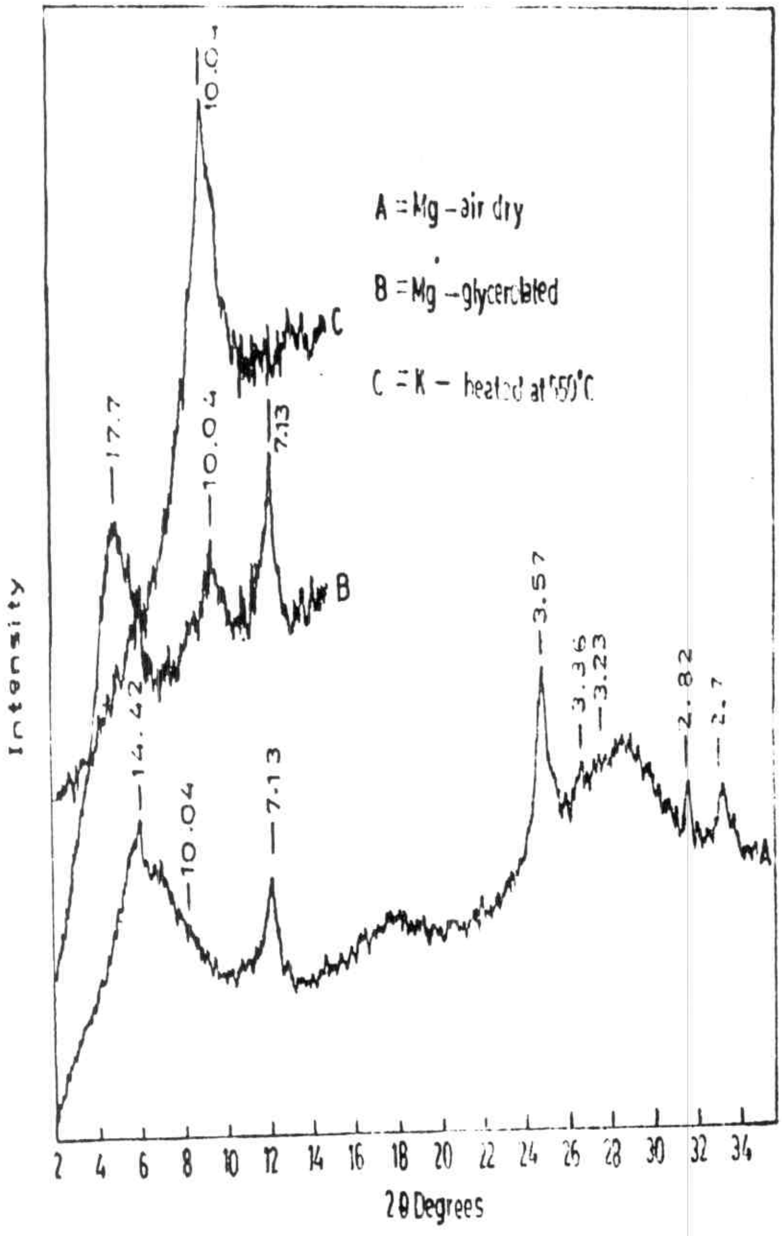
Fig(31) x-ray diffraction pattern of clay fraction profile No.8 - depth 20-40 cm



Fig(32) x-ray diffraction pattern of clay fraction profile No.8 - depth 40-90 cm



Fig(33) x-ray diffraction pattern of clay fraction profile No.11 - depth 25-50cm



Fig(34) x-ray diffraction pattern of clay fraction profile No.11 - depth 65-80cm

*4.2. Land evaluation:

The objective of land evaluation is to assess its value for definate purposes. Evaluation should not be limited to assessment of environmental characteristics , and can be extended to economic viability , social consequences and environmental impact .The "parallel" and the" two – stage" approaches are strategies of the land evaluation system forwarded by the FAO (1976) In the "parallel " , "land analyses" and "land use" relationships proceed concurrently with economic and social analysis. In the "two –stage approach", economic and social analyses may follow the qualitative land classification . Land use suitability assessment is an example of "the first stage" in the "two–stage approach" . The results can be directly incorporated into the planning decisions. Alternatively, the results of a land suitability assessment can be subjected to economic and social analyses to provide a quantitative land classification which can be applied in planning purposes .

The trend towards assessment procedures geared to particular land use is presented by the "FAO Framework for Land Evaluation" published by the (FAO,1976) in which the starting point is land use .It provides a structure by which land can be evaluated for any defined purpose as long as the land use requirments are known and the necessary data are available.

*4.2.1.Land assessment for irrigation:

The simple approach , proposed by Sys and Verheye (1978). is valid for irrigation purposes in arid and semi arid regions. The classification is processed according to the FAO Framework (FAO, 1976) .The aim is to provide a method for suitable evaluation for irrigation purposes based on the standared physical and chemical characteristics of soil profiles. Characteristics and their symbols used are as follows topography (t) ,wetness (w) , soil texture and stoniness (s_1) , soil depth (s_2) , calcium carbonate (s_3) , gypsum (s_4) , and salinity & sodicity (or alkanliity) (n) . The scale of limitation and the rating score regarding each characteristic include 5 levels as follows .

Symbol	Intensity of limitation	Rating
0	Non	95-100
1	Slight	85-95
2	Moderate	60-85
3	Severe	45-60
4	Very severe	<45

The irrigation suitability index Ci is calculated as follows

$$Ci = t \times w/100 \times s_1/100 \times s_2/100 \times s_3/100 \times s_4/100 \times n/100.$$

Based on the intensity of limitations , the system suggests definitions of suitability "orders". Each order consists of a number of "classes" Classes are divided into "units" which *specify the of kind of limitation and the minor differences in required , mangement.

The orders and classes are as follows :

Order S : Suitable for irrigation (Ci is more than 25).

Class S1 : Ci is more than 75

Class S2 : Ci is between 50 and 75

Class S3 :Ci is between 25 and 50

Order N : Not suitable for irrigation (Ci is less than 25)

Clas N1 :With limitations which can be corrected.

Class N2 : With limitation which can not be corrected.

The results of applying this system to the soils of the current study are shown in Table 13 . Ratings were calculated for current as well as potential suitability . The "current suitability" refers to the suitability of land for irrigation in "its present condition" , without major alterations or operations. The potential suitability refers to its suitability , after implementing specified major alterations or operations to improve the land.

The current rating (Table ,13) indicate that all soils have no or slight limitations regarding topagraphy (t) , soil depth (s_2) , calcium carbonate (s_3) and gypsum (s_4) . Concerning soil texture (s_1) , with exception of moderate intensity in the VA1 soil unit , all soils show none- to slight - limitations.The most effective characteristics are wetness (w) and salinity /sodicity (n) . The *intensity of their limitations varied widely from slight to very severe . Slight and moderate degrees of limitation were found in the relatively old reclaimed soils (profils 3 , 11, 12, 13 and 14). For other soils, limitations were severe to very severe. Wetness and salinity are soil variables that could be taken into consideration when major soil improvements are done . The intensity of the potential rating of these two characteristics could be modified into slight or moderately severe (Table 14).

The Ci parameter index is calculated , and the suitability classes are accordingly distinguished. Based on the kind of limitation , the classes are subdivided into subclasses . If necessary , the suitability units within subclasses could be differeniated. Suitability categories are presented in the from of "current land suitability" (Fig 35) , with explanatory legend in a summary form , Table 15 . The delineation of the suitability units are based on the soil mapping units .

Mapping units and their symbols are presented as follows:

- **S2 ws land unit**

This unit has limitations which are moderately severe . Soils of this category are in the old reclaimed clayey soils , of the VT physiographic unit that are represented by profile 11 . The current Ci value in this unit is 61.2 and is affected mainly by limitations of moderate intensity concerning wetness and texture .

Table 13 Intensity of limitation, and suitability classes of El-Hasainiya plain soils (according to Sys and Varheye 1978)

Soil mapping unit	Profile No.	Curr (t)	Wetness. (w)		Physical conditions (s)				Salinity and sodicity (n)		Capability index (Ci)		Suitability class	
			Cur.	Pot.	(s_1)	(s_2)	(s_3)	S_4)	Cur	Pot	Cur	Pot	Cur	Pot
VA1	3	100	70	80	65	100	95	90	65	85	25.3	37.8	S3	S3
	5	100	35	80	65	100	95	90	40	85	7.9	37.8	N1	S3
	6	100	50	80	65	100	95	90	50	85	13.9	37.8	N1	S3
	7	100	50	80	75	100	95	90	40	85	12.8	43.6	N1	S3
Average		100	51.3	80	67.5	100	95	90	48.8	85	14.4	39.2	N1	S3
VA2	1	100	35	80	85	100	100	90	40	90	10.7	55.1	N1	S2
	2	100	40	80	85	100	95	100	50	90	16.2	58.1	N1	S2
	4	100	55	80	80	100	95	90	75	90	28.2	49.2	S3	S3
	18	100	50	80	85	100	95	100	50	90	20.2	58.1	N1	S2
Average		100	45	80	83.8	100	96.3	95	53.8	90	18.6	55.2	N1	S2
VT	11	100	80	85	85	100	100	100	90	90	61.2	65	S2	S2
AV	10	100	55	85	87	100	95	90	50	90	20.5	56.9	N1	S2
	13	100	70	85	87	100	95	90	75	90	39.1	56.9	S3	S2
	14	100	70	85	87	100	95	100	60	90	34.7	63.2	S3	S2
	15	100	55	85	87	100	95	90	65	90	26.6	56.9	S3	.S2
	16	100	55	85	87	100	95	90	40	90	16.4	56.9	N1	S2
Average		100	61	85	87	100	95	92	58	90	26.9	58.2	S3	S2
AT	8	100	80	90	87	100	95	90	50	92	29.8	61.6	S3	S2
	9	100	60	90	100	100	95	100	75	92	42.7	78.7	S3	S1
	12	100	80	90	100	100	95	90	80	92	54.7	70.8	S2	S2
	17	100	50	90	87	100	100	90	70	92	27.4	64.8	S3	S2
Average		100	67.5	90	93.5	100	96.3	92.5	68.7	92	38.6	68.9	S3	S2

T= Topographic limitations S_1: texture classes s_2 : Soil depth Curr : Current S1 :Highly suitable Pot : potinial

w= Wetness s_4: Gypsum status s_3:Calciam carbonate stat S3:Marginally suitable N1:Currently not suitable

Table (14) : Comparison between current and potential suitability units of the El-Hasainiya plain soils

Soil mapping units	Current suitability				Potential suitability		
	Effective factors	Ci	Suit unit	Major soil improvements	Effective factors	Ci	Suit unit
VT	w :moderate s: moderate n:slight	61.2	S2ws	drainage condi- tion, gypsum treatment.	w: slight s:moderate n:slight	65.0	S2s-1
AT	w :moderate s: moderate n:moderate	38.6	S3wsn-1	drainage condi- tion,salt leaching and gypsum treatment	w: slight s:moderate n:slight		S2s-1
AV	w:moderate s: moderate n:moderate	26.9	S3wsn-2	drainage condi- tions, salt leaching and gypsum treatment	w:slight s:moderate n:slight	58.2	S2s-2
VA2	w:severe s: moderate n:severe	18.6	N1wsn-1	drainage condi- tions, salt, leaching and gypsum treatment.	w:moderate s:moderate n:slight	55.2	S2-ws
VA1	w:severe s:severe n:severe	14.4	N1wsn-2	drainage condi- ions, salt leaching and gypsum treatment	w:moderate s:moderate n:moderate to slight	39.2	S3ws

- ***S3 wsn-1 land unit** :

This unit , in its present condition , has more severe limitations than S2 unit. Soils of the S3 cetegery belong to the AT unit which are stratified loamy and clayey soils represented by profiles 8,9,12 and 17. The Ci value ranged from 27.4 to 54.7 with an average of 38.6 , and the highest value concerns the relatively old reclaimed soils of profile 12. The intensity of limitations in this unit is mainly moderate for wetness and salinity .For texture , gypsum and calcium carbonate, , ,limitations are , in general of slight intensity.

- **S3 wsn –2 land unit:**

This unit has the same kinds of limitations as in S3 wsn-1 unit , but differ in severity . It is represented by the AV soils of profiles 10,13,14,15 and 16 . The Ci value of this unit range from 16.4 to 39.1 with an average of 26.9 . The degree of limitation is more severe than S3wsn-1 unit .It has a moderate intensity for wetness , physical conditions and salinity .

- **N1 wsn-1 land unit:**

This unit has limitations which, in general, are very severe and are not suitable in its present condition . It is represented by the low lying clayey soils of the VA2 mapping unit which includes profiles 1,2,4 and 18 . The Ci value ranges from 10.7 to 28.2 with an average of 18.6. It has limitations of severe intensity for wetness and salinity and a limitation of moderate intensity for physical conditions

Table 15 Legend of current land suitability map

Land suitability				Intensity of limitation
Order	**Class**	**Subclass**	**Unit**	
S Suitable	S2 Moderately suitable	S2ws	-	moderate for both wetness and soil texture, slight for salinity
	S3 Marginal suitable	S3wsn	S3wsn1	moderate for wetness, salinity and physical soil conditions
			S3wsn2	as above , with more severely degrees
N Not suitable	N1	N1wsn	N1wsn-1	severe for wetness and salinity, moderate for physical conditions
	not suitable		N1wsn-2	sever for wetness , salinity and physical conditions

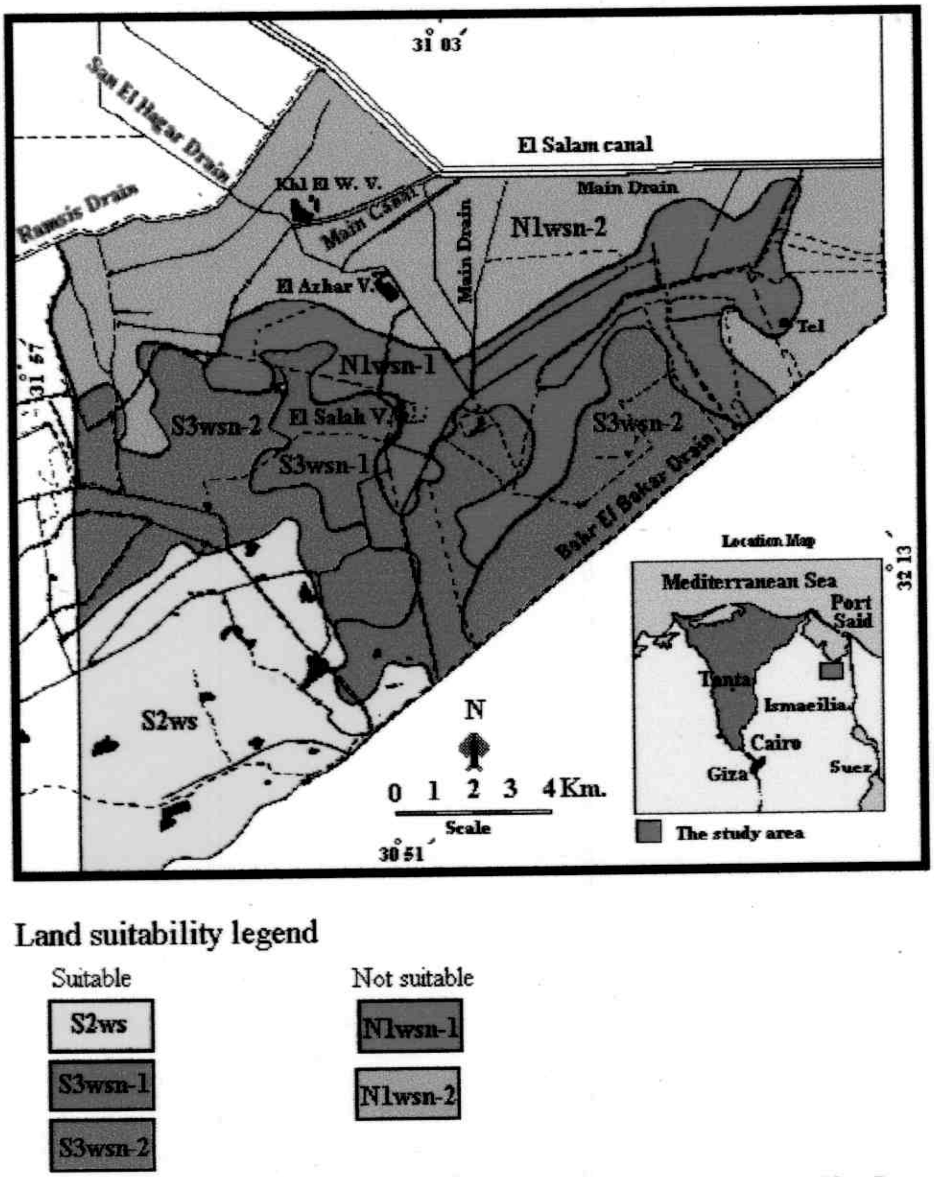


Fig. 35 Current land suitability map of the studied area.

This map was compiled by : *Fahmy Salem* (2002) ,based on the approach of Sys and Verheye (1978) for land suitability , considering the framework of FAO (1976)	Supervised by: Prof. Dr. *Ali A. Abdel Salam* Prof. Dr. *Hasan H. Abbas* Prof. Dr.Ibrahim F. Rashad

- ***N1wsn-2 land unit :**

This unit is almost the same as the N1wsn-1 unit , but has more severe limitations . It is represented by low lying clayey soils of the AV1 mapping unit which includes by profiles 3,5,6 and 7. The Ci value ranges from 7.9 to 25.3 with an average of 14.4 .The relatively high value concerns the old reclaimed soils of profile 3. The intensity of limitations of this unit are mainly severe for each of wetness , physical conditions and salinity.

Rating conclusion :

Such lands of soils of the current study could attain better , suitability classes if management and conservation practices are applied in a proper manner . The comparative approach relates a specific soil with the best soils known in the region, or with a hypotheticaly ideal soil. The comparison is made by judging the limitations of the evaluated soil with the real , (or hypothetical standard) ideal soil . In this respect , the old reclaimed soils of the VT mapping unit were used as an approximate guide in identifying the potential suitability units. The relation between current and potential suitability (after major improvements of the most effective soil factors) is summarized in Table 14 .

4.2.2. Quality of Irrigation water of the Salam canal.

According to Ayres and Westcot (1985) water quality is one of the variables affecting agronomic conditions in the list of class –determining factors (See Appendix 2) . Water qulity is used to assess the suitability class of land units . The suitability of water depends on (1) how it is managed , (2) The nature of the soil , and (3) crop tolerance to water salinity. A number of classifications systems including those of Eaton ,(1950), Wilcox (1955) , and the U.S. salinity laboratory of (USDA 1954). Ayers and Westcot (1976) and Ayers and Westcot (1985) were proposed. the latter two systems (which are basically one system) which have been adopted by the FAO. Evaluation of El-Salam water in the current study is based on the 1985 version (Aryes and Westcot 1985). In this system . there are four general aspects of evaluation i.e. (1) salinity (2) permeability (3) toxicity , and (4) miscellaneous . Each may affect crops singly or in combination. Classification of water quality is in three classes (i.e. a tri-class system).They are as follows : (starting from the most appropriate to the least)

Class 1 : named "non- restriction"i.e to be used with no restriction on the use of water of such category . In the 1976 – system (Ares and Westcot) the naming of this category is "no-problem (s) water" ; which indicates a use of such water with no problem.

Class 2 : named "slight to moderate restrictions" i.e if used , there must be some restictions to take , and such restrictions are of slight to moderate degree . In the (1976-system) the naming of this categroy is " increasing – problem (s)" waters ; which indicates that the use of such water involves problems of increasing magnitude.

*Class 3 : named " Severe restrictions" . i.e. if used , there must be severe restrictions on their use . In the (1976-system) the naming of this catogry is "severe –problem (s))water ; which indicates that the use of such water involves severe problems.

Table 16 show analysis of El –Salam water which is used for irrigation.

- **Salinity :**

Salinity problems arise when total soluble salts in the irrigation water are high enough to adverselly effect on plant roots and reduce yield. Excessive soluble salts in the root zone inhibit water uptake by plants. Salinity of water is expressed in terms of electrical conductivity (EC) of the water. Values of EC of water of El-salam cannal ranged from 1.2 to 1.8 dS/m . Accordingly water is of class 2 rating , regarding salinity hezards i.e. water of slight to moderate restrictions

Permeability:

The permeability problem relating water occurs when the rate of water infilteration into and througth the soil is reduced to such an extent that the crop is not adequately supplied with water and yield is reduced . Both salinity and sodicity affects infiltration. High sodicity and low salinity decrease infiltration since the SAR is below 6 and the EC is above 1.2 dS/m , thus water is of class 1- "no-restrictions" regarding permeability problems

- **Specific ion toxicity:**

In arid and semi –arid areas , the toxicity problem is usually related to one or more specific ions in the water , namely , boron , chloride , and sodium . The data of Table (16) , show that boron content is low and non-toxic for boron - sensitive crops, Contents of sodium and chloride ions indicate values ranged from values of 5.1 to 10.9 mmolc/L for Na and from 6.2 to 11.7 mmolc /L for Cl.. According to the FAO Guideline (Arys and westcot 1985), values of 9 mmole /L Na and > 10 Cl for water of Na or Cl values exceeding 3 is of slight to severe restictions. Concerning problems of specific ion taxicicty where sprinkler irrigation is used , some ions such as Na and Cl are considered With overhead irrigation and low humidity , sodium and chloride absorbed through the leaves of sensitive crops can cause damage .

- **Miscellaneous:**

Some other problems may occur , e.g. white deposits on fruit due to high bicarbonate in sprinkler applied water , and suspected abnormalities due to unusual pH. Since HCO_3^- values of El –Salam water are between 1.5 and 8.5 , this indicates slight to moderate restrictions . Regarding pH which is with the 7.62 to 8.37 range the water is withen the normal range (which is between 6.5 to 8.4 according to the FAO Guidelines.

4.2.3. Land assessment for specific use

The land assessment for irrigation shown in Tables 13 and 14 and Figure 36 characterizes and appraises land

Table (16) : Chemical analysis of El-Salam canal irrigation water

Month	p H	EC dS/m	TDS mg/L	Cations (mmolc/L)				Anions (mmolc/L)				SAR	RSC	Boron mg/L
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$			
May 2000	7.66	1.55	1005	4.36	3.66	7.30	0.38	0.00	3.40	8.20	4.10	3.65	0.00	0.11
July. 2000	7.62	1.50	960	2.64	4.06	7.71	0.32	0.00	3.28	9.10	2.35	4.21	0.00	0.11
Sep. 2000	7.80	1.68	1075	1.46	5.60	10.20	0.29	0.08	3.30	10.80	2.65	5.43	0.00	0.09
Nov. 2000	7.81	1.20	768	1.98	4.20	5.10	0.21	0.00	3.50	6.20	1.79	2.90	0.00	0.11
Jan. 2001	8.11	1.76	1126	2.10	5.37	10.90	0.31	0.00	3.20	10.60	4.88	5.65	0.00	0.10
May. 2001	8.37	1.72	1101	3.70	4.70	9.30	0.31	0.00	3.10	11.71	3.20	4.54	0.00	0.11

TDS : Total dissolved solids(calculated on the basis of (ds/m=640

SAR : Sodium adsorption ratio

RSC : Residual Sodium Carbonate

EC: Electrical Conductivity in deciseimens/m *development units for a general point of view without mentioning the specific kind of use . The obtained results may be very useful but , as one soil may be suitable for a specific crop but unsuitable for another , therefore precision of land utilization type is necessary.

Land utilization type (LUT) is a specific subdivision of a major kind of land use . It should not only define the crop or crop rotation, but it has to state how to farm these crops (management) . Thus the concept "LUT" implies the kind of crop , the succession of crops with precision of the management type.

LUT in the soils of the current study in the light of available date and field work could be assissed as follows:

1-**Produce:**

Field crops : rice , maize (grains and forage) , wheat , cotton
sorghum (forage) , barley , clover (forage) , suger beet , sunflower.

Vegetables and friuts : tomatoes , watermelon , green pepper , cabbage , ctrus , guava.

2-Management :

Irrigation method : Surface irrigation (basin and furrow).

Farm size : Small holding (often less than 5 feddans < 2.1 ha).

Capital intensity : High capital inputs (large government funds are required)

Labour intensity : High , including uncosted family labour .

Farm -power : Light to fully mechanized , and /or animal traction with improved implements

Market orientation : Subsistance production plus commercial sale of surplus.

Requirements regarding climate , landscape and soil conditions for a wide range of crops were suggested by Sys et al. (1993) .where crop requirements are put in separate tables with four limitation levels and corresponding land classes as well as rating. For certain crops the tables are elaborated on basis of available literature; for other crops they are adapted to specific site conditions using regional experience.

The landscape and soil conditions used in these tables are , topography (t) , wetness (w) , physical soil characteristics (s) , soil fertility (f) and salinity (n) . These paramaters are used to calculate the suitability index (Si) for cultivating a certain crop, by the following . equation :

$$Si = t \times w/100 \times s/100 \times f/100 \times n/100.$$

Appendix (2) shows rating values , suitability indecis and classes of the studied soils for twenty crops. Means for each soil mapping unit are given in (Table 17) . The studied crops are : rice (*oryza sativa)*, wheat (*Triticum aestivum)* ,maize (*Zea mays)*, cotton (*Gossypium hirsutum)*, barley (*Hordeum vulgare)*, sunflower (*Helianthus annuus)*, Egyption clover, (*Trifolium alexandri)* sorghum (*Sorghum bicolor)*, faba bean (*Vicia Faba*, alfalfa (*Medicage sativa)*, soyabean ,(*Glycine maximum)* millets , (*Pennisetum indica)* tomato (*Solanum lycopersicum)* , cabbage

*(*Brassica oleracea)* green pepper (*Capsicum annuum)* , watermelon (*Colocynthis citcullus)* , onion (*Allium cepa)*, beans (*Phaseolus Vulgaris)*, carrots (*Daucus)carotat*, citrus (*Citrus Spp)* , olives (*Olea europucae)* and guava (*Paidium guija va)*. Because faba bean , sugar beet and clover are absent from the list of (Sys et al 1993) , their requirements were assessed theoretically by comparison with other crops , especially for their salts and sodicity tolerances reported in (FAO 1985).

From the mean data in (Table 17) the climatic requirements for all crops are considered highly suitable except for sorghum and millets where they are moderately suitable . The potential suitability of the studied soils for crops is variable and could generally be arranged , as follows :

Grain crops :barley (S1) followed by rice ,wheat , and maize (S2)

Cash Crops: cotton and sugar beet (S2) followed by sunflower and soyabean (S3)

Forage crops : sorghum (S2) followed by alfalfa , maize , clover and millets (S2) .

Vegetables crops : cabbage (S2) followed by tomato , green pepper and watermelon (S3) followed by onion (S3) followed by carrots and beans (N1)

Friut crops : olives (S2) followed by guava and citrus (S3/N1)..

In addition , the potential suitability indices of the studied crops were arranged in descending order within each soil mapping unit. Then , the optimum , marginal and unsuitable land

Table 17 Mean values of soil suitability indeces (Si) and suitability classes for the studied crops Sys et al . 1993

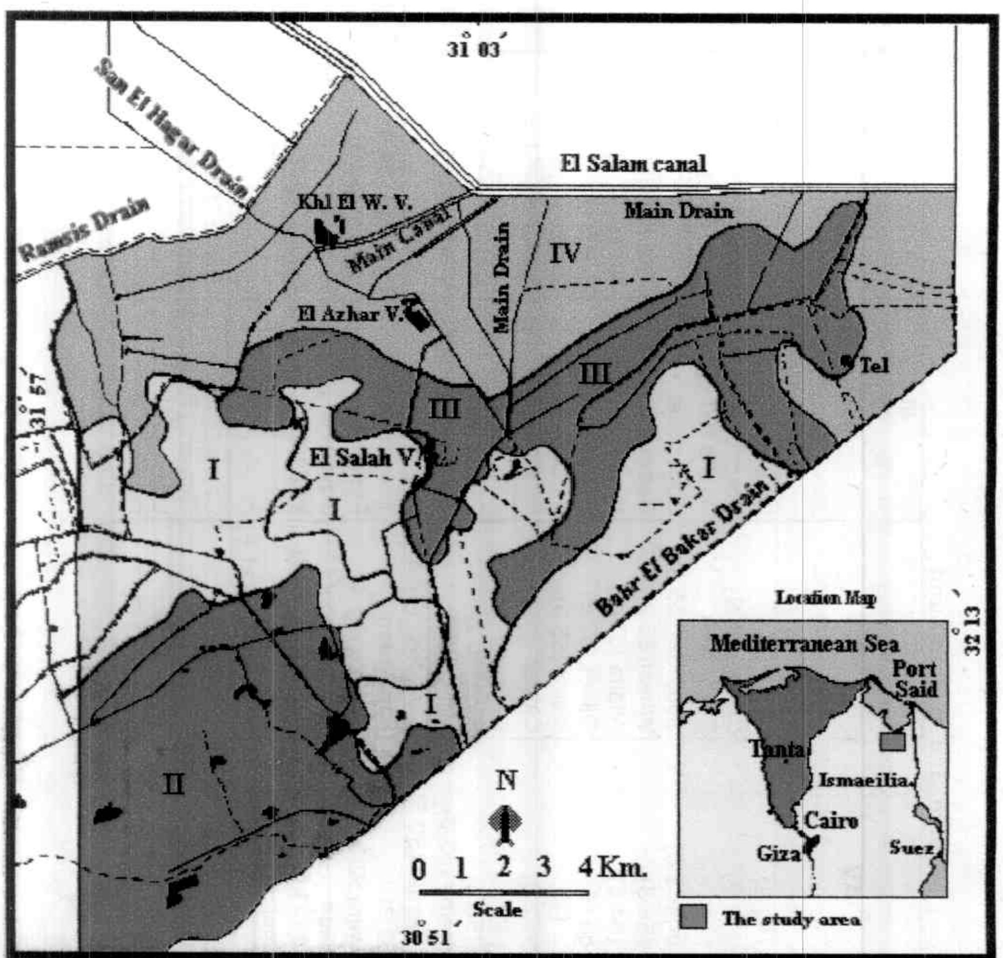
Produce	climatic requir.	Soil mapping units									
		VA1		VA2		VT		AV		AV	
		Curr. suit	Pot. suit	Curr. suit	Pot. suit	Curr. suit	Pot. suit	Curr. suit	Pot. suit	Curr. suit	Pot. suit
Grain crops											
Rice	S1	N1	S1	N1	S2	S2	S2	N1	S2	N1	S2
		13	52.7	17	50	50.2	50.2	19.6	52.3	18.6	50.9
Wheat	S1	N1	S3	N1	S3	S2	S2	S3	S2	N1	S2
		10.3	37.7	11.3	47.5	65.2	65.2	26.3	62.8	23.3	63.1
Maize	S1	N1	S3	N1	S2	S2	S2	S3	S2	N1	S2
		2.3	47.8	4.5	51.1	52.8	55.9	25.1	61	14.3	62.5
Barley	S1	N1	S2	N1	S2	S2	S2	S3	S1	S2	S1
		18.7	71.7	21.4	71.6	68.8	73.9	42.7	82.3	50.3	82.3
Faba bean *	S1	N1	S3	N1	S3	S3		N1	S2	N1	S2
Cash crops											
Cotton	S1	N1	S3	N1	S2	S2	S2	S3	S2	S3	S2
		8.1	41.6	12.6	52.6	65.9	65.9	32.6	71.2	38.3	74.8
Sunflower	S1	N1	S3	N1	S3	S3	S3	N1	S2	N1	S2
		4.6	41.2	7.1	46.6	47.3	47.3	16.8	52.3	18.5	51.5
Soyabean	S1	N1	S3	N1	S3	N1	S3	N1	S2	N1	S2
		1.5	41.2	2.4	37.7	18.2	40.9	13.4	51.3	12.5	54
Sugar beet*	S1	N1	S3	N1	S2	S2	S2	S3	S2	S3	S2
Forage crops :											
Clover*	S1	N1	S3	N1	S2	S2	S2	S3	S2	N1	S2
Sorghum	S2	N1	S2	N1	S2	S2	S2	S3	S2	S3	S2
		12.6	61.5	18.1	61.5	65.8	65.8	32.6	69.6	35.2	69.6
Alfaalfa	S1	N1	S3	N1	S2	S2	S2	S3	S2	N1	S2
		5	35.9	8.6	53.6	53.4	63	26.9	64.5	24.4	68.1
Maize	S1	N1	S3	N1	S2	S2	S2	S3	S2	N1	S2

Table 14 Cont.

Produce	climatic requir.	Soil mapping units									
		VA1		VA2		VT		AV		AV	
		Curr. suit	Pot. suit	Curr. suit	Pot. suit	Curr. suit	Pot. suit	Curr. suit	Pot. suit	Curr. suit	Pot. suit
		2.3	47.8	4.5	51.1	52.8	55.9	25.1	61	14.3	62.5
Millets	S2	N1	S3	N1	S3	S2	S2	N1	S2	N1	S2
		8	43.9	9.7	46.3	50	50	22.3	58.3	18.6	59.4
Vegetable crops :											
Tomato	S1	N1	S3	N1	S3	S3	S3	N1	S2	N1	S2
		2.3	33.3	5.7	44	30.7	45.4	17.8	51.6	18	52.8
Cabbage	S1	N1	S3	N1	S2	S2	S2	N1	S2	N1	S2
		1.7	34.9	3	50.9	50	55.9	17.1	61	18.5	63.4
Green pepper	S1	N1	N1	N1	S3	S3	S3	N1	S2	N1	S2
		1.4	23.3	2.8	32.9	28.9	44.9	13.6	52.5	12.8	57.9
Watermelon	S1	N1	S3	N1	S3	S3	S3	N1	S2	N1	S2
		1.1	30.7	2.2	34.7	25	31.6	21	53	12.1	54.4
Onion	S1	N1	N1	N1	S3	S3	S3	N1	S3	N1	S3
		3.6	21.1	6.4	26.4	26.6	29.9	13.9	34.2	9.9	33.4
Beans	S1	N1	N1	N1	N1	N1	N1	N1	N1	N1	N1
		1.4	6.3	1.8	5.9	6.9	12.6	4.2	14.2	3.6	14.3
Carrots	S1	N1	N1	N1	N1	N1	N1	N1	S3	N1	S3
		1.1	8.5	3.3	19.5	14.7	18.6	9	29.2	8.1	29.6
Fruit crops											
Citrus	S1	N1	N1	N1	N1	N1	S3	N1	S3	N1	S3
		0.5	7.5	1.2	16	12.5	12.5	3.2	31.6	3.6	36.3
Olives	S1	N1	S3	N1	S3	S3	S2	S3	S2	S3	S2
		10.7	47.4	12.9	47.4	41.9	62.8	25.4	66.3	32.1	67.5
Guava	S1	N1	N1	N1	N1	N1	S3	N1	S3	N1	S3
		2.1	16.1	2.2	17.6	16.4	32.3	9.5	35.9	9	35.3

Table 18 : Optimum , marginal and not suitable crops order in land mapping unit

Land unit	I		II	III	V
Soil mapping unit	AT	AV	VT	VA2	VA1
Optimum	Barley (82.3)	Barley (82.3)	Barly (73.9)	Baley (71.6)	Barley (71.7)
	Cotton (74.8)	Cotton (71.2)	Cotton (65.9)	Sorghum (61.5)	Sorghum (61.5)
	Suger beet	Suger beet	Suger beet	Alfalfa (53.6)	Rice (52.7)
	Sorghum (69.6)	Sorghum (69.6)	Sorghum (65.8)	Suger beet	Suger beet
	Alfalfa (68 1)	Olives (66.3)	Wheat(65.2)	Cotton (52.6)	Maiz (47.8)
	Olives (67.5)	Alfalfa (64.5)	Alfalfa (63)	Maize (51.1)	Olives (47.4)
	Cabbage (63.4)	Cabbage (61	Olives (62.8)	Cbbage (50.9)	Millets (43.9)
	Clover	Clover	Maize (55.9)	Vclover	Cotton (41.6)
	Wheat (63.1)	Wheat (62.8)	Clover	Rice (50.0)	Sunflower (41.2)
	Maize (62.5)	Maize (61)	Cabbage (55.9)	Wheat (47.5)	Soyabean (41.2)
	Millets (59.4)	Millets (58.3)	Rice (50.2)	Olives (47.4)	Wheat (37.7)
	Gren pepper (57.9)	Watermelon (53.0)	Millets (50)	Sunflower (46.6)	Alfalfa (35.9)
	Watermelon (54.4)	Green pepper (52.5)	Sunflower (47.3)	Millets (46.3)	Clover
	Soyabean (54.0)	Rice (52.3)	Faba bean	Tomato (44.0)	Cabbage (34.9)
	Faba bean	Sunflower (52.3)	Tomato (45.4)	Faba bean	Tomato (33.3)
	Tomato (52.8)	Faba bean	Green pepper (44.	Soyabean (37.7)	Faba bean
	Sunflower (51.5)	Tomato (51.6)	Soyabean (40.9)	Watermelon (34.7)	Watermelon (30.7)
	Rice (50.9)	Soya been (51.3)	Guava (32.3)	Green pepper (32.	Green pepper (23.3)
Marginal	Citrus (36.3)	Guava (35.9)	Watermelon (31.6)	Onion (26.4)	Onion (21.1)
	Guava (35.3)	Onion (34.2)	Onion (29.9)	Carrots (19.5)	Guava (16.1)
	Onion (33.4)	Citrus (31.6)	Citrus (26.5)	Guava (17.6)	Carrots (8.5)
	Carrots (29.6)	Carrots (29.2)	Carrots (18.6	Citrus (16)	Citrus (7.5)
Not suitable	Bean (14.3)	Bean (14.2)	Beans (12.6)	Beans (5.9	Beans(6.3)



Map legend

I	*Suitable for olives , all field crops and some vegetables.*
II	*Suitable for olives , cabbage and most of the field crops.*
III	*Suitable for cabbage and some field crops*
IV	*Suitable only for the barley , sorghum and rice.*

Fig. 36 Land unit map for the optimum utilization in the studied area.

*use could be identified as given in Table 18 . The optimum land use includes crops that have (Si) of 50 or more , while the marginal cetagory lies between 50 and 25 . Accordinglly , four land classification units were recognized and named as I,II,III and IV. The distribution of the optimum land use in these units are shown in Fig (36) and its optimum crops orders are illustrated in Table (18).

From the obtained results , it can be concluded that the present cropping system (produce) in the area seems to be remain unchanged. The kind and level of management (farming system) is the possible change in the present use . This could be due to the nature of the soils of the area . It is characterized by low lying fine textured soils and its related problems , such as drainage conditions , physical properties and salinity. The size of the forms is the important factor in the farming system , it will further interact with capital intensity , farm power , farm labour and technical know –how of the farmer . Therefore , the farm size could be changes from small holding to medium or large farms with fully mechanized and commercial production.