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LAND CAPABILITY AND SUITABILITY OF SOME SOILS IN TOSHKA AREA, SOUTHWESTERN EGYPT

BY

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ABSTRACT

The present work aimed at assessing land capability and suitability of some soils at Toshka area, southwestern Egypt. The studied area covers an area of about 60,000 feddans and extends between latitudes 22°54′57″ to 23°07′19″ North and longitudes 31°19′18″ to 31°30′21″ East. Eighteen soil profiles were dug to represent the studied area. The soils are of highly suitable class (S1) and moderately suitable class (S2) in their current and potential conditions. They were evaluated to determine their current and potential suitability for growing 15 crops (maize, wheat, barley, sesame, groundnuts, alfalfa, cowpea, carrots, cabbage, onion, tomato, watermelons, olives, guava and mango). The soils are not suitable in their current conditions (N1) for most of these crops, although some soils may be suitable (S1, S2 and S3) for maize, wheat, barley, sesame, groundnuts, alfalfa, cowpea, carrots, cabbage, watermelons, tomato and olives and permanently not suitable (N2) for carrots, onion, tomato and mango. By applying some improvements on the studied soils, they would be suitable for all the selected crops except for carrots, onion, tomato and mango.

INTRODUCTION

No doubt that the high density of population and the decreasing of the fertile and in the Nile Valley and Delta made the expansion of arable land a necessity not an option. Therefore, the government accelerated such expansion into the vast wide desert that comprises about 96% of the total area of Egypt. Toshka depression is one of those areas in the Western Desert that could be used for the agricultural expansion and development.

Toshka area consists of several inter-connected depressions located west of Lake Nasser, about 250 km south of Aswan between latitude 22° 30'and 23° 30'North, and longitude 30° 30'and 32°00' East. El-Sheikh Zayed Canal was constructed to convey Nile water to Toshka depression for reclamation and cultivation of about 5400.000 feddans. The canal branches into four sub-branches that extend through Toshka depression to carry Nile water for irrigation and different activities.

The exposed rock in Toshka area range in age from Precambrian to Quaternary (El-Ramly, 1972). However, the depressions are mostly underlied by Paleocene sedimentary formations (Esna Shale) and are partially surrounded by Lower Eocene pediments and scarps of different elevations (El-Shazly and Abd El-Hady, 1977), The Nubian sandstone (composed of sandstone and mudstone) extensively dominates the surface geology of Toshka area, and represents the main ground water aquifer in the area, and attains variable thickness (from few meters up to 300 m). Isasawi (1986) showed that the Nubian sandstone distributes widely throughout Toshka Basin. It usually forms a succession of sandstone beds of different colors including white, yellow, dark brown and black, passing through various gradations. In the lower beds, interbeds light cream to yellowish white clays, siltstones and shale are common.

The surface of Toshka depression is nearly flat in its eastern side and becomes interrupted with sand dunes and low hills in its western part (El-Shazly and Abd El-Hady, 1977). The depression is bordered at the north by Sum El-Kaddab Eocene limestone plateau and at the south by the Nubian pediplain. The border of the depression conforms nearly to contour line 200 m a.s.l. Sinn El-Kaddab plateau rises several hundred meters above sea level (+400m). Several small structural scarps encircle the plateau and forming a conspicuous feature. They are parallel to the dominant east-west faulting system. Several rock cut pediments surround the depression, to form wide flat terraces stretching form Sinn El-Kaddab scarp for several kilometers and gently slope towards the depression. The Nubian pediplain is an extensive erosional surface s with a very gentle slope towards the north. Individual conical and flat topped hills are commonly scattered over this pediplain. A pronounced extensive belt of barchan-type sand dunes crosses the western part of the depression in a north south direction.

This investigation is to asses land capability and suitability (current and potential) for growing certain crops on some soils lying on branch-2 of El-Sheikh Zayed canal (about 60.000 feddans) between latitudes 22°54′57″ to 23°07′19″ North and longitudes 31°19′18″ to 31°30′2l″ East (Fig., 1).

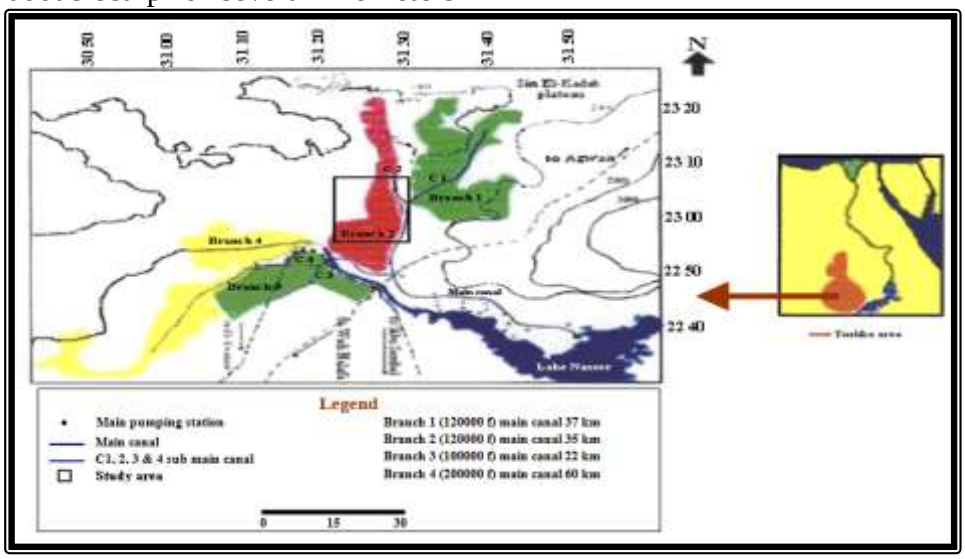

Fig. (1): Location map of the studied area

MATERIALS AND METHODS

Eighteen soil profiles representing two geomorphological units covering the area of study were dug. The first unit, i.e. the alluvial deposits was represented by ten soil profiles, while the second one, i.e. the pediplain was represented by eight soil profiles. The boundaries between horizons in the studied profiles are based mainly on the variations in some aspects such as color, texture, mottling, structure, consistency, content of gravel, carbonates and gypsum. The standard Guide-lines of FAO (1990) were used for assessing these boundaries. Soil profiles were described, using the nomenclature of the Soil Survey Manual (USDA, 1993) and soil color was described according to Munsell Color Charts (1971).

Fifty one soil samples were collected from the soil profiles, air dried, crushed and passed through a 2 mm sieve. Physical and chemical properties of the investigated soil were performed according to the standard methods outlined by Page et al. (1982) and Klute (1986).

The soils were evaluated using land capability classification according to Sys and Verheye (1978) and Sys etal. (1991) using to the following equation:

$$Ci = t \times \frac{w}{100} \times \frac{s_1}{100} \times \frac{s_2}{100} \times \frac{s_3}{100} \times \frac{s_4}{100} \times \frac{n}{100}$$

Where:

Ci = Capability index t = Slope
w = Drainage s_1 = Texture
s_2 = Soil depth s_3 = $CaCO_3$ content
s_4 = Gypsum content
n = Salinity and alkalinity (sodicity)

Suitability classes are arbitrary defined according to the value of the index as follows

Suitability class	Symbol	Capability index (Ci)
Highly suitable	**SI**	>75
Moderately suitable	**S2**	75-50
Marginally suitable	**S3**	50-25
Currently not suitable	**Nl**	<25
Permanently not suitable	**N2**	<25

Soil suitability classification for certain crops was done based on the concepts outlined by Sys et al. (1993) through matching soil characteristics together with crops requirements. Fifteen crops were selected to asses their suitability in the studied are. The selected crops are grouped into three categories as follows:

- Field crops: maize, wheat, barley, sesame, groundnut, alfalfa and cowpea.
- Vegetable crops: carrots, onion, tomato, cabbage and watermelons.
- Fruit crops: olives, guava and mango.

RESULTS AND DISCUSSION

Physical and chemical properties of the investigated soils

Data in Table (1) show that soil texture ranged between loamy sand to sandy clay in the alluvial deposits unit, while in the pediplain unit soil texture varied between sandy loam and clay.

Data in Table (2) show that soil pH varied from neutral to strongly alkaline since soil pH ranged from 7.02 to 8.65 in the alluvial deposits units, but differed from 6.95 to 8.70 in the pediplain unit.

Soil salinity varied from none saline to strongly saline as EC values of saturated soil paste extract ranged from 2.69 to 42.90 dSm^{-1} in alluvial deposits unit and from 2.37 to 48.50 dSm^{-1} in the pediplain unit.

Soluble cations followed the order $Na^+ > Ca^{++} > Mg^{++} > K^+$ in both studied units. On the other hand, soluble anions were dominated by Cl^- followed by $SO_4^=$ then HCO_3^-

Calcium carbonate content varied from 2.6 to 142.0 gkg^{-1} in the alluvial deposits unit, while in the pediplain unit it ranged from 2.7 to 179.0 gkg^{-1}

Gypsum content differed from 3.0 to 81.0 gkg^{-1} in the alluvial deposits unit and from 6.0 to 112.8 gkg^{-1} in the pediplain unit.

Organic matter content was very low and did not exceed 10 gkg^{-1} due to the arid climate prevailing in the region and absence of vegetation. In the alluvial deposits unit, the value of organic matter content ranged from 0.4 to 9.7 gkg^{-1}, while in the pediplain unit values differed from 0.8 to 9.6 gkg^{-1}.

Data in Table (3) illustrate that values of CEC differed from 7.02 to 31.24 $cmolckg^{-1}$ in the alluvial deposits unit and from 12.70 to 60.38 $cmolckg^{-1}$ in the pedipiain unit. Exchangeable cations were dominated by Ca^{++} followed by Mg^{++} then Na^+ and K^+ in the alluvial deposits unit, but in the pediplain unit, exchangeable cations followed the order $Ca^{++} > Na^+ > Mg^{++} > K^+$.

Table (1): Particle size distribution and textural classes of the studied soils of Toshka area.

Profile No.	Depth (cm)	Sand (%)		Silt (%)	Clay (%)	Textural class (according to USDA, 1993)
		Coarse	Fine			
The alluvial deposits unit						
1	0-25	25.10	42.49	5.00	27.11	**Sandy clay loam**
	25-50	35.50	30.85	2.50	31.15	**Sandy clay loam**
	50-75	19.00	37.35	2.15	41.10	**Sandy clay**
2	0 - 25	36.60	40.90	1.50	21.00	**Sandy clay loam**
	25-55	42.00	46.15	4.00	7.85	**Loamy Sand**
	55-75	51.00	22.40	1.10	25.50	**Sandy clay loam**
3	0 -25	45.6	28.90	2.50	23.00	**Sandy clay loam**
	25-55	29.80	45.60	1.10	23.50	**Sandy clay loam**
	55-80	10.00	65.60	1.40	23.00	**Sandy clay loam**
4	0 -25	69.00	18.50	1.50	11.00	**Loamy sand**
	25-70	43.20	31.20	3.10	22.50	**Sandy clay loam**
	70-100	40.80	25.90	3.30	30.00	**Sandy clay loam**
5	0-20	41.50	37.70	0.80	20.00	**Sandy clay loam**
	20-50	66.70	18.80	1.50	13.00	**Loamy sand**
	50-80	47.70	30.47	1.13	20.70	**Sandy clay loam**
6	0-25	54.50	30.40	1.50	13.60	**Loamy sand**
	25-55	26.90	33.00	4.10	36.00	**Sandy clay**
	55-80	22.50	24.50	11.50	41.50	**Sandy clay**
7	0-20	66.70	19.80	1.50	12.00	**Loamy sand**
	20-55	38.00	18.50	2.50	41.00	**Sandy clay**
	55-80	16.80	32.80	9.80	40.60	**Sandy clay**
8	0-25	26.00	36.50	4.00	33.50	**Sandy clay loam**
	25-60	25.50	31.42	10.50	32.58	**Sandy clay loam**
	60-80	23.90	28.85	10.10	37.15	**Sandy clay**
9	0-30	31.00	35.30	1.70	32.00	**Sandy clay loam**
	30-100	8.00	74.05	1.80	16.15	**Sandy loam**
10	0-10	32.30	30.60	5.50	31.60	**Sandy clay loam**
	10-50	24.10	32.10	11.50	32.30	**Sandy clay loam**
	50-80	21.60	35.00	11.00	32.40	**Sandy clay loam**
The pediplain unit						
11	0-40	48.00	21.20	3.30	27.50	**Sandy clay loam**
	40-100	35.30	26.40	7.30	31.00	**Sandy clay loam**
	100120	6.80	2.10	8.50	82.60	**Clay**
12	0-45	33.10	33.10	2.80	31.00	**Sandy clay loam**
	45-90	28.01	34.69	10.50	26.80	**Sandy clay loam**
	90-115	16.00	38.60	6.50	38.90	**Sandy clay**
13	0-20	22.50	52.75	3.75	21.00	**Sandy clay loam**
	20-70	10.00	66.20	4.00	19.80	**Sandy loam**
	70-110	5.50	53.00	4.50	37.00	**Sandy clay**
14	0-20	24.50	43.20	3.70	28.60	**Sandy clay loam**
	20-50	11.50	44.60	8.30	35.60	**Sandy clay**
	50-80	11.40	40.45	11.15	37.00	**Sandy clay**
15	0-20	14.30	55.25	4.50	25.95	**Sandy clay loam**
	20-50	23.50	34.40	2.70	39.40	**Sandy clay**
	50-150	9.10	45.40	6.00	39.50	**Sandy clay**
16	0-20	38.40	33.00	2.30	26.30	**Sandy clay loam**
	20-45	22.30	36.70	4.00	37.00	**Sandy clay**
17	0-30	60.00	24.70	2.00	13.30	**Loamy sand**
	30-90	4.50	46.20	4.50	44.80	**Sandy clay**
18	0-25	58.00	1.60	24.40	16.00	**Sandy loam**
	25-60	9.80	7.40	41.80	41.00	**Silty clay**
	60-90	5.70	7.20	47.15	39.95	**Silty clay loam**

*** Texture was done according to USDA textural triangle (USDA, 1993)**

Table (2): Chemical properties of the studied soils of Toshka area.

Profile No.	Depth (cm)	pHe 1:2.5 Susp.	ECe (dSm^{-1})	Soluble cations ($mmol_C L^{-1}$)				Soluble anions ($mmol_C L^{-1}$)				$CaCO_3$ (gkg^{-1})	Gypsum (gkg^{-1})	O.M (gkg^{-1})
				Ca^{++}	Mg^{+}+	Na^{+}	K^{+}	Cl^{-}	$CO_3^{=}$	HCO_3^{-}	$SO_4^{=}$			
The alluvial deposits unit														
1	0-25	7.80	7.10	49.00	14.00	5.34	2.66	61.00	0.00	5.00	5.00	121.0	60	1.2
	25-50	8.01	25.42	59.00	31.00	159.9	4.30	192.00	0.00	4.00	58.20	97.4	18.2	7.1
	50-75	7.80	24.70	59.00	6.00	176.88	5.12	193.00	0.00	6.00	48.50	35.5	52.6	6.3
2	0-25	7.80	5.38	28.00	14.00	7.46	4,34	35.00	0.00	10.00	8.80	60.5	15.2	9.2
	25-55	7.30	37.24	280.00	40.00	47.64	4.76	350.00	0.00	12.00	10.40	63.2	42.6	8.9
	55-75	7.20	4294	350.00	17.00	60.20	2.20	410.00	0.00	13.00	6.40	60.5	15.2	8.9
3	0-25	7.5	9.47	12.00	26.00	52.25	4.45	6800	0.00	12.00	14.70	14.5	12.1	9.7
	25-55	8.65	2.69	14.00	7.00	4.92	0.98	15.00	0.00	11.70	0.90	92.1	3.0	7.9
	55-80	8.03	2.80	15.00	2.00	10.30	0.70	20.00	0.00	7.00	1.00	68.4	3.0	8.7
4	0-25	8.61	3.34	18.00	9.00	5.23	1.17	16.00	0.00	8.00	9.40	142.0	9.1	8.9
	25-70	7.74	12.05	36.00	18.00	64.06	2.49	78.00	0.00	11.00	31.50	73.7	9.1	8.9
	70-100	7.79	20.34	39.00	9.00	154.30	1.14	170.00	0.00	12.00	21.40	36.8	12.1	0.4
5	0-20	7.61	9.90	30.00	11.00	53.50	4,50	57.00	0.00	7.00	35.00	73.7	6.1	1.2
	20-50	7.70	12,80	17.00	38.00	69.31	3.79	90.00	0.00	8.00	30.00	22.4	12.1	3.0
	50-80	7.80	10.22	16.00	3.00	82.15	1.07	85.00	0,00	11.00	6.20	81.6	3.0	2.2
6	0-25	7.50	5.17	29.00	13.00	7.50	2.17	20.00	0.00	16.00	15.70	22.4	24.3	8.9
	25-55	7.76	16.36	56.00	28.00	78.40	1.26	149.00	0.00	13.00	1.60	17.1	66.6	9.2
	55-80	7.75	15.40	40.00	36.00	77.01	0.99	137.00	0.00	8.00	9.00	73.7	52.6	6.0
7	0-20	8.62	3.99	7.00	3.00	25.31	0.68	30.00	0.00	9.00	0.90	92.1	3.0	8.9
	20-55	8.10	6.46	10.00	10.00	43.63	0,83	50,00	0.00	12.00	2.60	31.6	12.2	1.4
	55-80	8.00	1550	30.00	24.00	99.68	132	11300	0.00	16.00	26.00	2.6	9.1	1.2
8	0-25	7.00	10.00	29.00	22.00	47.92	1.18	60.00	0.00	17.00	23.00	118.0	18.2	2.2
	25-60	7.02	20.56	46.00	34.00	115.71	3.85	185.00	0.00	20.00	0.60	92.1	30.4	2.5
	60-80	6.95	23.35	60.00	67.00	105.08	1.47	223,00	0.00	10.00	0.50	73.7	18.2	8.9
9	0-30	7.78	6.67	35.00	15.00	14.52	2.15	36.00	0.00	14.00	16.70	113.0	63.1	4.3
	30-100	7.95	15.07	25.00	25.00	96.67	4.03	96.00	0.00	15.00	39.70	10.5	81.0	0.6
10	0-10	7.55	8.29	25.00	34.00	21.35	2.54	4900	0.00	9.00	24.90	105.0	27.4	2.5
	10-50	7.50	16.90	84.00	64.00	19.43	1.57	148.00	0.00	10.00	11.00	73.7	21.3	6.0
	50-80	7.90	32.07	61.00	43.00	215.08	1.69	300.00	0.00	16.00	4.70	52.6	18.2	6 1.2

Table (2): Cont.

Profile No.	Depth (cm)	pHe 1:2.5 Susp.	ECe (dsm^{-1})	Soluble cations ($mmol_C L^{-1}$)				Soluble anions ($mmol_C L^{-1}$)				$CaCO_3$ (gkg^{-1})	Gypsum (gkg^{-1})	O.M (gkg^{-1})
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	$CO_3^{=}$	HCO_3^{-}	$SO_4^{=}$			
The pediplain unit														
11	0-40	7.82	13.13	24.00	10.00	96.67	0.63	109.00	0.00	9.00	13.30	81.6	18.2	6.5
	40-100	8.06	48.54	24.00	19.00	440.37	2.03	455.00	0.00	11.00	19.40	10.5	101.1	7.8
	100120	8.10	31.86	23.00	21.00	272.65	1.95	151.00	0.00	12.00	155.60	84.2	33.5	6.5
12	0-45	7.08	7.64	34.00	16.00	25.14	1.26	52.00	0.00	10.00	14.40	36.8	39.5	8.8
	45-90	7.60	14.74	26.00	25.00	95.60	0.84	130.00	0.00	15.00	2.40	2.7	15.2	3.9
	90-115	7.00	8.72	21.00	34.00	31.55	0.65	47.00	0.00	16.00	24.20	9.2	66.6	9.1
13	0-20	7.00	3.77	25.00	18.00	2.84	0.86	19.00	0.00	10.00	8.70	121.0	108.8	0.8
	20-70	7.28	5.27	20.00	25.00	2.85	4.85	18.00	0.00	14.00	20.70	78.9	112.8	7.5
	70-110	7.80	36.38	40.00	42.00	277.68	4.12	340.00	0.00	17.00	6.80	11.8	104.7	7.8
14	0-20	7.33	16.14	39.00	33.00	85.19	4.21	135.00	0.00	11.00	15.40	145.0	108.8	9.6
	20-50	7.00	15.39	92.00	10.00	50.05	1.85	139.00	0.00	13.00	1.90	132.0	56.1	1.3
	50-80	7.20	3.34	7.00	3.00	23.02	0.83	25.00	0.00	8.00	0.40	118.0	80.6	2.1
15	0-20	7.07	5.70	24.00	13.00	15.46	4.54	29.00	0.00	10.00	18.00	129.0	104.8	5.3
	20-50	7.20	10.01	28.00	17.00	53.28	1.82	72.00	0.00	11.00	17.10	47.4	100.7	8.3
	50-150	6.95	2.90	7.00	3.00	18.62	0.83	18.00	0.00	10.00	1.00	116.0	6.1	6.2
16	0-20	8.10	7.53	26.00	18.00	29.57	1.73	40.00	0.00	12.00	23.30	125.0	56.1	2.3
	20-45	7.01	9.69	30.00	10.00	55.22	1.68	68.00	0.00	14.00	14.90	52.6	80.6	8.8
17	0-30	8.25	5.17	21.00	9.00	21.29	0.41	23.00	0.00	11.00	17.70	179.0	70.1	6.5
	30-90	7.90	2.34	8.00	3.00	10.69	1.71	8.00	0.00	13.00	2.40	31.6	56.1	4.7
18	0-25	8.2	6.03	18.00	13.00	27.42	1.88	21.00	0.00	15.00	24.30	145.0	52.6	8.0
	25-60	7.99	2.70	7.00	9.00	10.61	0.39	14.00	0.00	10.00	3.00	34.2	63.1	8.0
	60-90	8.70	2.48	6.00	12.00	6.24	0.56	10.00	0.00	10.00	4.80	27.6	70.1	0.8

Table 3: Exchangeable cations, cation exchange capacity (CEC) and exchangeable sodium percent (ESP) of the studied soils of Toshka area.

Profile No.	Depth (cm)	Exchangeable cations ($cmol_C kg^{-1}$)				CEC ($cmol_C kg^{-1}$)	ESP
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}		
The alluvial deposits unit							
1	0-25	11.12	3.41	1.59	2.57	18.69	8.51
	25-50	14.91	2.21	5.82	1.64	24.58	23.68
	50-75	24.25	3.50	1.65	1.47	30.87	5.36
2	0 - 25	12.64	2.22	1.08	2.39	18.33	5.89
	25-55	5.80	0.20	1.01	0.01	7.02	14.39
	55-75	9.10	9.84	0.46	1.89	21.29	2.15
3	0 -25	13.14	2.03	2.09	2.36	19.62	10.65
	25-55	10.15	1.98	5.40	1.97	19.50	27.69
	55-80	10.11	3.51	4.61	1.26	19.49	23.65
4	0 -25	6.20	1.20	1.88	1.45	10.73	17.49
	25-70	15.05	1.42	0.47	2.32	19.26	2.45
	70-100	14.50	4.59	0.35	1.50	20.94	1.68
5	0-20	9.19	2.70	0.10	2.46	14.45	0.67
	20-50	3.86	4.04	0.46	1.54	9.90	4.62
	50-80	11.62	1.93	0.44	1.31	15.30	2.91
6	0-25	9.33	1.70	0.10	1.78	12.91	0.72
	25-55	22.37	2.69	1.69	1.68	28.43	5.94
	55-80	18.12	10.31	1.24	1.57	31.24	3.98
7	0-20	7.06	0.66	2.21	1.33	11.26	19.59
	20-55	17.55	2.75	6.57	2.04	28.91	22.74
	55-80	24.08	0.26	3.29	1.22	28.85	11.41
8	0-25	17.50	3.25	1.35	2.18	24.28	5.54
	25-60	13.00	7.40	1.80	1.61	23.81	7.55
	60-80	25.00	1.45	1.46	1.64	29.55	4.95
9	0-30	18.60	2.90	0.35	2.34	24.19	1.50
	30-100	7.00	0.75	2.33	2.25	12.33	18.90
10	0-10	18.88	1.28	1.51	2.11	23.08	6.53
	10-50	20.00	0.25	2.23	2.76	25.24	8.82
	50-80	20.21	0.49	0.6	1.82	23.12	2.58
The pediplain unit							
11	0-40	18.97	0.37	0.96	1.52	21.82	4.38
	40-100	22.24	0.04	0.46	1.87	24.61	1.86
	100-120	26.99	12.28	١8.65	2.46	60.38	30.89
12	0-45	16.00	6.33	0.81	1.97	25.11	3.22
	45-90	17.34	0.80	0.33	1.80	20.27	1.61
	90-115	27.75	0.70	0.64	1.73	30.82	2.08
13	0-20	11.00	1.47	0.62	1.61	14.70	4.23
	20-70	13.00	0.95	0.35	2.52	16.82	2.09
	70-110	25.80	0.30	0.44	2.41	28.95	1.52
14	0-20	19.64	0.85	0.85	2.48	23.82	3.58
	20-50	18.14	3.58	1.61	2.08	25.41	6.33
	50-80	18.25	6.05	0.24	2.13	26.67	0.91
15	0-20	11.04	5.48	1.25	2.48	20.25	6.19
	20-50	27.00	1.30	0.43	1.99	30.72	1.41
	50-150	11.85	12.45	3.82	1.94	30.06	12.70
16	0-20	8.51	3.64	5.24	1.87	19.26	27.19
	20-45	26.20	0.58	0.65	2.01	29.44	2.20
17	0-30	6.73	1.71	2.36	1.90	12.70	18.58
	30-90	25.50	3.37	2.38	1.87	33.12	7.19
18	0-25	7.42	2.58	1.74	1.78	13.52	12.87
	25-60	22.27	4.62	2.48	1.99	31.36	7.91
	60-90	16.50	2.20	8.34	1.89	28.93	28.83

Land Capability

Data in Table (4) show that all soils are suitable for agriculture since their capability index is more than 25 (**Sys and Verheye, 1978)**. Values of capability index (Ci) varied from 51.30 to 85.50 in the alluvial deposits unit and from 62.14 to 81.23 in the pediplain unit.

Soils in the alluvial deposits unit belong to the highly suitable class (S1) that represents about 20% of the studied soils in this unit and the moderately suitable class (S2) that represents about 80% of the studied soils in this unit.

Class S2 is subdivided into subclasses S2-s_1 where soil texture is the limiting factor, S2-n where salinity and alkalinity is the limiting factor and S2-s_1n where soil texture and salinity are the limiting factors. These subclasses represent about 10, 50 and 20% of the aforementioned class, respectively.

Soils in the pediplain unit belong to class S1 and class S2. Class S1 represents about 37.5% of the studied soils in this unit and class S2 that represents about 62.5% of the studied soils in this unit. Class S2 includes the subclasses S2-s_1 (where soil texture is the limiting factor), S2-s_4 (where gypsum content is the limiting factor) and S2-n (where salinity and alkalinity (sodicity) is the limiting factor). These subclasses represent about 12.5, 12.5 and 37.5% for S2-s_1, S2-s_4 and S2-n of the aforementioned class, respectively.

Leaching salts to reduce soil salinity and application of gypsum to reduce alkalinity are the most important procedures that should be performed to improve the soils under study and hence to modify their capability classes and subclasses. Soils of the alluvial deposits unit would accordingly be placed at classes S1 (that represents about 70% of soils in this unit) and S2 (that represents about 30% of soils in this unit). Class S2 includes only subclass S2-s_1 (soil texture is the limiting factor). On the other hand, soils in the pediplain unit would be placed in the classes S1 that represents about 75% of soils in this unit and S2 that represents about 25% of soils in this unit. Class S2 includes two subclasses S2-s_1 (soil texture is the limiting factor and S2-s_4 (gypsum content is the limiting factor). Each of these subclasses represents about 12.5%.

Land suitability for the selected crops

Data in Table (5) indicate that nearly all the studied soils in the two units are not suitable (N1) in their current conditions for nearly all the selected crops. However, some soils may be suitable (S1, S2 and S3) for maize, wheat, barley, sesame, groundnuts, alfalfa, cowpea, cabbage, watermelons, tomato and olives. All soils are permanently not suitable (N2) for carrots, onion, tomato and mango.

By applying some improvements on the studied soils such as leaching salts to reduce soil salinity, application of gypsum to reduce soil alkalinity (sodicity) and application of organic matter to enrich soil with organic matter and nutrients, all studied soils in the two units would be suitable for most of the selected crops. Soil represented by profiles 9, 11, 13, 14, 15, 16, 17 and 18 are permanently not suitable (N) for carrots, onion, tomato and mango as these crops are highly sensitive for gypsum more than 5%.

Table (4): Rating of limitations, current and potential classes and subclasses of the studied soils of Toshka area.

Profile No.	Slope (t)		Drainage (w)	Land characteristics						Capability index (Ci)		Land suitability			
				Texture (s_1)	Depth (s_2)	$CaCO_3$ (s_3)	Gypsum (s_4)	Salinity and alkalinity (sodicity) (n)				Class		Subclass	
	C	P						C	P	C	P	C	P	C	P
The alluvial deposits unit															
1	100	100	100	95	100	95	100	75	100	67.69	90.25	S2	S1	S2-n	S1
2	95	100	100	75	90	95	100	80	100	48.74	64.13	S2	S2	S2-s_1n	S2-s_1
3	100	100	100	95	100	95	90	85	100	69.04	81.23	S2	S1	S2-n	S1
4	100	100	100	75	100	95	90	80	100	51.30	64.13	S2	S2	S2-s_1n	S2-s_1
5	100	100	100	75	100	95	90	90	100	57.71	64.13	S2	S2	S2-s_1	S2-s_1
6	100	100	100	95	100	95	100	90	100	81.23	90.25	S1	S1	S1	S1
7	100	100	100	95	100	95	90	85	100	69.04	81.23	S2	S1	S2-n	S1
8	100	100	100	95	100	100	100	90	100	85.50	95.00	S1	S1	S1	S1
9	95	100	100	95	90	95	100	80	100	61.73	81.23	S2	S1	S2-n	S1
10	100	100	100	95	100	95	100	80	100	72.20	90.25	S2	S1	S2-n	S1
The pediplain unit															
11	90	100	90	95	100	95	100	85	100	62.14	81.23	S2	S1	S2-n	S1
12	100	100	100	95	100	95	100	90	100	81.23	90.25	S1	S1	S1	S1
13	100	100	100	95	100	100	80	90	100	68.40	76.00	S2	S2	S2-s_4	S2-s_4
14	100	100	100	95	90	100	100	90	100	76.95	85.50	S1	S1	S1	S1
15	100	100	100	95	100	95	100	90	100	81.23	90.25	S1	S1	S1	S1
16	100	100	100	95	90	95	100	80	100	64.98	81.23	S2	S1	S2-n	S1
17	100	100	100	95	90	100	100	90	100	76.95	85.50	S1	S1	S2-n	S1
18	100	100	100	85	90	95	100	90	100	65.41	72.68	S2	S2	S2-s_1	S2-s_1

C = Current suitability **P = Potential suitability** **S1 = Highly suitable** **S2 = Moderately suitable**

Table (5): Current and potential suitability classes of the studied soils for the selected crops.

Crops			The alluvial deposits unit									
			Profile No.									
			1	2	3	4	5	6	7	8	9	10
Filed crops	Maize	C	7.33 (N1)	12.51 (N1)	16.30 (N1)	5.83 (N1)	19.38 (N1)	29.15 (S3)	4.87 (N1)	12.86 (N1)	14.12 (N1)	11.61 (N1)
		P	85.74 (S11)	76.71 (S1)	95.00 (S1)	80.75 (S1)	85.00 (S1)	90.25 (S1)	95.00 (S1)	85.74 (S1)	76.71 (S1)	85.74 (S1)
	Wheat	C	14.59 (N1)	11.51 (N1)	39.12 (S3)	5.42 (N1)	12.11 (N1)	18.22 (N1)	6.14 (N1)	18.06 (N1)	18.84 (N1)	17.16 (N1)
		P	85.00 (S1)	60.00 (S2)	85.00 (S1)	60.00 (S2)	60.00 (S2)	80.75 (S1)	85.00 (S1)	72.25 (S2)	85.00 (S1)	72.25 (S2)
	Barely	C	24.71 (S3)	16.47 (N1)	58.34 (S2)	11.51 (N1)	32.49 (S3)	61.95 (S2)	10.84 (N1)	30.60 (S3)	31.59 (S3)	29.07 (S3)
		P	85.00 (S1)	60.00 (S2)	85.00 (S1)	60.00 (S2)	60.00 (S2)	80.75 (S1)	85.00 (S1)	72.25 (S2)	85.00 (S1)	72.25 (S2)
	Sesame	C	9.00 (N1)	10.84 (N1)	61.41 (S2)	5.31 (N1)	9.00 (N1)	18.06 (N1)	9.00 (N1)	12.75 (N1)	7.65 (N1)	9.00 (N1)
		P	100.00 (S1)	100.00 (S1)	100.00 (S1)	100.00 (S1)	100.00 (S1)	100.00 (S1)	100.00 (S1)	100.00 (S1)	100.00 (S1)	100.00 (S1)
	Ground-nuts	C	3.03 (N1)	8.75 (N1)	17.16 (N1)	5.10 (N1)	20.40 (N1)	27.26 (S3)	2.25 (N1)	13.54 (N1)	8.84 (N1)	11.51 (N1)
		P	95.00 (S1)	95.00 (S1)	100.00 (S1)	100.00 (S1)	100.00 (S1)	85.00 (S1)	100.00 (S1)	95.00 (S1)	95.00 (S1)	95.00 (S1)
	Alfalfa	C	11.51 (N1)	14.71 (N1)	61.41 (S2)	61.30 (N1)	36.00 (N1)	43.35 (S3)	10.84 (N1)	13.54 (N1)	33.25 (S3)	12.86 (N1)
		P	90.00 (S1)	90.25 (S1)	100.00 (S1)	95.00 (S1)	100.00 (S1)	85.00 (S1)	100.00 (S1)	90.25 (S1)	80.75 (S1)	90.25 (S1)
	Cowpea	C	11.51 (N1)	14.71 (N1)	61.41 (S2)	61.30 (N1)	36.00 (N1)	43.35 (S3)	10.84 (N1)	13.54 (N1)	33.25 (S3)	12.86 (N1)
		P	90.00 (S1)	90.25 (S1)	100.00 (S1)	95.00 (S1)	100.00 (S1)	85.00 (S1)	100.00 (S1)	90.25 (S1)	80.75 (S1)	90.25 (S1)
Vegetable crops	Carrots	C	5.25 (N1)	7.44 (N1)	29.75 (S3)	4.29 (N1)	7.56 (N1)	9.78 (N1)	2.88 (N1)	6.18 (N1)	1.47 (N2)	8.31 (N1)
		P	68.64 (S2)	72.25 (S2)	80.75 (S1)	85.00 (S1)	85.00 (S1)	54.15 (S2)	90.25 (S1)	48.45 (S3)	20.19 (N2)	86.64 (S2)
	Onion	C	8.75 (N1)	10.01 (N1)	14.59 (N1)	4.08 (N1)	11.51 (N1)	11.51 (N1)	3.03 (N1)	7.65 (N1)	2.45 (N2)	9.70 (N1)
		P	72.25 (S2)	68.64 (S2)	85.00 (S1)	80.85 (S1)	80.75 (S1)	57.00 (S2)	95.00 (S1)	51.00 (S2)	21.25 (N2)	72.25 (S2)
	Tomato	C	7.44 (N1)	8.51 (N1)	31.59 (S3)	7.83 (N1)	14.00 (N1)	16.62 (N1)	9.29 (N1)	6.56 (N1)	4.24 (N2)	7.90 (N1)
		P	68.64 (S2)	58.34 (S2)	76.71 (S1)	72.25 (S2)	68.64 (S2)	51.44 (N2)	85.74 (S1)	46.03 (S3)	19.18 (N2)	65.21 (S2)
	Cabbage	C	10.93 (N1)	13.98 (N1)	20.19 (N1)	19.18 (N1)	20.19 (N1)	7.56 (N1)	19.18 (N1)	28.27 (S3)	17.31 (N1)	2.30 (N1)
		P	90.25 (S1)	85.74 (S1)	100.00 (S1)	90.25 (S1)	95.00 (S1)	85.00 (S1)	100.00 (S1)	90.25 (S1)	80.75 (S1)	90.25 (S1)
	Water-melon	C	7.24 (N1)	13.86 (N1)	15.49 (N1)	7.23 (N1)	12.11 (N1)	18.22 (N1)	4.87 (N1)	12.86 (N1)	13.30 (N1)	12.22 (N1)
		P	95.00 (S1)	95.00 (S1)	90.25 (S1)	100.00 (S1)	95.00 (S1)	90.25 (S1)	90.25 (S1)	90.25 (S1)	90.25 (S1)	90.25 (S1)
Fruit crops	Olives	C	29.07 (S3)	29.15 (S3)	76.71 (S1)	21.43 (S3)	51.44 (S2)	85.74 (S1)	17.16 (N1)	34.20 (S3)	58.85 (S2)	32.49 (S3)
		P	96.57 (S1)	69.05 (S2)	82.56 (S1)	94.59 (S1)	80.42 (S1)	85.85 (S1)	78.14 (S1)	81.91 (S1)	53.57 (S2)	81.96 (S1)
	Guava	C	7.27 (N1)	12.40 (N1)	4.29 (N1)	3.84 (N1)	12.11 (N1)	1.91 (N1)	12.11 (N1)	8.75 (N1)	11.51 (N1)	1.63 (N1)
		P	85.00 (S1)	85.00 (S1)	85.00 (S1)	85.00 (S1)	85.00 (S1)	85.00 (S1)	85.00 (S1)	85.00 (S1)	85.00 (S1)	85.00 (S1)
	Mango	C	5.25 (N1)	10.01 (N1)	13.16 (N1)	6.14 (N1)	10.30 (N1)	10.38 (N1)	4.63 (N1)	6.56 (N1)	2.83 (N2)	7.90 (N1)
		P	68.64 (S2)	68.64 (S2)	76.71 (S1)	85.00 (S1)	80.75 (S1)	51.44 (S2)	85.74 (S1)	46.03 (S3)	19.18 (N2)	65.21 (S2)

C = Current Suitability **P = Potentials Suitability** **S1 = Highly suitable**
S2 = Moderately suitable **S3 = Marginally suitable** **N1 = Currently not suitable**
N2 = Permanently not suitable

Table (5): Cont.

Crops			The pediplain unit							
			Profile No.							
			11	12	13	14	15	16	17	18
Filed crops	Maize	C	3.32 (N1)	29.15 (S3)	12.35 (N1)	10.93 (N1)	35.13 (S3)	3.91 (N1)	20.07 (N1)	9.29 (N1)
		P	80.75 (S1)	90.25 (S1)	54.15 (S2)	76.71 (S1)	76.71 (S1)	76.71 (S1)	76.71 (S1)	76.71 (S1)
	Wheat	C	7.44 (N1)	19.18 (N1)	10.84 (N1)	15.35 (N1)	36.85 (S3)	19.84 (N1)	25.29 (S3)	47.11 (S3)
		P	72.25 (S2)	80.75 (S1)	39.32 (S3)	51.00 (S2)	72.25 (S2)	72.25 (S2)	72.25 (S2)	80.75 (S1)
	Barely	C	5.25 (N1)	65.21 (S2)	29.07 (S3)	36.85 (S3)	43.35 (S3)	33.25 (S3)	21.00 (N1)	49.59 (S3)
		P	72.25 (S2)	80.75 (S1)	39.32 (S3)	51.00 (S2)	72.25 (S2)	72.25 (S2)	72.25 (S2)	80.75 (S1)
	Sesame	C	5.40 (N1)	18.06 (N1)	12.75 (N1)	12.75 (N1)	43.35 (S3)	9.00 (N1)	13.68 (N1)	45.90 (S3)
		P	100.00 (S1)	100.00 (S1)	100.00 (S1)	100.00 (S1)	100.00 (S1)	100.00 (S1)	100.00 (S1)	100.00 (S1)
	Ground-nuts	C	1.63 (N1)	30.69 (S3)	13.68 (N1)	12.11 (N1)	35.01 (S3)	4.34 (N1)	4.36 (S3)	4.29 (N1)
		P	85.00 (S1)	95.00 (S1)	60.00 (S2)	85.00 (S1)	85.00 (S1)	85.00 (S1)	85.00 (S1)	85.00 (S1)
	Alfalfa	C	6.18 (N1)	48.45 (S3)	20.52 (N1)	12.11 (N1)	39.12 (S3)	33.25 (S3)	15.74 (N1)	33.25 (S3)
		P	85.00 (S1)	95.00 (S1)	57.00 (S2)	80.75 (S1)	80.75 (S1)	80.785 (S1)	80.75 (S1)	80.75 (S1)
	Cowpea	C	6.18 (N1)	48.45 (S3)	20.52 (N1)	12.11 (N1)	39.12 (S3)	33.25 (S3)	15.74 (N1)	33.25 (S3)
		P	85.00 (S1)	95.00 (S1)	57.00 (S2)	80.75 (S1)	80.75 (S1)	80.75 (S1)	80.75 (S1)	80.75 (S1)
Vegetable crops	Carrots	C	0.93 (N2)	10.30 (N1)	1.82 (N2)	2.57 (N2)	4.14 (N2)	1.54 (N2)	1.04 (N2)	5.22 (N2)
		P	14.19 (N2)	57.00 (S2)	14.25 (N2)	20.19 (N2)	14.25 (N2)	20.19 (N2)	14.25 (N2)	21.25 (N2)
	Onion	C	1.38 (N2)	12.75 (N1)	2.25 (N2)	3.03 (N2)	2.14 (N2)	2.30 (N2)	0.77 (N2)	5.53 (N2)
		P	21.25 (N2)	60.00 (S2)	15.00 (N2)	21.25 (N2)	15.00 (N2)	21.25 (N2)	15.00 (N2)	21.25 (N2)
	Tomato	C	0.93 (N2)	11.51 (N1)	1.93 (N2)	2.73 (N2)	6.23 (N2)	3.52 (N2)	0.98 (N2)	5.87 (N2)
		P	20.19 (N2)	57.00 (S2)	13.54 (N2)	19.18 (N2)	13.54 (N2)	19.18 (N2)	13.54 (N2)	20.19 (N2
	Cabbage	C	2.30 (N1)	22.56 (N1)	12.11 (N1)	17.16 (N1)	55.42 (S2)	8.75 (N1)	8.31 (N1)	10.93 (N1)
		P	85.00 (S1)	95.00 (S1)	57.00 (S2)	80.75 (S1)	80.75 (S1)	80.75 (S1)	80.75 (S1)	80.75 (S1)
	Water-melon	C	1.82 (N1)	30.69 (S3)	12.86 (N1)	12.86 (N1)	41.54 (S3)	4.60 (N1)	6.56 (N1)	11.51 (N1)
		P	95.00 (S1)	95.00 (S1)	90.25 (S1)	90.25 (S1)	90.25 (S1)	90.25 (S1)	90.25 (S2)	95.00 (S1)
Fruit crops	Olives	C	10.30 (N1)	36.10 (S3)	51.44 (S2)	68.64 (S2)	80.75 (S1)	43.73 (S3)	27.62 (N1)	46.03 (S3)
		P	100.00 (S1)	100.00 (S1)	90.25 (S1)	90.00 (S1)	90.00 (S1)	90.00 (S1)	90.00 (S1)	90.00 (S2)
	Guava	C	1.63 (N1)	17.16 (N1)	12.11 (N1)	12.11 (N1)	11.51 (N1)	2.71 (N1)	3.90 (N1)	7.27 (N1)
		P	85.00 (S1)	85.00 (S1)	85.00 (S1)	85.00 (S1)	85.00 (S1)	85.00 (S1)	85.00 (S1)	95.00 (S1)
	Mango	C	0.93 (N2)	18.41 (N1)	1.93 (N2)	2.73 (N2)	6.23 (N2)	0.98 (N2)	0.98 (N2)	2.45 (N2)
		P	20.19 (N2)	57.00 (S3)	13.54 (N2)	19.18 (N2)	13.54 (N2)	19.18 (N2)	13.54 (N2)	20.19 (N2)

C = Current Suitability **P = Potentials Suitability** **S1 = Highly suitable**
S2 = Moderately suitable **S3 = Marginally suitable** **N1 = Currently not suitable**
N2 = Permanently not suitable

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قدرة و ملاءمة بعض الأراضي في منطقة توشكي – جنوب غرب مصر

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يهدف هذا البحث إلى تقييم بعض أراضي منطقة توشكي – جنوب غرب مصر وتحديد مدى ملاءمتها للزراعة ببعض المحاصيل. تشغل منطقة الدراسة حوالي ٦٠.٠٠٠ فدان تقع علي زمام الفرع الثاني لترعة الشيخ زايد بين دائرتي عرض ٥٧″٥٤′ ٢٢° و ١٩″ ٧′ ٢٣° شمالا وخطي طول ١٨″ ١٩′ ٣١° و ٢١″ ٣٠′ ٣١° شرقا. تم حفر ثمانية عشر قطاعا أرضيا لتمثيل منطقة الدراسة.

ولقد أوضحت النتائج أن الأراضي المدروسة تنتمي إلى أقسام عالية الصلاحية (S1) و متوسطة الصلاحية (S2) تحت الظروف الحالية والمستقبلية (الكامنة).

أوضحت النتائج أن الأراضي المدروسة غير صالحة تحت الظروف الحالية (N1) لكل المحاصيل المختارة، عدا بعض الأراضي التي تبدو صالحة لكل من الذرة الشامية والقمح والشعير والسمسم والفول السوداني والبرسيم الحجازي ولوبيا العلف والكرنب والبطيخ والطماطم والزيتون، وغير صالحة تحت الظروف الكامنة (N2) لكل من الجزر والبصل والطماطم والجوافة والمانجو. وبإجراء بعض التحسينات اللازمة تصبح الأراضي المدروسة صالحة لكل المحاصيل المختارة وغير صالحة فقط للجزر والبصل والطماطم والمانجو حيث أن هذه المحاصيل حساسة للجبس (أكثر من ٥%).