PN-AAR-139

ISN 36620

EWUP TECHNICAL REPORT NO. 33

SOIL SURVEY REPORT
FOR
ABYUHA AREA - MINYA GOVERNORATE

By:
Abdel Wahed A. Selim
Mohamed A. el-Nahal
Mohamed H. Assal

January - 1983

EGYPT WATER USE AND MANAGEMENT PROJECT

22 El Galaa St., Bulak, Cairo, Egypt

SOIL SURVEY REPORT
FOR
ABYUHA AREA - MINYA GOVERNORATE

By:
Abdel Wahed A. Selim
Mohamed A. El-Nahal
Mohamed A. Assal

EWUP PROJECT TECHNICAL REPORT NO. 33

Prepared under support of

WATER DISTRIBUTION RESEARCH INSTITUTE, WATER RESEARCH CENTER

MINISTRY OF IRRIGATION, GOVERNMENT OF EGYPT

Contracting agencies

Colorado State University
Engineering Research Center
Ft. Collins, Colorado 80521
USA

Consortium for International
Development
5151 E. Broadway, Ste., 1500
Tucson, Arizona 85711 USA

All reported opinions, conclusions or
recommendations are those of the writers
and not those of the supporting or contracting agencies.

ABSTRACT

A soil characterization survey of Abyuha was made at a sampling density of 1 profile per 20 *feddans*. The survey showed all soils to be in the Typic Torrerts great group of the Vertisol order, with no additional series or phase subdivisions. The surface horizons of all profiles were usually low in both salinity and sodicity. Both salinity and sodicity increased with depth. Maps have been drawn to show sampling locations, sodicity, and subsurface salinity. Tables of chemical and physical analyses are also included.

38 pages, 3 Tables, 5 Figures

/mh

مستخلـــــص

تم القيام بحصـــر لخواص الأرض فى منطقة أبيوها ، مركز أبو قرقـــاص ، محافظة المنيا وذلك بأخذ قطاع ممثل لكل ٢٠ فدان . وقد أظهـــــر الحصر أن كل الأراضى تنتمى الى المجموعة الكبرى التوررتس النمطيـــــة لرتبة الفيرتيسول بدون وجود أى سلاسل أو تحت أقسام . كانت الأفاق السطحية لكل القطاعات منخفضة فى كل من الملوحة والصودية (القلوية) واللتـــان تزدادان بالعمق . رسمت خرائط لتوضيح أماكن أخذ القطاعات والصوديـــــة وملوحة تحت السطح . أرفقت كذلك جداول التحليلات الطبيعية والكيماوية .

٣٨ صفحـــــة ، ٣ جداول ، ٥ أشكـــال

TABLE OF CONTENTS

ABSTRACT (English & Arabic) i
TABLE OF CONTENTS iii
LIST OF FIGURES iv
LIST OF TABLES v
ACKNOWLEDGEMENTS vi

I. Introduction 1

II. Physiographic Features of the Area 1

1. Location 1
2. Topography 1
3. Climate 1
4. Geological History of the Nile Valley 3

III. Materials and Methods 5

1. Field Survey 5
2. Soil Analysis 5
3. Criteria for Classification 6
4. Soil Characteristics 6
5. Soil Classification 7

IV. References 9

V. Appendix 10

American Equivalents of Egyptian Arabic Terms and Measures Commonly Used in Irrigation Work 34

List of EWUP Reports 35

LIST OF FIGURES

Fig. 1. EWUP Pilot Study Area at Abyuha 2

Appendix

Fig. A-1. Location of profiles sampled in Abyuha 11

Fig. A-2. Salinity levels for sub-surface samples in Abyuha 12

Fig. A-3. SAR values for surface samples from Abyuha 13

Fig. A-4. SAR values for sub-surface samples from Abyuha 14

LIST OF TABLES

Appendix

Table A-1. Chemical Characterization Data of Selected Soil Profiles - Abyuha Study Area 15

Table A-2. Particle Size Data for Selected Soil Profiles in the Abyuha Study Area 25

Table A-3. Morphological and Associated Site Characteristics for Representative Soil Profiles - Abyuha Study Area 28

ACKNOWLEDGEMENTS

The authors wish to express their thanks and appreciation for the contributions made to this paper by the staff of the Egypt Water Use and Management Project, and to the field teams at Mansuriya, Kafr El-Sheikh and El-Minya.

The Project is funded jointly by the Arab Republic of Egypt, and by the United States Agency for International Development. The United States Agency for International Development in Egypt is under the directorship of Mr. Michael P. W. Stone. Mr. Robert Fulton is the United States Agency for International Development Project Officer for the Egypt Water Use and Management Project.

The Egypt Water Use and Management Project is implemented under the auspices of the Ministry of Irrigation's Water Management and Irrigation Technologies Research Institute and in collaboration with both the Ministry of Irrigation and the Ministry of Agriculture through the Soil and Water Research Institute and the Agriculture Economics Institute, which provide the Project with personnel and services.

The Consortium for International Development, with executive offices in Tucson, Arizona, is the United States Agency for International Development Contractor for the Project. American Project personnel are drawn from the faculties of Colorado State University, the lead American university taking part in the Project, Oregon State University, New Mexico State University, and Montana State University. The Project Director is Dr. Hassan Wahby and the Project Technical Director is Dr. Eugene Quenemoen. Dr. E. V. Richardson is the Campus Project Coordinator at Colorado State University.

I. Introduction

Abyuha area is the third EWUP site selected for conducting the water use and management studies in the Nile Valley and Delta. It lies about mid-way between Alexandria and Aswan and is representative of the central valley soils. In contrast to the other two areas, Abyuha is characterized by having sugarcane as a main crop in rotation.

The area was surveyed in detail using the cadastral map (scale 1:2500) as a base map. Soil profiles were described, sampled and classified according to the U.S. Soil Taxonomy System (1975). Because of their heavy texture and the montmorillonitic nature of the clay, all soils of the area are classified as Vertisols.

II. Physiographic Features of the Area

1. Location

Abyuha area lies about 14 km south of the city of Minya. It covers about 1800 *feddans* on the western side of Ibrahimiya main canal. The area is bordered on the west by El-Hosha drain and Dyrutiya canal, on the south by the Abyuha canal and on the north by Kom El-Zoheir canal (fig. 1). Abyuha village occupies the southeastern corner of the area.

2. Topography

Abyuha area lies within the floodplain of the Nile about 2 km west of the river channel. The area has a flat surface, and slopes very gently toward the northwest.

3. Climate

The area is characterized by a warm, dry climate. The mean daily temperature ranges from a minimum of 11.8°C in January to a maximum of 35.8°C in September with a mean annual of 22.1°C. The diurnal fluc-

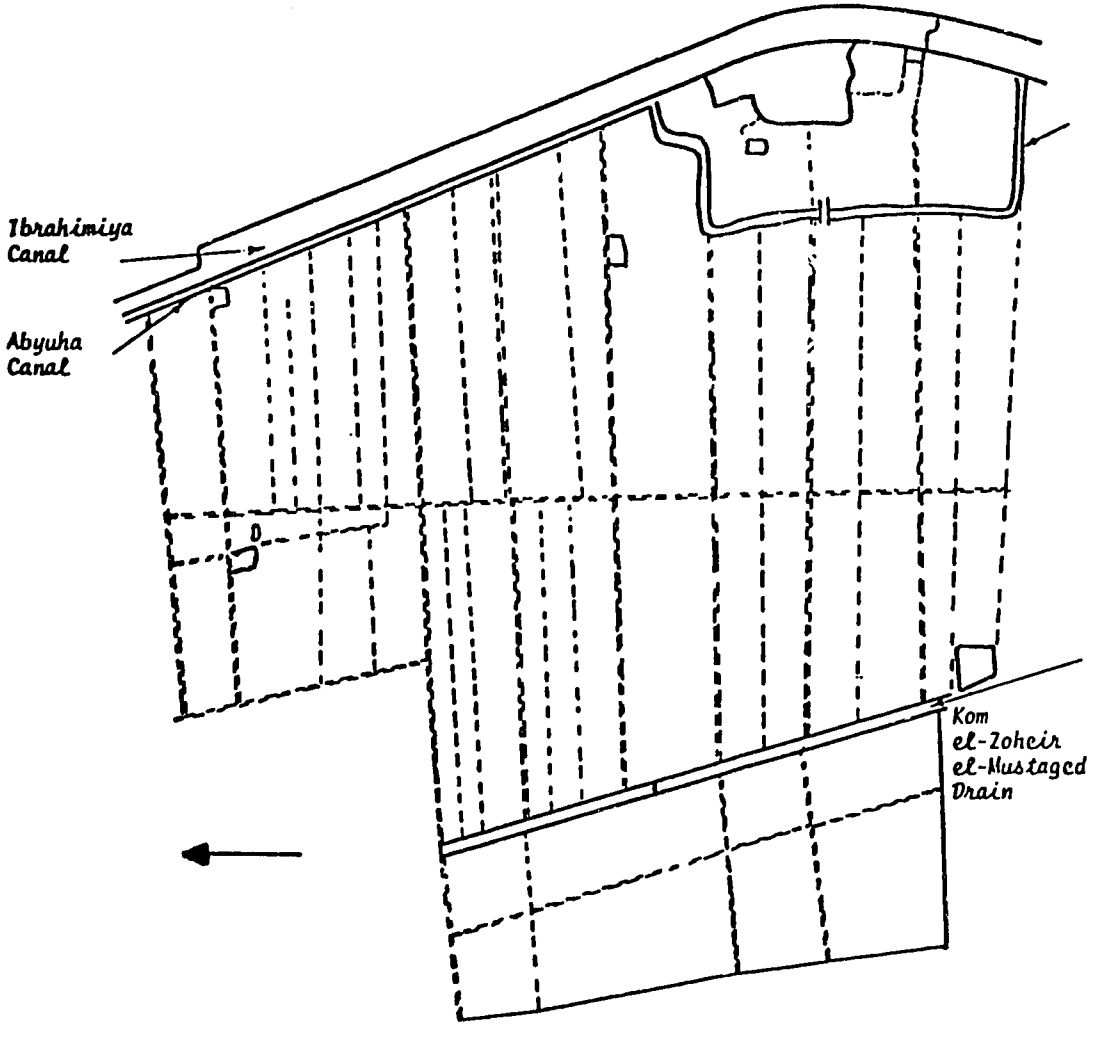

Figure 1. EWUP Pilot Study Area at Abyuha

tuation is about 16°C with occasional frost during January and February. The mean annual rainfall is almost negligible, being only 5.3 mm distributed as very light showers in the fall and winter months. In some years, there may be only a trace or complete absence of rain. the relative humidity is quite low, ranging from a minimum of 37% in May to a maximum of 62% in December.

4. Geological History of the Nile Valley

In the Cretaceous Period (50 million years ago), Egypt and a large part of North Africa became submerged beneath the sea. This period is marked by the shallow water deposits such as sandstones as well as the deeper water deposits of limestones and clays. Near the end of the Cretaceous Period, the sea retreated gradually northward, and the Cretaceous deposits were raised above sea level and then were subjected to denudation by the action of rain and rivers.

The limit to which the sea retreated at the close of the Cretaceous Period cannot be definitely ascertained, but the very decided unconformity which exists between the Cretaceous strata and the overlying Eocene deposits at Abu Rawash near the Pyramids of Giza shows that it was at least as far northward as Cairo.

Throughout the different periods of the Caenozoic Era, down from the Eocene (30 million years ago) to the Recent Period, there have been many cycles of advance and retreat of the sea. Periods of submergence are known by the presence of special deposits of different periods, and retreat as revealed by the denudation of such strata. Deposits of different periods make a written history on the floor of the Nile Valley and Delta (Ball, 1952).

Deposits of gravels and sands were laid down in the Pleistocene and recent geological periods in the Nile Valley where they formed a series of terraces at various heights above the valley floor. These terraces were formed by the river at successively lower levels as it gradually deepened its channel.

The clay that covers the flat floor of the Nile Valley and forms the arable land of Upper Egypt was deposited by the floodwaters of the river in the course of the recent geological time. The Uppermost part of the Nile deposit averages some 9 m in thickness. This deposit is composed of very finely divided mineral matter with comparatively little admixture of sand, and probably has been deposited within the last 10,000 years. Deposition continued until the construction of the large dam.

Beneath the uppermost accumulation of Nile-suspended matter is a considerable thickness of mixed sand and silt, deposited from the river during the transition period between Paleolithic and Neolithic times (from 10,000 to about 8,000 B.C.). Owing to the rising sea level, the Nile was aggrading its bed and raising the levels of its floor-plain in northern Egypt relatively fast.

The thickness of the Nile deposits varies in different localities owing partly to the sands and gravels on which it was originally laid down which presented a somewhat irregular surface, and partly to the river having from time to time changed its path. This resulted in materials that had been deposited from the inundation of water at one time to be scoured away at a later time and replaced by fine sand from the river itself. Moreover, it is sometimes difficult to determine the exact thickness of the accumulation at a particular place by borings. In some localities, the silt is sharply marked from the underlying sands and gravels, in others there is a gradual change with depth from the silt proper through a considerable thickness of mixed sand and silt before reaching the clean sands and gravel below. The thickness of the Nile deposits varies from about 6.5 m in Upper Egypt to about 11 m in the northern part of the Delta.

III. Materials and Methods

1. Field Survey

The soil survey of the Abyuha area was carried out using a cadastral map at a scale of 1.2500. A total of 87 soil profiles were examined in the area averaging one profile per 20 *feddans* or 12 profiles per km^2.

The profile characteristics were described in accordance with the USDA Soil Survey Manual (1951). These characteristics included: soil depth, sequence and thickness of horizons or layers, color, texture, structure, consistency, porosity, lime and/or gypsum accumulations, nodules or concretions, root distribution, effervescence with HCl and water table depth. The land surface features, namely topography, relief, crops and salinity or alkalinity symptoms were also described. Soil samples were collected from each profile, by layer, to 150 cm. A total of 192 soil samples were collected for laboratory analysis.

2. Soil Analysis

The soil samples were air-dried, ground and passed through a 2 mm sieve for analysis. The electrical conductivity, soluble cations (Ca, Mg, Na, and K) and anions (HCO_3 and Cl) were determined in the saturation extract using the analytical procedures of the USA Salinity Laboratory Staff (1954). The pH of the saturation paste was determined.

Particle size distribution, calcium carbonate content, cation exchange capacity (CEC), exchangeable sodium percentage (ESP) and soil organic matter were determined in some of the samples.

3. Criteria for Classification

Soils of the study area were classified according to the USDA Soil Taxonomy System (1975). The key for the soil orders identified in Abyuha area is described in the Abu Raya Soil Survey Report by Selim et al. (1982).

4. Soil Characteristics

The field and laboratory studies (Tables A-1 and A-2) show that the area has a considerable uniformity in soil morphology, salinity and physical characteristics. Exchangeable sodium levels, however, varied both in amount and in distribution in the soil profile.

The soil texture is clayey throughout the profile depth but tends to be more clayey in the subsoil. Particle size distribution analysis of the representative samples show that the clay content of the surface soil ranges from 37% to 67%, with an average of 52%. The clay content of the subsoil is generally slightly higher.

The soil has a weak subangular blocky structure at the surface and becomes more developed at the lower depths to give a strong fine angular blocky structure.

As crops are grown under irrigation, the soil profile usually remains very moist, except for the plough layer which develops wide cracks as the soil dries between irrigations. Between crops, deep cracking develops.

The soil has a firm, sticky, and plastic consistency. Slickensides are quite evident in the subsoil. Fine lime concretions occasionally occur in the middle layer, and the calcium carbonate content ranges from 2 to 4%. No gypsum accumulations were observed in the soil profile.

Although the subsoil is very wet over long periods during cropping, no evidence of gleying was observed. The water table was always deeper than 150 cm at the time of field survey (August and September, 1979).

The soils of the area were generally non-saline. The electrical conductivity of the saturation extract in the surface soil was low, being about 1.5 mmhos/cm in most samples and slightly above 2 mmhos in a few samples. In no profiles did the electrical conductivity of the surface layer exceed 4 mmhos/cm. Electrical conductivity increased slightly in the subsoil and was more than 8 mmhos in few of the samples (Figure A-2).

Sodium adsorption ratios (SAR) were low in the surface of most soils and increased gradually with depth but remained below 15 in most profiles (Figures A-3 and A-4).

The soil cation exchange capacity ranges from 40 to 50 meq/100g, and based on the clay content, indicates that the clay fraction has a cation exchange capacity of about 80 meq/100 g. With the low organic matter content of the soil (2.2-0.6%), this high cation exchange capacity indicates (as shown by Heakal, 1968) that the dominant clay is montmorillonite.

5. Soil Classification

From the above description of the soil characteristics, all the soils of the area were classified as Typic-Torrerts without series or phase subdivisions. Typic-Torrerts belong to the Vertisol soil order. This soil order gets its name from the Latin work verto "to turn" or "invert". These soils are characterized by deep cracking during drying. Soil particles may fall into these cracks causing substantial upward movement upon rewetting.

Location of the examined profiles are shown on the map of the study area, Figure A-1. Distribution of potentially adverse sub-surface salinity conditions are shown in Figure A-2, and for sodicity in Figures A-3 and A-4. Morphological properties of representative soil profiles are described in Table A-3.

IV. References

Ball, J. 1952. Contribution to the Geology of Egypt. Gov. Press, Cairo, Egypt.

Heakal, M.S. 1968. Mineralogical Study of Some Egyptian Alluvial Profiles and its Relation to Fertility. M.Sc. Thesis, Cairo University, Egypt.

Selim, Abdel-Wahed, A., M. A. El-Nahal and M. H. Assal. 1982. Soil Survey Report for Abu Raya Area. EWUP Technical Report No. 34.

Soil Survey Staff. 1951. Soil Survey Manual. U.S. Department of Agriculture Handbook No. 18, U.S. government Printing Office, Washington, D.C.

Soil Survey Staff. 1975. Soil Taxonomy, A Basic System of Soil Classification for Making and Interpreting Soil Surveys. USDA Handbook No. 436, U.S. Government Printing Office, Washington, D.C.

U.S. Salinity Laboratory Staff. 1954. Diagnosis and Improvement of Saline and Alkali Soils. U.S. Dept. Agr. Handbook No. 60, U.S. Government Printing Office, Washington, D.C.

APPENDIX

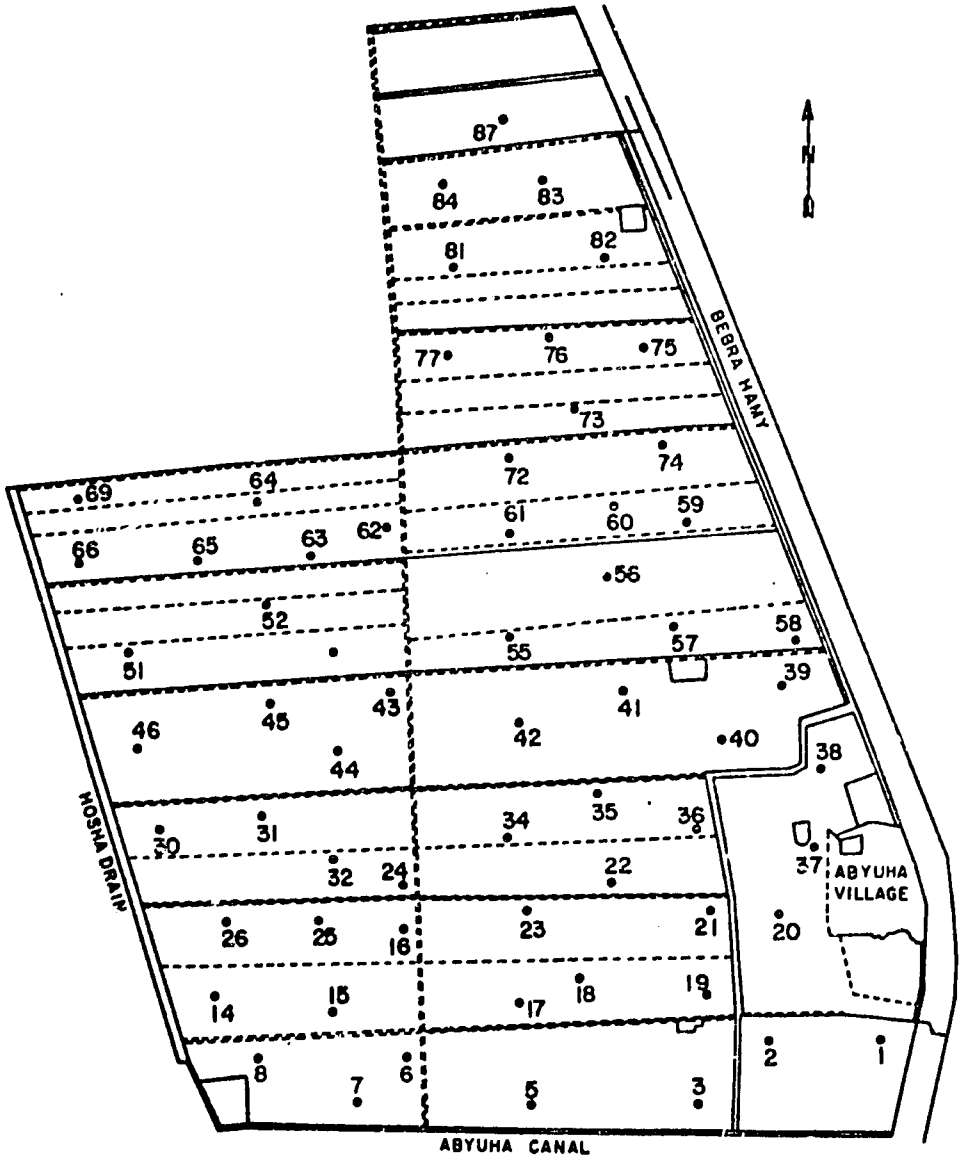

Figure A-1. Location of profiles sampled in Abyuha.

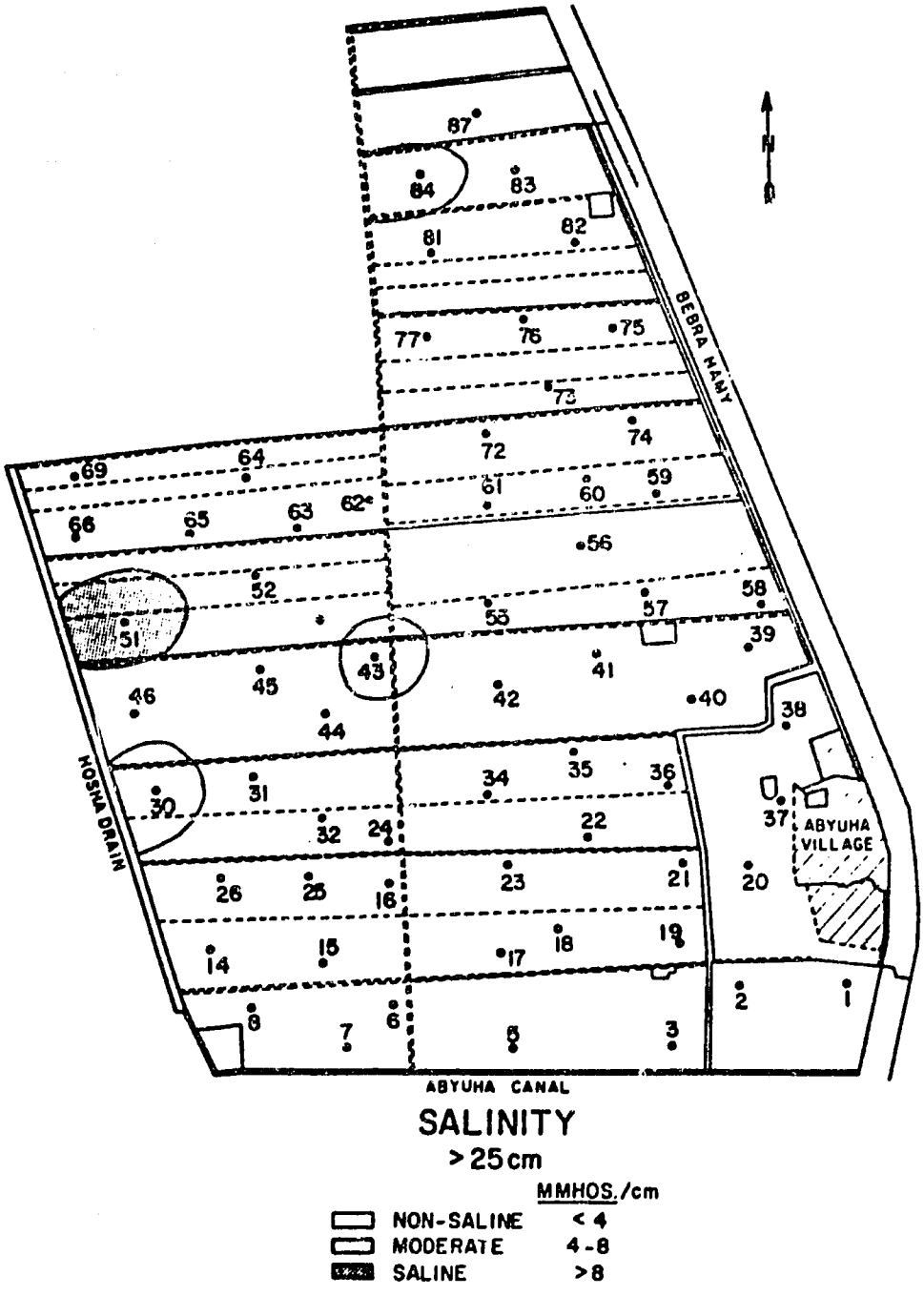

Figure A-2. Salinity levels for sub-surface samples in Abyuha.

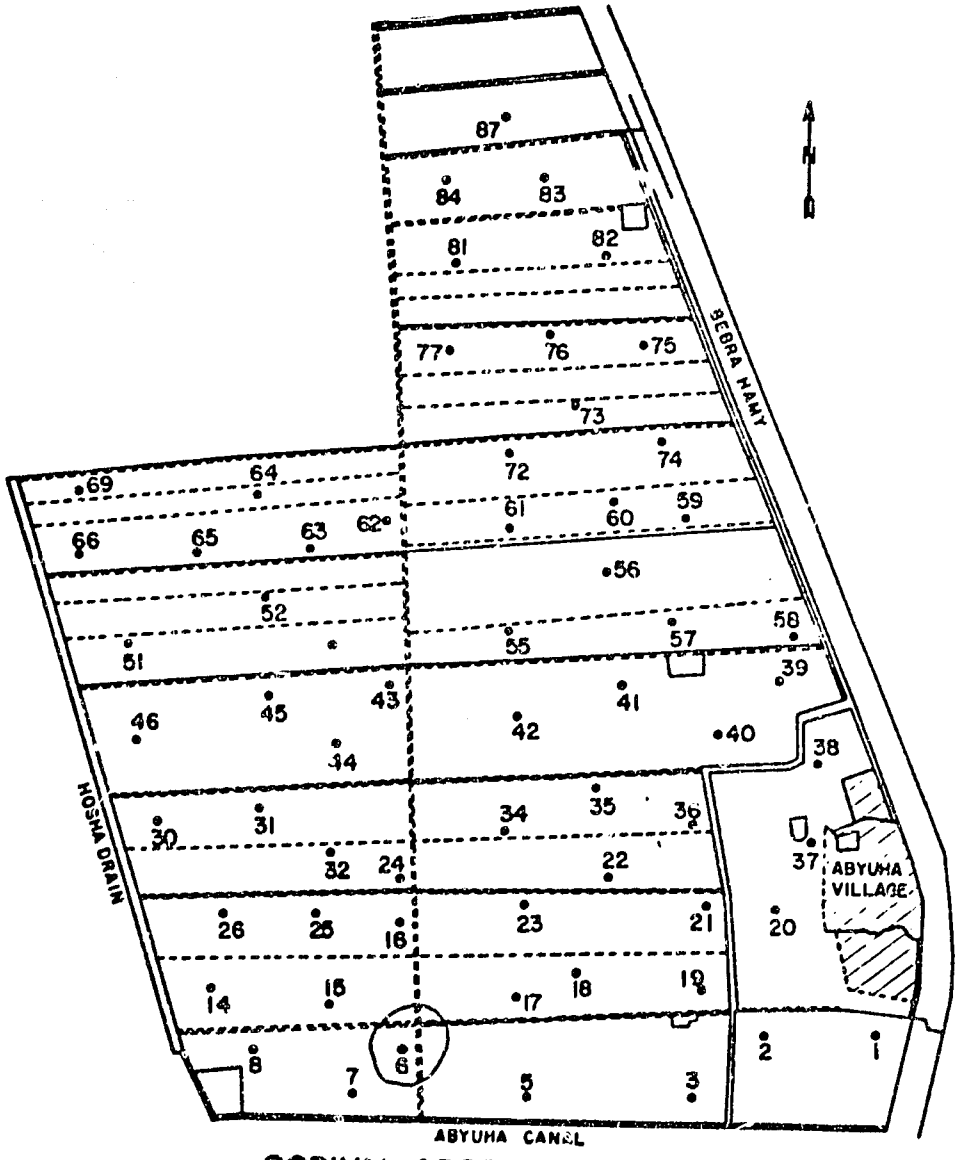

Figure A-3. SAR values for surface samples from Abyuha.

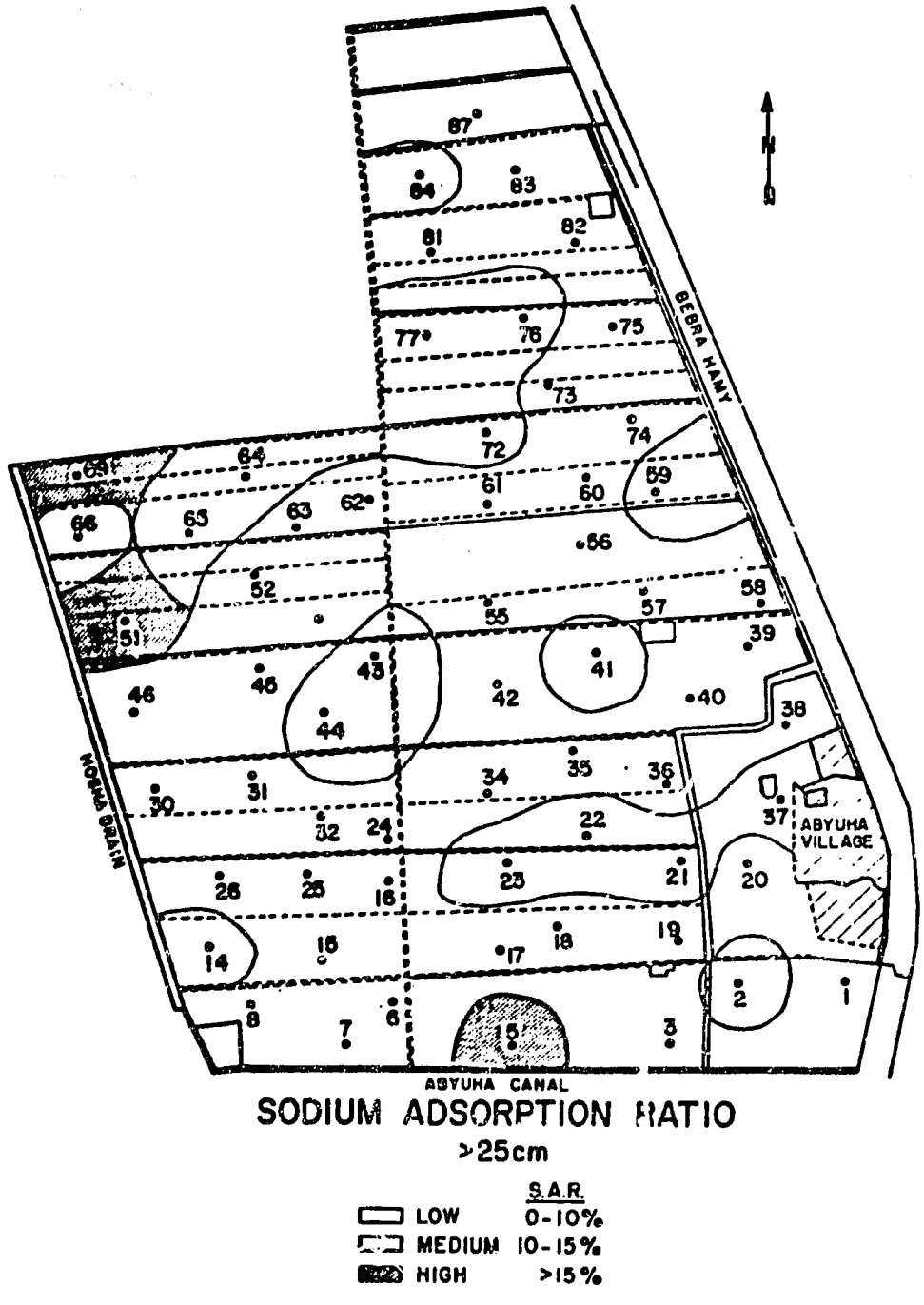

Figure A-4. SAR values for sub-surface samples from Abyuha.

Table A-1 Chemical Characterization Data of Selected Soil Profiles - Minya - Abyuha Study Area

Profile No.	Depth cm	pH*	SP**	EC*** mmhos/cm	Composition of the Saturation Extract meq/l						SAR***	ESP	CEC meq/100 gm soil	O.M. %
					Ca	Mg	Na	K	HCO_3	Cl				
1	0-20	8.1	76	2.2	4.4	7.2	11.6	0.5	2.5	5.1	4.8	1.5	45	2.4
	20-70	8.3	100	1.5	2.2	1.5	13.6	0.2	2.0	4.1	9.9	-	-	-
	70-150	8.3	99	3.0	2.2	3.1	26.5	0.5	1.5	6.1	16.3	21.0	48	1.1
2	0-30	8.2	73	1.3	2.8	2.5	8.9	0.2	1.5	3.1	5.4			
	30-70	8.3	96	2.6	1.7	3.6	23.9	0.4	3.0	6.1	14.7			
	70-150	8.1	98	4.1	3.3	6.2	36.0	0.6	2.0	11.2	16.5			
3	0-35	7.8	66	1.8	7.2	6.1	6.1	0.9	2.5	4.1	2.4			
	35-80	8.1	73	0.9	1.7	2.6	5.5	0.2	3.0	4.1	3.7			
	80-150	8.2	79	1.1	1.7	2.6	7.9	0.1	3.0	3.1	5.4			
4	0-30	7.9	80	1.6	3.9	4.1	9.7	0.3	2.5	5.1	4.9			
	30-90	8.3	100	1.9	3.3	3.0	13.6	0.3	2.5	8.2	7.6			
	90-150	8.0	100	4.6	5.0	7.7	37.0	2.3	2.0	14.3	17.7			
5	0-20	8.3	74	1.3	2.2	2.6	8.9	0.2	2.5	4.1	5.7	11.3	45	2.1
	20-80	8.3	110	3.2	2.8	3.1	27.3	0.5	1.5	10.2	16.0	18.0	48	0.9
	80-150	8.3	107	5.3	4.4	5.7	44.3	0.5	2.0	14.3	19.7	--	--	--
6	0-20	8.1	89	2.4	3.3	3.0	19.5	0.3	2.5	4.1	10.9			
	20-60	8.3	95	1.1	1.7	2.6	8.6	0.2	3.0	2.0	5.9			
	60-150	8.3	108	1.1	1.7	1.0	9.7	0.1	3.0	2.0	8.4			
7	0-20	7.8	63	2.2	3.9	4.6	16.3	3.3	2.5	9.2	7.9			
	20-50	7.9	87	2.3	2.8	4.1	16.6	0.4	2.0	6.1	9.0			
	50-150	8.1	103	1.7	1.7	2.6	13.0	0.1	2.1	7.1	8.9			

* pH of the saturation paste
** Saturation percentage
*** Of the saturation extract

Table A-1. Chemical Characterization Data of Seclected Soil Profiles - Minya-Abyuha Study Area

Profile No.	Depth cm	pH	SP	EC mmhos/cm	Composition of the Saturation Extract meq/l						SAR	ESP	CEC meq/100 gm soil	O.M. %
					Ca	Mg	Na	K	HCO_3	Cl				
8	0-20	8.1	78	1.1	2.2	4.2	6.8	0.3	2.0	3.1	3.8			
	20-60	7.8	80	0.8	3.9	4.1	2.2	0.2	1.5	2.0	1.1			
	60-150	7.9	85	0.7	1.7	2.1	3.3	0.2	2.5	2.0	2.4			
14	0-20	8.2	75	1.5	2.2	2.0	10.0	1.9	1.0	4.1	6.9			
	20-40	7.9	93	2.2	2.8	2.5	18.0	0.3	2.0	4.1	11.1			
	40-150	8.0	115	3.1	2.2	3.1	26.0	0.6	2.0	5.1	16.0			
15	0-15	7.8	74	1.2	3.3	2.0	8.1	0.3	3.0	2.0	5.0	8.3	43	2.1
	15-45	8.1	88	1.5	2.2	3.6	11.6	0.2	2.5	4.1	6.8	11.0	45	1.2
	45-150	8.1	105	3.8	3.3	4.6	37.3	0.6	2.0	8.2	15.7	19.0	47	0.9
16	0-25	7.8	70	1.6	3.3	6.2	9.9	0.3	2.0	4.1	4.5			
	25-60	7.9	67	0.9	2.8	3.1	6.3	0.2	3.0	2.0	3.7			
	60-150	8.2	95	1.1	1.7	2.6	8.6	0.1	3.0	2.0	5.9			
17	15-40	7.9	80	0.9	2.8	3.1	4.4	0.2	2.5	2.0	2.6			
	40-150	8.1	90	1.5	1.7	3.6	10.9	0.1	2.5	3.1	6.7			
18	0-25	7.8	75	0.9	4.4	1.4	4.4	0.3	2.0	2.0	2.6	3.7	45	2.1
	25-80	7.9	85	1.3	3.3	2.5	8.7	0.4	3.0	2.0	5.1	12.0	48	1.2
	80-150	8.0	80	3.8	3.3	2.5	33.2	0.3	3.0	9.0	19.4	23.0	48	0.9
19	0-30	7.9	61	1.4	6.7	2.5	4.7	0.5	2.5	3.0	2.2			
	30-150	7.9	80	1.7	3.3	2.5	11.0	0.2	2.5	2.0	6.4			
20	0-25	7.9	66	1.5	6.1	4.5	6.1	0.4	3.0	4.0	2.6	5.3	45	2.1
	25-80	8.0	73	1.1	2.2	1.0	8.6	0.2	2.5	2.0	6.8	11.5	46	2.1
	80-150	8.0	85	1.5	1.7	1.0	12.3	0.1	2.5	2.0	10.7	14.8	48	1.4

Table A-1. Continued

Profile No.	Depth cm	pH	SP	EC mmhos/cm	Composition of the Saturation Extract meq/l						SAR	ESP	CEC meq/100 gm soil	O.M. %
					Ca	Mg	Na	K	HCO_3	Cl				
21	0-25	7.9	73	1.5	4.4	3.0	7.5	0.4	2.5	2.0	3.9			
	25-80	8.0	100	2.3	3.3	2.5	18.0	0.5	3.0	3.0	10.5			
	80-150	8.0	70	3.8	4.4	3.0	29.2	0.4	2.0	9.0	15.2			
22	0-30	8.0	110	1.4	3.3	1.5	10.3	0.3	3.0	2.0	6.7			
	30-70	8.2	110	1.8	1.7	1.0	14.7	0.2	3.0	4.0	12.8			
	70-150	8.0	66	2.9	2.8	0.9	26.0	0.4	2.5	10.0	19.1			
23	0-30	7.9	95	1.5	7.8	4.5	3.3	0.4	3.0	2.0	1.3			
	30-70	8.2	110	1.3	1.7	1.0	12.0	0.1	2.5	2.0	10.4			
	70-150	8.1	75	2.9	2.8	2.5	24.5	0.2	2.0	6.0	15.0			
24	0-20	8.0	80	1.0	5.0	2.4	3.0	0.2	3.0	2.0	1.5			
	20-50	8.1	95	0.9	2.8	0.9	5.2	0.1	2.0	2.0	3.8			
	50-150	8.2	110	1.5	1.7	1.0	12.3	0.2	2.5	4.0	10.7			
25	0-20	8.0	73	1.4	5.0	1.9	6.6	0.2	2.0	4.0	3.6			
	20-55	8.1	105	1.1	2.2	1.0	8.3	0.1	2.5	6.0	6.6			
	55-150	8.1	98	2.6	3.9	2.0	20.5	0.3	2.5	10.0	12.0			
26	0-25	7.8	70	2.1	10.8	4.1	7.4	0.6	3.0	6.0	2.7			
	25-50	7.9	80	2.1	6.1	6.1	10.3	0.2	2.5	4.0	4.1			
	50-90	8.1	82	1.8	3.9	2.0	12.8	0.1	2.0	6.0	7.5			
	90-150	8.1	88	1.6	3.5	2.5	12.3	0.1	2.0	6.0	6.9			

Table A-1 Continued

Profile No.	Depth cm	pH	SP	EC mmhos/cm	Composition of the Saturation Extract meq/l						SAR	ESP	CEC meq/100 gm soil	O.M. %
					Ca	Mg	Na	K	HCO_3	Cl				
30	25-70	8.3	80	1.5	2.2	1.0	12.0	0.1	3.0	6.0	9.5			
	70-150	7.9	101	5.3	10.6	12.8	29.2	0.3	2.0	12.0	8.5			
31	0-35	8.1	77	1.4	5.0	2.4	7.0	0.2	2.0	4.0	3.6			
	35-65	8.2	99	1.6	6.1	1.9	9.6	0.1	3.0	4.0	4.8			
	65-150	8.3	108	1.3	1.7	1.0	10.8	0.1	3.0	6.0	9.4			
32	0-20	8.0	73	1.3	4.4	2.5	6.6	0.2	2.0	6.0	3.6	4.8	47	2.1
	20-70	8.1	85	1.3	2.2	1.0	9.6	0.1	3.0	4.0	7.6	12.0	48	1.4
	70-100	8.1	85	1.5	1.7	2.1	11.1	0.1	2.5	4.0	8.1	14.0	48	1.2
33	0-30	7.7	76	1.0	3.3	4.6	4.4	0.2	3.0	3.0	2.2			
	30-90	8.3	93	1.0	0.7	2.6	8.6	0.1	3.0	2.0	5.9			
	90-150	8.2	100	2.4	2.2	3.6	20.3	0.1	2.5	2.0	11.9			
34	0-20	7.9	75	0.9	2.8	3.6	3.5	0.2	3.0	2.0	2.0			
	20-60	8.0	78	0.6	2.2	2.0	3.5	0.1	3.0	2.0	2.4			
	60-150	8.1	100	1.3	1.7	2.6	10.9	0.1	4.5	4.0	7.4			
35	0-25	7.9	75	1.4	3.9	2.5	8.3	0.2	4.0	4.0	4.7	6.6	45	2.1
	25-70	8.3	107	1.2	2.2	2.0	10.0	0.1	5.0	3.0	6.9	13.0	48	0.9
	70-150	8.2	93	7.3	18.9	16.7	56.6	0.3	2.5	7.0	13.5	17.0	48	0.9
36	0-30	8.2	70	0.7	3.9	3.0	2.0	0.2	3.5	2.0	1.1			
	30-70	8.0	77	0.7	2.2	2.6	3.2	0.1	3.0	2.0	2.1			
	70-150	8.2	82	0.7	2.2	1.5	4.9	0.0	3.5	2.0	3.6			

Table A-1 Continued

Profile No.	Depth cm	pH	SP	EC mmhos/cm	Composition of the Saturation Extract meq/l						SAR	ESP	CEC meq/100 gm soil	O.M. %
					Ca	Mg	Na	K	HCO_3	Cl				
37	0-35	8.2	67	0.9	2.8	2.0	4.9	0.3	4.0	2.0	3.2			
	35-150	8.1	100	3.0	3.3	3.0	22.8	0.2	3.5	8.0	12.8			
38	0-35	7.9	65	0.8	3.9	2.5	2.7	0.1	4.0	2.0	1.5	4.1	43	2.1
	35-80	8.1	80	0.8	2.8	2.5	3.1	0.1	3.0	2.0	1.9	6.0	45	0.8
	80-150	8.4	87	0.8	2.8	0.2	5.2	0.1	3.0	2.0	3.6	11.0	46	1.0
39	0-40	8.1	70	0.8	2.2	0.4	5.5	0.2	3.0	2.0	4.8			
	40-150	8.3	112	1.4	1.7	3.6	11.4	0.1	4.0	3.0	7.0			
40	0-30	8.0	72	1.1	3.9	2.5	4.7	0.2	3.5	3.0	2.6			
	30-70	7.8	91	0.9	1.7	1.0	7.0	0.1	4.5	2.0	6.0			
	70-150	8.1	97	1.0	3.9	5.5	9.1	0.1	4.0	7.0	4.2			
41	0-30	7.9	75	1.6	1.7	1.5	11.4	0.3	3.5	4.0	9.0			
	30-70	8.3	126	1.7	1.7	2.1	15.2	0.1	4.0	5.0	11.4			
	70-150	8.2	95	1.6	3.3	2.0	12.4	0.1	3.0	2.0	7.6			
42	0-20	7.8	86	0.7	2.8	1.0	3.3	0.2	3.5	3.0	2.4	2.7	47	2.2
	20-60	8.1	90	1.0	2.8	1.4	7.2	0.1	2.5	3.0	5.7	11.5	49	1.2
	60-150	8.1	96	1.6	3.3	0.4	12.0	0.1	4.0	4.0	8.8	14.0	49	[illegible].9
43	0-30	8.0	82	1.5	1.7	2.6	10.9	0.3	3.5	4.0	7.4			
	30-70	7.9	90	5.6	10.0	7.5	42.5	0.4	2.0	6.0	14.4			
	70-150	7.8	100	6.5	10.6	13.4	44.2	0.3	2.0	20.0	12.8			

Table A-1 Continued

Profile No.	Depth cm	pH	SP	EC mmhos/cm	Composition of the Saturation Extract meq/l						SAR	ESP	CEC meq/100 gm soil	O.M. %
					Ca	Mg	Na	K	HCO_3	Cl				
44	0-30	8.0	85	1.1	3.3	1.5	5.5	0.3	4.0	3.0	3.6			
	30-70	8.2	109	2.2	3.3	2.0	16.9	0.1	3.0	7.0	10.4			
	70-150	7.9	92	7.3	16.4	19.7	46.5	0.2	2.5	12.0	10.9			
45	0-25	8.1	85	0.9	3.9	2.0	3.5	0.2	3.5	2.0	2.1	5.1	49	1.6
	25-60	8.4	113	1.0	2.8	2.0	8.1	0.1	3.5	3.0	5.2	5.5	50	0.9
	60-150	8.3	110	1.4	3.3	1.5	10.9	0.2	3.0	4.0	7.0	7.1	49	1.1
46	0-20	8.1	86	1.1	2.8	0.9	7.6	0.2	3.5	3.0	5.6			
	20-70	8.4	111	0.9	3.3	0.9	5.8	0.2	4.0	2.0	3.9			
	70-150	8.4	113	2.4	3.9	2.0	19.6	0.1	3.0	5.0	11.5			

Table A-1 Continued

Profile No.	Depth cm	pH	SP	EC mmhos/cm	Composition of the Saturation Extract meq/l						SAR	ESP	CEC meq/100 gm soil	O.M. %
					Ca	Mg	Na	K	HCO_3	Cl				
51	0-35	8.4	90	2.5	5.2	4.5	18.5	0.7	2.5	8.0	8.4	15.5	46	1.4
	35-70	7.9	81	8.7	18.2	11.1	74.0	0.7	2.0	20.0	19.3	16.0	48	0.9
	70-150	8.0	87	9.6	24.4	25.5	95.5	0.7	1.5	44.0	19.1	16.0	48	1.1
52	0-20	8.2	81	1.0	3.4	1.4	7.2	0.3	1.5	4.0	4.7			
	20-60	8.2	80	1.6	4.3	2.1	12.0	0.2	2.0	3.0	6.7			
	60-150	8.2	92	1.5	4.4	2.5	12.8	0.1	2.0	4.0	6.9			
53	0-30	8.1	74	1.0	5.0	1.9	4.3	0.2	2.0	5.0	2.3			
	30-70	8.2	87	1.3	3.5	1.4	10.3	0.1	2.5	3.0	6.6			
	70-150	8.3	97	2.0	4.6	1.4	16.5	0.1	1.5	6.0	9.5			
54	0-30	8.2	77	1.5	3.1	2.1	12.0	0.2	2.0	4.0	7.4			
	30-80	8.3	97	2.1	5.2	1.3	18.0	0.2	1.5	8.0	10.0			
	80-150	8.2	105	2.8	5.2	2.4	23.2	0.2	2.0	8.0	11.9			
55	0-30	8.1	75	1.2	3.8	2.0	8.6	0.2	1.5	4.0	5.0			
	30-150	8.3	105	2.7	5.6	4.4	20.7	0.2	2.0	5.0	9.2			
56	0-20	8.2	74	0.8	3.9	1.4	4.9	0.2	2.0	2.0	3.0	7.1	45	1.8
	20-60	8.2	94	1.4	2.8	2.0	12.0	0.1	2.0	3.0	7.8	13.5	47	1.1
	60-150	8.0	99	3.9	4.4	3.1	35.5	0.1	2.0	10.0	18.3	21.0	48	1.1
57	0-25	7.9	74	2.5	7.2	6.6	12.6	0.3	2.0	4.0	4.8			
	25-70	8.1	94	2.3	4.5	2.9	18.0	0.3	2.5	6.0	9.3			
	70-150	8.0	90	6.3	8.9	4.9	60.0	0.3	2.5	14.0	22.8			
58	0-30	8.0	73	2.0	6.6	3.0	12.0	0.4	1.5	3.0	5.5	7.9	43	2.1
	30-70	8.1	74	1.8	3.8	2.0	13.5	0.4	1.5	5.0	7.9	14.0	44	-
	70-150	8.3	97	3.2	5.4	3.5	24.2	0.1	2.5	10.0	11.5	18.0	46	0.6

Table A-1 Continued

Profile No.	Depth cm	pH	SP	EC mmhos/cm	Composition of the Saturation Extract meq/l						SAR	ESP	CEC meq/100 gm soil	O.M. %
					Ca	Mg	Na	K	HCO_3	Cl				
59	0-30	8.1	75	1.5	3.3	1.6	11.3	0.3	2.5	3.0	7.2			
	30-70	8.3	110	2.2	3.3	2.6	19.6	0.4	2.0	7.0	11.4			
	70-150	8.4	110	3.8	6.6	4.0	35.0	0.2	2.0	16.0	15.2			
60	0-30	8.2	73	1.1	3.3	2.6	8.1	0.2	3.0	3.0	4.7			
	30-100	8.3	120	2.8	5.5	5.1	20.2	0.2	2.5	10.0	8.8			
	100-150	8.2	85	4.9	7.7	5.1	43.0	0.2	3.5	18.0	17.0			
61	0-20	8.2	77	0.9	3.8	2.1	5.0	0.6	2.0	2.0	5.1			
	20-65	8.3	80	1.2	2.1	1.4	9.5	0.2	2.5	3.0	7.2			
	65-150	8.1	120	1.7	3.6	2.4	14.2	0.1	4.0	4.0	9.0			
62	0-20	8.1	75	0.9	4.8	2.1	3.2	0.3	2.5	3.0	1.7			
	20-60	8.2	80	1.1	5.1	2.4	5.6	0.2	3.0	4.0	2.9			
	60-150	8.1	76	0.7	2.8	1.4	3.7	0.1	2.0	2.0	2.5			
63	0-30	8.1	65	1.1	3.3	5.2	9.1	0.2	3.0	3.0	4.4			
	30-150	8.1	75	1.5	3.3	2.5	11.3	0.2	2.5	5.0	6.6			
64	0-30	8.1	70	1.2	3.3	5.2	8.3	0.3	4.0	2.0	4.0	8.7	41	2.1
	30-70	8.2	110	2.8	3.9	1.9	23.0	0.3	2.5	8.0	13.5	17.0	48	1.2
	70-150	8.1	105	5.9	5.5	6.2	49.2	0.6	2.5	16.0	20.3	23.0	48	0.9
65	0-30	8.1	75	1.9	3.9	2.5	12.3	0.5	4.0	6.0	6.9			
	30-80	8.3	140	2.5	4.4	3.5	20.7	0.3	3.0	6.0	10.4			
	80-150	8.3	120	4.3	5.5	4.1	37.0	0.5	2.5	10.0	16.9			
66	0-30	8.2	70	1.6	5.0	3.5	10.3	0.3	3.0	4.0	5.0			
	30-75	8.2	115	2.1	3.9	5.7	16.5	0.2	3.0	6.0	7.6			
	75-150	8.2	79	7.3	16.7	3.5	57.0	0.3	1.5	22.0	17.9			

Table A-1 Continued

Profile No.	Depth cm	pH	SP	EC mmhos/cm	Composition of the Saturation Extract meq/l						SAR	ESP	CEC meq/100 gm soil	C.M. %
					Ca	Mg	Na	K	HCO_3	Cl				
69	0-30	8.2	80	1.0	2.2	2.6	8.3	0.2	2.5	2.0	5.4			
	30-70	8.2	115	3.4	3.3	3.1	32.0	0.3	2.5	6.0	17.9			
	70-150	8.4	112	1.5	2.2	2.0	13.5	0.1	3.0	3.0	9.3			
72	0-30	8.1	65	0.9	2.8	1.4	5.2	0.2	2.5	2.0	3.6	5.3	46	2.1
	30-65	8.2	100	2.6	2.2	3.1	22.7	0.2	2.5	5.0	13.9	16.0	48	1.2
	65-150	7.9	85	8.6	16.1	15.8	78.5	0.7	2.0	15.0	19.7	20.0	47	0.9
73	0-25	8.1	72	1.0	3.9	3.5	5.2	0.3	2.0	2.0	2.7			
	25-70	8.3	95	1.4	3.3	3.1	10.8	0.1	2.5	3.0	6.1			
	70-150	8.4	115	1.5	2.8	3.0	11.0	0.1	2.5	3.0	6.4			
74	0-30	8.0	67	1.4	2.8	5.1	9.5	0.1	4.0	2.0	4.8			
	30-100	8.0	80	1.5	2.2	5.2	11.3	0.1	3.0	3.0	5.9			
	100-130	8.0	70	1.4	1.7	1.5	10.8	0.2	3.5	2.0	8.5			
75	0-30	8.0	62	1.0	2.8	3.0	5.2	0.4	3.5	3.0	3.0	5.5	45	2.1
	70-150	8.1	71	1.4	3.9	3.5	8.3	0.2	3.5	4.0	4.3	11.0	46	2.2
76	0-20	8.2	66	0.9	2.2	2.0	5.7	0.1	4.0	2.0	3.9			
	20-60	8.3	83	1.8	2.2	1.5	15.5	0.0	3.0	5.0	11.4			
	60-150	8.1	110	2.4	2.8	3.6	20.7	0.3	3.0	7.0	11.5			
77	0-30	8.0	65	1.0	2.2	4.2	7.2	0.1	3.5	3.0	4.0	8.2	45	2.2
	30-80	8.2	85	1.7	1.7	1.5	14.7	0.1	2.5	3.0	11.6	14.0	46	1.2
	80-150	7.8	74	5.4	10.0	11.2	47.5	0.1	2.5	18.0	14.6	19.0	46	1.1
81	0-25	8.1	70	3.5	12.7	5.8	15.2	0.6	2.0	18.0	5.0			
	25-70	8.2	90	1.8	2.7	2.6	14.2	0.1	3.0	5.0	8.7			
	70-150	8.3	60	0.8	3.3	3.1	5.7	0.1	2.0	3.0	3.2			

Table A-1 Continued

Profile No.	Depth cm	pH	SP	EC mmhos/cm	Composition of the Saturation Extract meq/l						SAR	ESP	CEC meq/100 gm soil	O.M. %
					Ca	Mg	Na	K	HCO_3	Cl				
82	0-20	8.1	70	0.6	2.7	2.6	3.0	0.2	2.0	2.0	1.8	5.0	32	0.8
	20-60	8.0	75	0.7	2.7	2.6	2.9	0.2	2.5	2.0	1.8	5.1	40	0.9
	60-110	7.8	40	0.9	3.3	3.6	3.7	0.1	2.0	3.0	2.0	6.2	23	1.1
	110-125	7.9	60	0.9	3.3	3.1	3.0	0.1	2.0	3.0	1.7	6.2	36	0.9
	125-150	8.0	70	0.6	3.3	2.0	3.2	0.1	3.0	2.0	2.0	8.0	41	
83	0-15	7.9	64	0.8	3.9	3.0	2.6	0.4	1.5	1.0	1.4			
	15-50	8.0	64	0.8	3.9	3.0	3.3	0.1	2.0	3.0	1.8			
	50-100	7.9	50	0.6	2.2	1.5	2.2	0.1	1.0	2.0	1.6			
	100-150	8.1	62	0.8	2.7	2.1	3.7	0.1	1.5	3.0	2.4			
84	0-20	8.0	90	1.8	5.6	2.3	12.1	0.4	2.0	5.0	6.1	11.7	45	2.0
	20-100	8.0	83	5.0	10.0	8.0	43.0	0.6	2.0	13.0	14.3	19.0	43	1.2
	100-150	8.0	85	6.5	11.1	10.9	55.0	0.8	2.0	30.0	16.6	19.5	44	0.9
87	0-30	8.2	53	0.9	4.4	2.0	4.1	0.2	1.5	4.0	2.3	4.9	37	1.8
	30-60	8.2	67	1.1	3.9	1.4	6.6	0.2	2.0	2.0	4.1	11.0	38	0.9

Table A-1 Continued

Profile No.	Depth cm	Clay %	Silt %	Fine Sand %	Coarse Sand %	$CaCO_3$ %	TSS %
1	0-20	50.4	25.3	22.2	0.9	3.7	0.2
	70-150	60.2	19.5	19.6	0.4	2.9	0.3
2	0-20	59.4	19.6	20.4	0.5	4.0	0.1
	80-150	65.4	18.4	14.2	0.5	3.7	0.5
15	0-35	48.5	32.4	14.3	4.6	5.6	0.2
	35-45	58.1	23.9	15.1	2.7	5.5	0.2
	45-150	59.4	29.9	8.2	2.0	4.3	0.6
18	0-25	46.4	30.5	21.3	1.8	3.2	0.1
	25-80	48.6	33.3	66.1	1.6	4.8	0.4
	80-150	59.5	31.2	6.8	2.3	2.7	0.2
20	0-25	50.2	28.1	19.0	2.6	3.8	0.1
	25-80	50.3	39.9	7.9	1.8	4.2	0.2
	80-150	59.1	31.0	8.2	1.5	3.4	0.3
32	0-20	57.9	33.9	5.9	2.1	4.6	0.3
	20-70	71.0	20.8	5.8	2.3	4.9	0.1
	70-100	57.5	34.4	5.4	2.6	3.8	0.2
35	0-25	60.4	24.7	12.1	2.6	4.2	0.2
	25-70	60.0	30.3	8.1	1.4	4.1	0.3
	70-150	59.8	30.1	7.8	1.5	3.0	0.9

Table A-2. Particle Size Data for Selected Soil Profiles in the Abyuha Study Site

Profile No.	Depth cm	Clay %	Silt %	F Sand %	C Sand %	$CaCO_3$ %	TSS %
38	0-35	46.5	34.3	16.8	2.3	3.1	0.1
	35-80	50.3	30.0	17.1	2.5	4.4	0.1
	80-150	44.7	37.3	15.8	2.1	3.9	0.2
42	0-20	46.2	36.5	16.0	1.3	4.3	0.1
	20-60	50.8	43.9	3.2	1.9	4.1	0.2
	60-150	54.6	36.5	7.1	1.6	3.7	0.3
45	0-25	67.4	16.1	14.2	2.1	4.2	0.2
	25-65	63.2	10.0	25.0	1.7	3.9	0.2
	65-150	68.5	18.2	10.7	2.4	3.4	0.2
51	0-35	52.5	24.8	20.6	1.8	3.9	0.3
	35-70	60.7	13.6	21.6	3.2	3.4	0.9
	70-150	60.2	10.6	27.4	1.7	2.6	0.1
56	0-20	53.2	20.0	25.9	0.9	4.0	0.0
	20-60	54.7	19.1	24.5	1.5	3.0	0.2
	60-150	56.0	16.9	24.4	1.8	2.5	0.4
58	0-30	37.0	13.5	47.4	2.0	3.7	0.2
	30-70	58.3	26.4	23.2	1.9	3.2	0.3
	70-150	49.0	33.1	17.0	0.9	2.8	0.1
64	0-30	56.6	22.7	19.8	0.8	4.4	0.2
	30-70	59.8	16.3	21.9	1.6	3.9	0.4
	70-150	60.7	21.3	15.6	1.8	3.7	0.6

Table A-2 Continued

Profile No.	Depth cm	Clay %	Silt %	F Sand %	C Sand %	$CaCO_3$ %	TSS %
69	0-25	67.2	27.1	1.0	1.0	3.5	0.2
	25-60	64.4	23.6	9.8	0.9	1.2	0.2
	60-100	43.3	42.4	12.1	0.7	1.3	0.2
73	0-35	50.0	20.0	20.0	21.0	1.5	1.1
	35-90	65.1	31.1	0.2	0.8	2.7	0.2
	90-150	68.1	27.8	0.8	1.3	0.7	0.3
75	0-30	50.5	38.5	7.9	0.8	2.2	0.1
	30-100	50.0	27.9	19.8	0.7	1.6	0.1
	100-150	20.6	30.4	46.7	1.0	1.2	0.1
81	0-30	40.0	14.0	43.5	1.2	1.1	0.3
	30-90	63.0	27.4	6.1	1.7	1.5	0.5
	90-150	62.0	35.1	0.5	0.6	0.4	1.4
82	0-25	61.0	30.2	4.7	1.9	3.1	0.1
	25-70	53.0	24.1	18.3	0.7	3.7	0.2
	70-90	38.0	25.9	33.2	1.4	0.9	0.6
	90-110	19.0	15.2	63.3	1.4	0.5	0.7
85	0-25	60.5	21.8	10.3	1.3	0.9	4.3
	25-60	64.0	18.8	12.8	0.8	0.8	2.8
	60-150	56.5	20.7	13.9	1.8	0.5	3.1
93	0-20	67.0	24.9	4.5	1.1	2.2	0.2
	20-100	63.0	29.6	4.2	1.1	2.0	0.2
	100-130	30.0	39.6	27.6	1.3	1.3	0.3
94	0-35	56.6	29.5	10.6	0.6	1.9	0.5
	35-100	54.0	30.1	15.2	0.7	1.5	0.5
99	0-25	48.0	27.0	22.9	1.2	2.4	0.5
	25-90	50.0	33.5	13.0	0.6	0.8	0.5
	90-150	49.0	36.0	11.4	0.3	0.9	0.6

Table A-2 Continued

Table A-3 Morphological and Associated Site Characteristics for Representative Soil Profiles - Abyuha Study Area

Profile No.: 18 Date: 19/9/1979

Location: Osman Basin

Land Form: Floodplain Water table: More than 150 cm

Slope: Level Vegetation: Cotton

Depth cm:	DESCRIPTION:
0-25	Very dark greyish brown (10 YR 3/2) moist, clay, moderate medium subangular blocky, firm, sticky, plastic, many fine and medium pores, many fine and medium roots, moderate effervescence, diffuse boundary.
25-80	Dark brown (10 YR 3/3) moist, clay, strong medium angular blocky, slickensides, firm, sticky, plastic, common fine pores, few lime concretions, few fine roots, moderate effervescence, diffuse boundary.
80-150	Dark brown (10 YR 3/3) moist, clay, strong fine angular blocky, slickensides, friable, sticky, plastic, common fine pores, few lime concretions, weak effervescence.

Table A-3 (Continued)

Profile No.: 32 Date: 20/9/1979

Location: Mohamed Youssef north

Surface: Cracks of 30-50 cm depth and 2-5 cm wide

Land Form: Floodplain

Water table: More than 150 cm

Slope: Level

Vegetation: Cotton

Depth cm:	DESCRIPTION:
0-20	Very dark greyish brown (10 YR 3/2) moist, clay, weak subangular blocky, firm, sticky, plastic, very fine and medium pores, many fine and medium roots, moderate effervescence, diffuse boundary.
20-70	Very dark greyish brown (10 YR 3/2) moist, clay, moderate medium angular blocky, slickensides, firm, sticky, plastic, common fine pores, few fine roots, weak effervescence, diffuse boundary.
70-100	Very dark greyish brown (10 YR 3/2) moist, clay, strong fine angular blocky slickensides, friable, sticky, plastic, common fine pores, weak effervescence.

Table A-3 (Continued)

Profile No.: 38 Date: 19/9/1979

Location: Abdel Latif basin

Land Form: Floodplain Water table: More than 150 cm

Slope: Level Vegetation: Maize

Depth cm:	DESCRIPTION:
0-35	Very dark greyish brown (10 YR 3/2) moist, clay, weak subangular blocky, firm, sticky, plastic, many fine and medium pores, many fine to coarse roots, moderate effervescence, diffuse boundary.
35-80	Dark brown (10 YR 3/3) moist, clay, morderate medium angular blocky, slickensides, friable, sticky, plastic, common fine pores, many fine roots, weak effervescence, diffuse boundary.
80-150	Dark brown (10 YR 3/3) moist, clay, strong, fine angular blocky, slickensides, friable, sticky, plastic, common fine pores, common soft lime concretions, weak effervescence.

Table A-3 (Continued)

Profile No.: 56 Date: 24/9/1979

Location: El-Hagar south basin

Land Form: Floodplain Water table: More than 150 cm

Slope: Level Vegetation: Maize

Depth cm:	DESCRIPTION:
0-20	Very dark greyish brown (10 YR 3/2) moist, clay, weak subangular blocky, firm, sticky, plastic, many fine and medium pores, common fine and medium roots, moderate effervescence, diffuse boundary.
20-60	Dark brown (10 YR 3/3) moist, clay, morderate medium angular blocky, slickensides, firm , sticky , plastic, many fine and medium pores, few fine roots, moderate effervescence, diffuse boundary.
10-150	Dark brown (10 YR 3/3) moist, clay, strong fine angular blocky, slickensides, firm, sticky, plastic, many fine pores, few soft lime concretions, few gypsum nodules, weak effervescence.

Table A-3 (Continued)

Profile No.: 64 Date: 22/9/1979

Location: El-Sabil basin

Land Form: Floodplain Water table: More than 150 cm

Slope: Level Vegetation: Cotton

Depth cm:	DESCRIPTION:
0-3o	Very dark greyish brown (10 YR 3/2) moist, clay, weak subangular blocky, firm, sticky, plastic, many fine and medium pores, many fine and medium roots, moderate effervescence, diffuse boundary.
30-70	Dark brown (10 YR 3/3) moist, clay, morderate medium angular blocky, slickensides, firm , sticky, plastic, many fine pores, few fine roots, moderate effervescence, diffuse boundary.
70-150	Dark brown (10 YR 3/3) moist, clay, strong fine angular blocky, slickensides, friable, sticky, plastic, common fine pores, few lime concretions, moderate effervescence.

Table A-3 (Continued)

Profile No.: 84 Date: 2/8/1979

Location: El-Nazelah North

Land Form: Floodplain Water table: More than 150 cm

Slope: Level Vegetation: Cotton

Depth cm:	DESCRIPTION:
0-20	Dark brown (10 YR 3/3) moist, clay, massive, friable, sticky, plastic, many fine and medium pores, many fine and medium roots, strong effervescence, diffuse boundary.
20-100	Dark brown (10 YR 3/3) moist, clay, moderate fine angular blocky, slickensides, friable, sticky, plastic, common fine pores, few soft, lime concretions, few fine roots, moderate effervescence, diffuse boundary.
100-150	Dark brown (10 YR 3/3) moist, clay, strong fine angular blocky, slickensides, friable, sticky, plastic, common fine pores, few gypsum veins and concretions, moderate effervescence.

AMERICAN EQUIVALENTS OF EGYPTIAN ARABIC TERMS AND MEASURES COMMONLY USED IN IRRIGATION WORK

LAND AREA	IN SQ METERS	IN ACRES	IN FEDDANS	IN HECTARES
1 acre	4,046.856	1.000	0.963	0.405
1 feddan	4,200.833	1.038	1.000	0.420
1 hectare (ha)	10,000.000	2.471	2.380	1.000
1 sq. kilometer	100×10^4	247.105	238.048	100.000
1 sq. mile	259×10^6	640.000	616.400	259.000

WATER MEASUREMENTS	FEDDAN-CM	ACRE-FEET	ACRE-INCHES
1 billion m^3	23,809,000.000	810,710.000	
1,000 m^3	23.809	0.811	9.728
1,000 m^3 /Feddan (= 238 mm rainfall)	23.809	0.781	9.372
420 m^3 /Feddan (100 mm rainfall)	10.00	0.328	3.936

OTHER CONVERSION		METRIC	U.S.
1 ardab	=	198 liters	5.62 bushels
1 ardab/feddan	=		5.41 bushels/acre
1 kg/feddan	=		2.12 lb/acre
1 donkey load	=	100 kg	
1 camel load	=	250 kg	
1 donkey load of manure	=	0.1 m^3	
1 camel load of manure	=	0.25 m^3	

EGYPTIAN UNITS OF FIELD CROPS

CROP	EG. UNIT	IN KG	IN LBS	IN BUSHELS
Lentils	ardeb	160.0	352.42	5.87
Clover	ardeb	157.0	345.81	5.76
Broadbeans	ardeb	155.0	341.41	6.10
Wheat	ardeb	150.0	330.40	5.51
Maize, Sorghum	ardeb	140.0	308.37	5.51
Barley	ardeb	120.0	264.32	5.51
Cottonseed	ardeb	120.0	264.32	8.26
Sesame	ardeb	120.0	264.32	
Groundnut	ardeb	75.0	165.20	7.51
Rice	dariba	945.0	2081.50	46.26
Chick-peas	ardeb	150.0	330.40	
Lupine	ardeb	150.0	330.40	
Linseed	ardeb	122.0	268.72	
Fenugreek	ardeb	155.0	341.41	
Cotton (unginned)	metric qintar	157.5	346.92	
Cotton (lint or ginned)	metric qintar	50.0	110.13	

EGYPTIAN FARMING AND IRRIGATION TERMS

fara = branch
marwa = small distributer, irrigation ditch
masraf = field drain
mesqa = small canal feeding from 10 to 40 farms
qirat = cf. English "karat", A land measure of 1/24 feddan, 175.03 m^2
qaria = village
sahm = 1/24th of a qirat, 7.29 m^2
saqia = animal powered water wheel
sarf = drain (vb.), or drainage. See also masraf, (n.)

EGYPT WATER USE AND MANAGEMENT PROJECT

PROJECT TECHNICAL REPORTS

NO.	TITLE	AUTHOR
PTR#1	Problem Identification Report for Mansuriya Study Area, 10/77 to 10/78.	Egyptian and American Field Teams.
PTR#2	Preliminary Soil Survey Report for the Beni Magdul and El-Hammami Areas.	A. D. Dotzenko, M. Zanati, A. A. Abdel Wahed, & A. M. Keleg.
PTR#3	Preliminary Evaluation of Mansuriya Canal System, Giza Governorate, Egypt.	American and Egyptian Field Teams.
PTR#4	On-farm Irrigation Practices in Mansuriya District, Egypt.	M. El-Kady, W. Clyma & M. Abu-Zeid
PTR#5	Economic Costs of Water Shortage Along Branch Canals.	A. El Shinnawi M. Skold & M. Nasr
PTR#6	Problem Identification Report For Kafr El-Sheikh Study Area.	Egyptian and American Field Teams.
PTR#7	A Procedure for Evaluating the Cost of Lifting Water for Irrigation in Egypt.	H. Wahby, G. Quenemoen & M. Helal
PTR#8	Farm Record Summary and Analysis for Study Cases at Abu Raya and Mansuriya Sites, 1978/1979.	F. Abdel Al & M. Skold
PTR#9	Irrigation & Production of Rice in Abu Raya, Kafr El-Sheikh Governorate.	Kafr El-Sheikh Team as Compiled by T. W. Ley & R. L. Tinsley
PTR#10	Soil Fertility Survey in Kafr El-Sheikh, El Mansuriya and El-Minya Sites.	M. Zanati, P. N. Soltanpour, A.T.A. Mostafa, & A. Keleg.
PTR#11	Kafr El-Sheikh Farm Management Survey Crop Enterprise Budgets and Profitability Analysis.	M. Haider & F. Abdel Al
PTR#12	Use of Feasibility Studies and Evaluation of Irrigation Projects: Procedures for Analysing Alternative Water Distribution System in Egypt.	R. J. McConnen, F. Abdel Al, M. Skold, G. Ayad & E. Sorial

NO.	TITLE	AUTHOR
PTR#13	The Role of Rural Sociologists in an Interdisciplinary, Action-Oriented Project: An Egyptian Case Study.	J. Layton and M. Sallam
PTR#14	Administering an Interdisciplinary Project: Some Fundamental Assumptions Upon Which to Build.	J. B. Mayfield & M. Naguib
PTR#15	Village Bank Loans to Egyptian Farmers.	G. Ayad, M. Skold, & M. Quenemoen.
PTR#16A	Irrigation System Improvement By Simulation and Optimization: 1. Theory.	J. Mohan Reddy & W. Clyma
PTR#16B	Irrigation System Improvement By Simulation and Optimization: 1. Application.	J. Mohan Reddy & W. Clyma
PTR#17	Optimal Design of Border Irrigation System	J. Mohan Reddy & W. Clyma
PTR#18	Population Growth and Development in Egypt: Farmers' and Rural Development Officials' Perspectives.	M. Sallam, E.C. Knop, & S.A. Knop
PTR#19	Rural Development and Effective Extension Strategies: Farmers' and Officials' Views.	M. S. Sallam, E. C. Knop, & S. A. Knop
PTR#20	The Rotation Water Distribution System vs. The Continual Flow Water Distribution System.	M. El-Kady, J. Wolfe, & H. Wahby
PTR#21	El-Hammami Pipeline Design.	Fort Collins Staff Team
PTR#22	The Hydraulic Design of Mesqa 10, An Egyptian Irrigation Canal.	W.O. Ree, M. El-Kady, J. Wolfe, & W. Fahim
PTR#23	Farm Record Summary and Analysis for Study Cases at Abyuha, Mansuriya and Abu Raya Sites, 79/80.	F. Abdel Al, & M. Skold
PTR#24	Agricultural Pests and Their Control: General Concepts.	E. Attalla
PTR#25	Problem Identification Report for El-Minya	R. Brooks

NO.	TITLE	AUTHOR
PTR#26	Social Dimensions of Egyptian Irrigation Patterns.	E.C. Knop, M. Sallam, S.A. Knop & M. El-Kady
PTR#27	Alternative Approaches in Extension and Rural Development Work: An Analysis of Differing Perspective In Egypt.	M. Sallam & E. C. Knop
PTR#28	Economic Evaluation of Wheat Trials at Abyuha, El-Minya Governorate 79/80-80/81.	N. K. Farag, E. Sorial, & M. Awad
PTR#29	Irrigation Practices Reported by EWUP Farm Record Keepers.	F. Abdel Al, M. Skold & D. Martella
PTR#30	The Role of Farm Records in the EWUP Project.	F. Abdel Al & D. Martella.
PTR#31	Analysis of Farm Management Data From Abyuha Project Site.	E. Sorial, M. Skold, R. Rehnberg & F. Abdel Al
PTR#32	Accessibility of EWUP Pilot Sites.	A. El-Kayal, S. Saleh, A. Bayoumi & R. L. Tinsley
PTR#33	Soil Survey Report for Abyuha Area Minya Governorate.	A. A. Selim, M. A. El-Nahal, & M. H. Assal
PTR#34	Soil Survey Report for Abu Raya Area, Kafr El-Sheikh Governorate	A. A. Selim, M. A. El-Nahal, M. A. Assal & F. Hawela.
PTR#35	Farm Irrigation System Design, Kafr El-Sheikh, Egypt.	Kafr El-Sheikh Team as compiled by T. W. Ley
PTR#36	Discharge and Mechanical Efficiency of Egyptian Water-Lifting Wheels.	R. Slack, H. Wahby, W. Clyma, & D. K. Sunada
PTR#37	Allocative Efficiency and Equity of Alternative Methods of Charging for Irrigation Water: A Case Study in Egypt.	R. Bowen and R. A. Young
PTR#38	Precision Land Leveling On Abu Raya Farms, Kafr El-Sheikh Governorate, Egypt.	EWUP Kafr El-Sheikh Team, as compiled by T. W. Ley
PTR#39*	On-Farm Irrigation Practices for Winter Crops at Abu Raya.	A. F. Metawie, N. L. Adams, & T. A. Tawfic

NO.	TITLE	AUTHOR
PTR#40	A Procedure For Evaluation Crop Growth Environments For Optimal Drain Design.	D. S. Durnford, E. V. Richardson & T. H. Podmore
PTR#41	The Influence of Farm Irrigation System Design and Precision Land Leveling on Irrigation Efficiency and Irrigation Water Management.	T. W. Ley, M. El-Kady K. Litwiller, E. Hanson W. S. Braunworth, A. El-Falaky & E. Wafik
PTR#42	Mesqa Renovation Report.	N. Illsley & A. Bayoumi
PTR#43	Planning Irrigation Improvements in Egypt: The Impact of Policies and Prices on Farm Income and Resource Use.	M. Haider & M. Skold
PTR#44*	Conjunctive Water Use - The State of the Art and Potential for Egypt.	V. H. Scott & A. El-Falaky
PTR#45*	Irrigation Practices of EWUP Study Abyuha and Abu Raya Sites for 1979-1980, 1980-1981, 1981-1982.	F. Abdel Al, D. Martella, & R. L. Tinsley
PTR#46	Hydraulic Design of a Canal System For Gravity Irrigation.	T. K. Gates, W. O. Ree M. Helal & A. Nasr
PTR#47	Water Budgets for Irrigated Regions in Egypt	M. Helal, A Nasr, M. Ibrahim, T. K. Gates, W. O. Ree & M. Semaika
PTR#48*	A Method for Evaluating and Revising Irrigation Rotations.	R. L. Tinsley, A. Ismail & M. El-Kady
PTR#49*	Farming System of Egypt: With Special Reference to EWUP Project Sites.	G. Fawzy, M. Skold & F. Abdel Al.
PTR#50	Farming System Economic Analysis of EWUP Study Cases.	F. Abdel Al, D. Martella, & D. W. Lybecker
PTR#51	Structural Specifications and Construction of a Canal System for Gravity Irrigation.	W. R. Gwinn, T. K. Gates, A. Raouf, E. Wafik & E. Nielsen
PTR#52*	Status of Zinc in the Soils of Project Sites.	M. Abdel Naim
PTR#53*	Crop Management Studies by EWUP.	M. Abdel Naim
PTR#54*	Criteria for Determining Desirable Irrigation Frequencies and Requirements and Comparisons with Conventional Frequencies and Amounts Measured in EWUP.	M. El-Kady, J. Wolfe & M. Semaika

NO.	TITLE	AUTHOR
PTR#55*	Design and Evaluation of Water Delivery System Improvement Alternatives.	T. K. Gates, J. Andrew, J. Ruff, D. Martella, J. Layton, M. Helal & A. Nasr.
PTR#56	Egyptian Canal Lining Techniques and Economic Analysis	M. El-Kady, H. Wahby, J. Andrew
PTR#57	Infiltration Studies on Egyptian Vertisols.	K. Litwiller, R. L. Tinsley H. Deweeb, & T. W. Ley
PTR#58*	Cotton Field Trials, Summer, 1980 Abu Raya.	Kafr El-Sheikh Team as compiled by M. Awad & A. El-Kayal
PTR#59*	Management Plan for a Distributary Canal System	A. Saber, E. Wafik, T. K. Gates, & J. Layton
PTR#60	Hydraulic Conductivity and Vertical Leakage in the Clay-Silt Layer of the Nile Alluvium in Egypt.	J. W. Warner, T. K. Gates, W. Fahim, M. Ibrahim, M. Awad, & T. W. Ley.
PTR#61	The Relation Between Irrigation Water Management and High Water Tables in Egypt.	K. Litwiller, M. El-Kady T. K. Gates & E. Hanson
PTR#62*	Water Quality of Irrigation Canals, Drains and Groundwater in Mansuriya, Kafr El-Sheikh and El-Minya Project Sites.	A. El-Falaky & V. H. Scott
PTR#63	Watercourse Improvement Evaluation (Mesqa #26 and Mesqa #10)	R. McConnen, E. Sorial, G. Fawzy
PTR#64*	Influence of Soil Properties on Irrigation Management in Egypt.	A.T.A. Moustafa & R. L. Tinsley
PTR#65	Experiences in Developing Water Users' Associations.	J. Layton and Sociology Team
PTR#66*	The Irrigation Advisory Service: A Proposed Organization for Improving On-Farm Irrigation Management in Egypt.	J. Layton and Sociology Team
PTR#67*	Sociological Evaluation of the On-Farm Irrigation Practices Introduced in Kafr El-Sheikh.	J. Layton, A. El-Attar H. Hussein, S. Kamal & A. El-Masry
PTR#68*	Developing Local Farmer Organizations: A Theoretical Procedure.	J. B. Mayfield & M. Naguib
PTR#69*	The Administrative and Social Environmentof the Farmers in an Egyptian Village.	J. B. Mayfield & M. Naguib

NO.	TITLE	AUTHOR
PTR#70*	Factors Affecting the Ability of Farmers to Effectively Irrigate: A Case Study of the Manshiya Mesqa, Kafr El-Sheikh.	M. Naguib & J. Layton
PTR#71*	Impact of Turnout Size and Condition on Water Management on Farms.	E. Hanson, M. El-Kady & K. Litwiller
PTR#72*	Baseline Data for Improvement of a Distributary Canal System.	K. Ezz El-Din, K. Litwiller, & Kafr El-Sheikh Team
PTR#73	Considerations of Various Soil Properties For The Irrigation Management of Vertisols	C. W. Honeycutt & R. D.Heil
PTR#74*	Farmers's Irrigation Practices in El-Hammami Sands	T. A. Tawfic, & R. J. Tinsley
PTR#75	Abyuha Farm Record Summary 1979-1983	EWUP Field Team
PTR#76	Kafr El Sheikh Farm Record Summary	EWUP Field Team
PTR#77*	El Hammami Farm Record Summary & Analysis	M. Haider & M. Skold
PTR#78	Beni Magdul Farm Record Summary	EWUP Field Team
PTR#79	Analysis of Low Lift Irrigation Pumping	H. R. Horsey, E. V. Richardson M. Skold & D. K. Sunada

EGYPT WATER USE AND MANAGEMENT PROJECT MANUALS

NO.	TITLE	AUTHOR
MAN.#1	Trapezoidal Flumes for the Egypt Water Use Project.	By: A. R. Robinson.
MAN.#2	Programs for the HP Computer Model 9825 for EWUP Operations.	By: M. Helal, D. Sunada, J. Loftis, M. Quenemoen, W. Ree, R. McConnen, R. King, A. Nazr and R. Stalford.
MAN.#5	Precison Land Leveling Data Analysis Program for HP9825 Desktop Calculator	T. W. Ley
MAN.#8	Thirty Steps to Precision Land Leveling	A. Bayoumi, S. Boctor & N. Dimick
MAN.#9	Alphabetical List of Some Crops and Plants with Their English, Egyptian, Botanical & Arabic Names and Vocabulary of Agricultural and other Terms Commonly Used.	G. Ayad
MAN.#10	EWUP Farm Record System	Farouk Abdel Al, David R. Martella, and Gamal Ayad

TO ACQUIRE REPORTS LISTED IN THE ATTACHED
PLEASE WRITE TO:

EGYPT WATER USE AND MANAGEMENT PROJECT
COLORADO STATE UNIVERSITY
ENGINEERING RESEARCH CENTER
FORT COLLINS, COLORADO 80523

Reports available at nominal cost, plus postage and handling.

*In Progress