THE USE OF DIGITAL IMAGE PROCESSING IN COMBINATION WITH A GEOGRAPHIC INFORMATION SYSTEM FOR MONITORING THE DEVELOPMENT OF RECENTLY RECLAIMED CALCAREOUS SOILS IN EGYPT.

by: WADID FAWZY ERIAN

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" And the LORD was with Joseph, and
he was a prosperous man.."

(GENESIS 39:2)

NANCY ,

For taking the time
to care....

For caring enough
to love....

For loving enough
to understand me

I love you.

Wadid

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ABSTRACT

In this study soil mapping and land evaluation were carried out by integrating a geographic information system with image processing techniques, in an attempt to obtain information about the degree of profile development through time in reclaimed calcareous soils in Nubariya province, Egypt.

TM digital data from September 1989 have been registered, transformed, and classified. A maximum-likelihood algorithm was applied in a rule-based supervised approach by means of which spectral information was transformed into landform information. The result has been evaluated in order to identify and enhance spectral variabilities between and within information units and to relate these to soil differences. A physiographic soil map was compiled by visual interpretation of the enhanced image with the support of ancillary information such as topographic maps and soil data in order to improve the reliability of the multispectral classification .

Geographic information system capabilities were used to improve the quality and reliability of the spectral classification. The visual interpretation map and the spectral classification were compiled using GIS procedures and few changes were made to come to the final physiographic soil map .

The physiographic soil map has been used as a base for presenting the different potential suitabilities for the most recommended LUT's for the study area. The resulting outputs were potential land suitability maps.

1. INTRODUCTION

The Egyptian civilization arose thousands of years ago on both sides of the Nile Valley and since then the Egyptians have mastered the technique of agriculture, so that the whole world started to follow in their footsteps.

Nowadays, Egypt's population is increasing by one million every ten months and the total population is today of 55 million. That is why more and more arable land is occupied by people. Statistics show that there is today 0.10 feddan(1 feddan=4,200m2) of agricultural land for every Egyptian, but this figure will drop drastically to 0.07 by the end of the century.

Nubariya district is located in the Northwestern part of the Nile Delta and is considered to have scope for the expansion of arable land as the Nile Delta traditionally forms the old alluvial cultivated land. This area is a part of the governmental national allocation program for university graduates with employment problems. It is considered to be one of the main targets in Egypt to overcome the unemployment problem, by using modern techniques for agriculture under desertic conditions. The total area of Nubariya district is about 500,000 feddans (1 feddan=4,200m2), part of which is an old reclaimed area and the new reclamation site is known as the Sugar Beet Zone(SBZ).

The surface area of the SBZ is of about 64,000 feddans. The area comprises 50 villages for university graduates with a capacity of accommodating 10,000 graduates. Each graduate will be able to receive a piece of land by the end of 1989 or the beginning of 1990. The number of inhabitants of these villages is expected to reach 20,000 by 1990 and to be increasing at an annual rate of 10% at least (since most of the graduates are at the age of marriage), to reach some 40,000 inhabitants by the end of the century.

The SBZ is considered as a "virgin area" since it has not been cultivated before . Therefore no recent soil or Land-use/cover maps of the area are available.

2. OBJECTIVES OF THE STUDY.

Summarising from the introduction the following points should be stressed :

a. The SBZ is a fertile zone for social, cultural and agricultural work.

b. The new generation of university graduates lacks experience and proper information about these recently reclaimed areas and about the modern technology and practices to be used under desertic conditions.

c. Advice about the best use of land and a proper crop rotation is highly needed to maximize the income of the users of the SBZ.

Accordingly , the main objectives of the study are:

1. The study of the soils of the area using digital image processing and geographic information system next to the data obtained from the field, will help to arrive at a soil map of the area (scale 1:100,000.).

2. The study of the changes in characteristics of calcareous soils under different stages of reclamation e.g.

-the thickness of the "A" horizon,
-the soil structure (type, size, grade),
-the bulk density and soil porosity (to study soil compaction),
-the soil salinity distribution,
-the fertility status (P,K,micronutrients and O.M. content),
-the water table levels,

will give an idea about soil profile development in these condition.

3. The study of the parameters determining the land qualities of the area will be a good base for establishing the potential land use patterns mainly for Sugar Beet, Wheat, Sweet Melon and some more fruit crops.

3. AGRICULTURAL DEVELOPMENT OF NEW LANDS IN EGYPT.

3.1. Land Reclamation - Past Experience.

Modern technology makes desert development and farming in arid zones a real possibility, but it generally remains a costly and risky undertaking. Capital and labour productivity in the agricultural sector in Egypt are low. Table (1-app.) presents the crop yields on new lands in Egypt (1976-1983). Also Table (2 a-app.) presents the yield projections for new lands.

Land reclamation before 1952 was mainly undertaken by individuals and private sector companies which have been nationalized afterwards, while lands was distributed among the tillers (Agrarian Reform Law 1952). It would be difficult for anyone to tell the difference now between the then successfully reclaimed land and the surrounding areas. Apart from the farm size, which is slightly larger on reclaimed land than that on 'old-old' land, all other features are the same. It should be noted that early land reclamation took place on heavy deltaic clay soils, similar to the soils with which the Egyptian farmer is so familiar.

Successful land reclamation after 1952 has taken place in parts of Nahda and Abis near Alexandria. Both areas are currently managed and cultivated by small to medium-size farmers. Families had obtained full ownership of the land in the early days of the project.

Also in the other parts of the Delta, e.g. Hamul, Kafr el Sheikh, Fariskur, and Damietta, Numerous farmers have succeeded in transforming former 'prairie lands' into productive farmland and today obtain crop yields which are comparable to those obtained elsewhere in the country. On the other hand, state farms which are considered successful still depend on the government budget rather than on crop yields to make ends meet. Public capital could have been saved and production delays avoided, if there had been a better distribution of duties and responsibilities between public and private sector.

Although the reclamation of coarse structured sandy desert soils has been undertaken for quite some time already and the agronomic viability of the venture has been proven in some projects such as Tahadi, it is still too early to definitely conclude on its economic and social viability since none of the schemes has reached the stage of full development or the stage of sustained growth. Gainfull cultivation of the sandy desert land has not yet been achieved in Egypt. Examples in other countries, however, show that modern farm technology permits profitable desert farming.

Table (2 b-app.) presents the international yield comparison for irrigated crops.

3.2. Geographical Location of the "New Lands".

3.2.1. "Old-new lands".

It is estimated that about 50,000 hectares were reclaimed during the first half of this century. Between 1952 and 1980 a total of about 372,000 hectares were reclaimed, of which about two thirds have been brought into production, and most of which are located in the Delta (see Table 3). The area reclaimed between 1952 and 1980 is widely referred to as the 'old-new lands'.

TABLE (3) Geographical Location Of the Old-New Lands

	Reclaimed area ('000 hectares)	%	of which productive ('000 hectares)	%
Western Delta	156]		120]	
Middle Delta	60 }	70	52 }	76
Eastern Delta	44]		32]	
Middle and Upper Egypt	88	24	52	19.5
Other	24	6	12	4.5
	----		----	
	372		268	

Source: PACER, 1986.

The reclamation projects on heavy deltaic soils are all located along the Northern coast of the Delta. The projects on calcareous soils, both completed and planned, are only found West of the Delta in the Nubariya area, Southwest of Alexandria. The projects on sandy soils have been constructed or are planned throughout the whole of Egypt.

Table (4) shows that although reclamation was started on 184,000 hectares of sandy soils only 104,000 hectares have been actually brought under cultivation. The remainder was either never completed or has been abandoned.

The heavy deltaic soils and the calcareous soils show a brighter picture. These soils have been put under the traditional basin irrigation. Specifically where the land is being farmed by smallholders, reclamation has been quite successful. It should be noted, however, that considerable parts of the calcareous soils now suffer from waterlogging and increasing salinity.

TABLE (4) Main Soil Types in the Old-New Lands, Reclaimed in the Period 1952-1979

	Area in which reclamation initiated (hectares)	**Area brought into production (hectares)**	**Area in production % of total**
Heavy deltaic soils	**108,000**	**96,000**	**89**
Calcareous soils	**80,000**	**68,000**	**85**
Sandy soils	**184,000**	**104,000**	**56**
Total	**372,000**	**270,000**	**72**

Source: World Bank Review 1984.

3.2.2. "New-New Lands".

Since 1980 there has been renewed interest in expanding the irrigated areas. During the period 1979/80 - 1981/82 reclamation was initiated in 56,500 hectares of new lands. West of the Delta about 24,000 hectares of sandy soils have been equipped with several types of sprinkler irrigation. East of the Delta 9,200 hectares in Salhiya and 13,200 hectares in Youth province have been provided with central pivot and drip irrigation. Specifically in these last two projects, which are managed as large-scale private agricultural enterprises using modern technology, reasonable yields have been obtained.

Moreover, there are a number of scattered areas along the mainstream of the Nile, along the Mediterranean coast and in the Sinai which are earmarked for reclamation.

New areas put under land reclamation since 1980 are listed in Table (5). These are generally referred to as the 'new-new lands'.

Soils reclaimed before 1952 were almost entirely clay soils, mainly situated in the Delta and some near Kom Ombo. For future land reclamation schemes one has to reckon with an ever increasing percentage of sandy soils, at higher elevations and generally further away from the main source of water, (World Bank Review, 1980) and (PACER, 1986).

TABLE (5) Geographical location of new-new lands

	Reclamation area (hectares)	%
Western Delta	**73,600**	
Middle Delta	**18,000** }	**82**
Eastern Delta	**116,800**	
Middle and Upper Egypt	**41,200**	**16**
Other	**5,200**	**2**

	254,800	

Source: PACER, 1986.

3.3. Land Reclamation Projects to the West of the Delta.

Recently large reclamation projects have been started on the desert fringe west of the Delta. Some areas have been reclaimed as North Tahrir (8,000 ha), a Mechanized farm (4,000 ha), Maryut area (20,000 ha), Maryut extension area (18,000 ha), El-Nahda area (13,200 ha), and South Tahrir and El-Tahady area (25,600 ha).

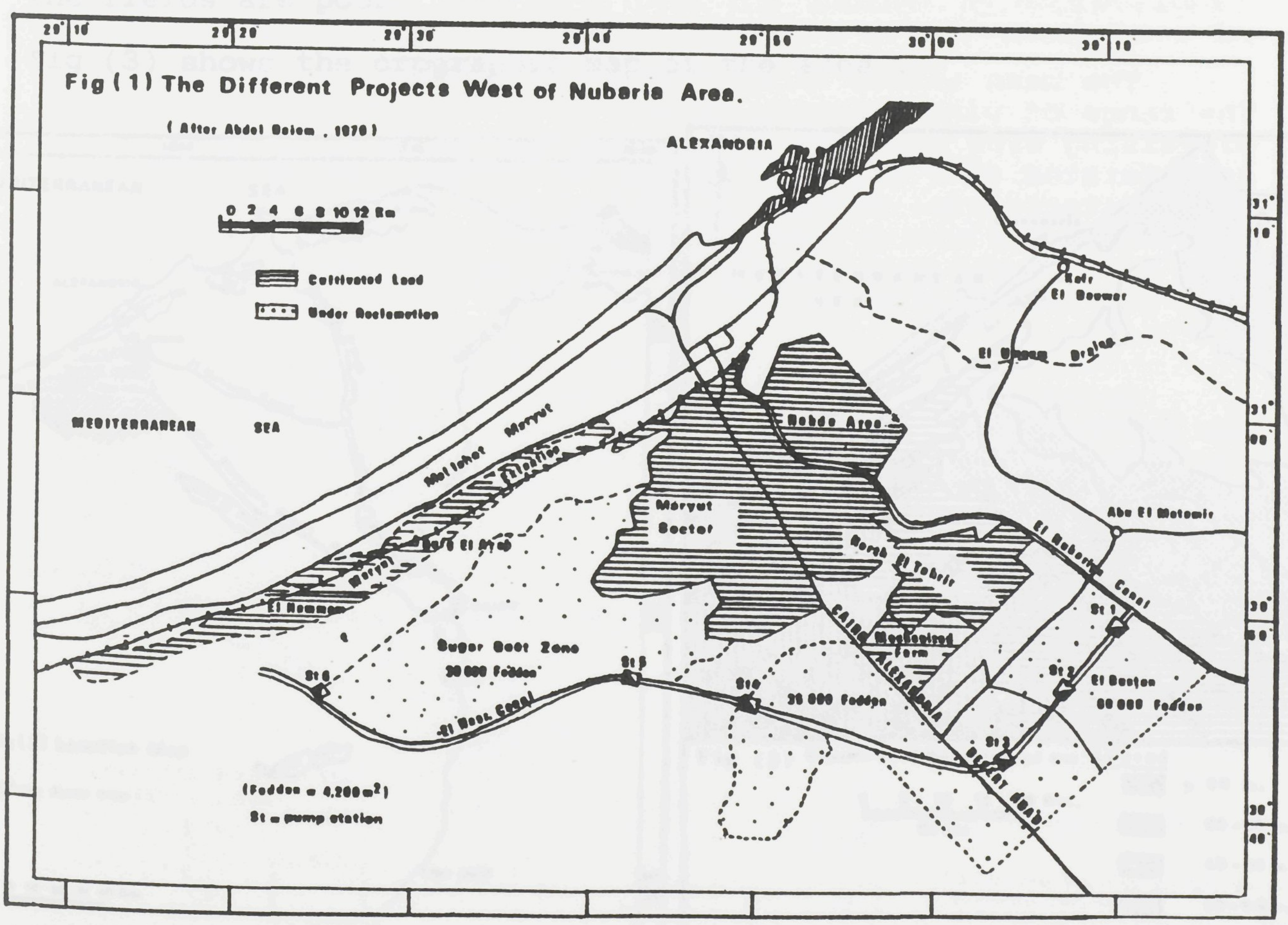
Some other areas are under reclamation as are the 117,720 ha of the project which is located south and west of Maryut extension area, table (6).

TABLE (6) List of Areas to be Developed to the West of Delta.

NAME of AREA	AREA (in ha.)
Bustan I (completed)	12,000
Bustan II (completed)	7,560
Bustan Extention	19,640
West Nubariya (partly reclaimed)	36,800
Sugar Beet Zone	26,800
Zawyet Sidi Abdel Ati	8,800
El Hammam *	6,000
Total	117,720

* Part of it within boudaries of new Burg El-Arab City.
Source: PACER, 1986.

Fig (1) the different projects to the west of the Nubariya area.



4. GENERAL CHARACTERISTICS OF THE NUBARIYA AREA:

4.1 Location and Accessibility:

The Nubariya area is situated between latitude 29° 30' N and 30° 00' N, and longitudes 29° 30' E and 30° 10' E, covering an area of about 500,000 feddans (1 feddan =4,200 m2). The location of the area under consideration is shown in Fig(2). The area selected for study is part of Nubariya area , and covers an area of about 215,000 feddans (910 Km2). Part of this area is in the province of Maryut, which is an old reclaimed area. The rest of the area is the most recently reclaimed area and is called the SBZ.

The elevation varies from +16 m to +50 m asl. with mostly flat slopes in all directions except of limited areas with a gentle slope. The main irrigation canal in the area is El Nubariya and its supplement is El Nasr canal. Most of the roads are newly constructed and motorable but the secondary roads to the fields are poor.

Fig (3) shows the orographic map of the area .

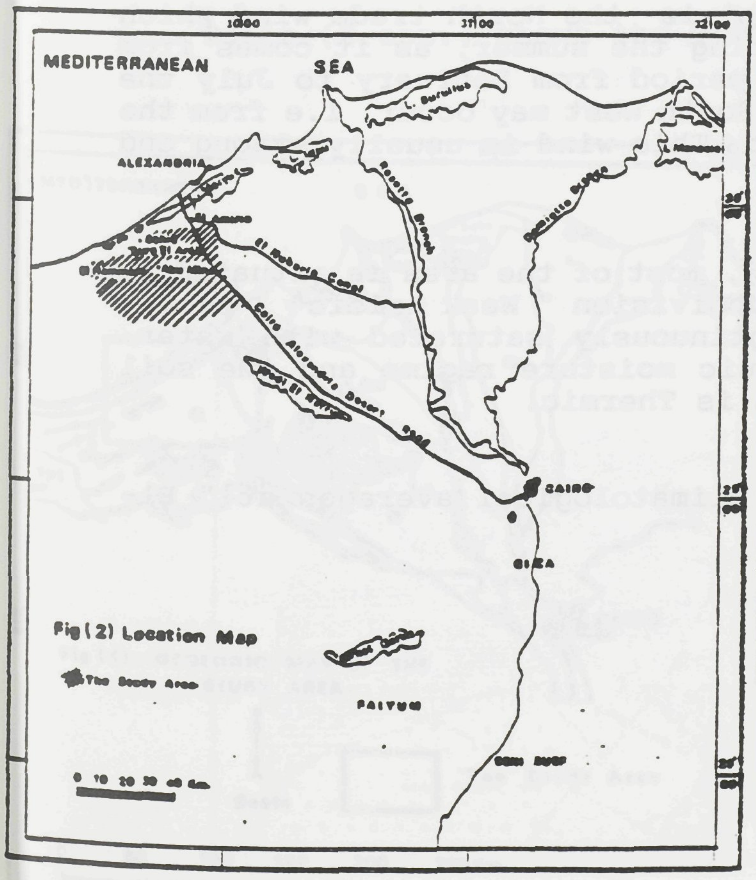


Fig (2) Location Map

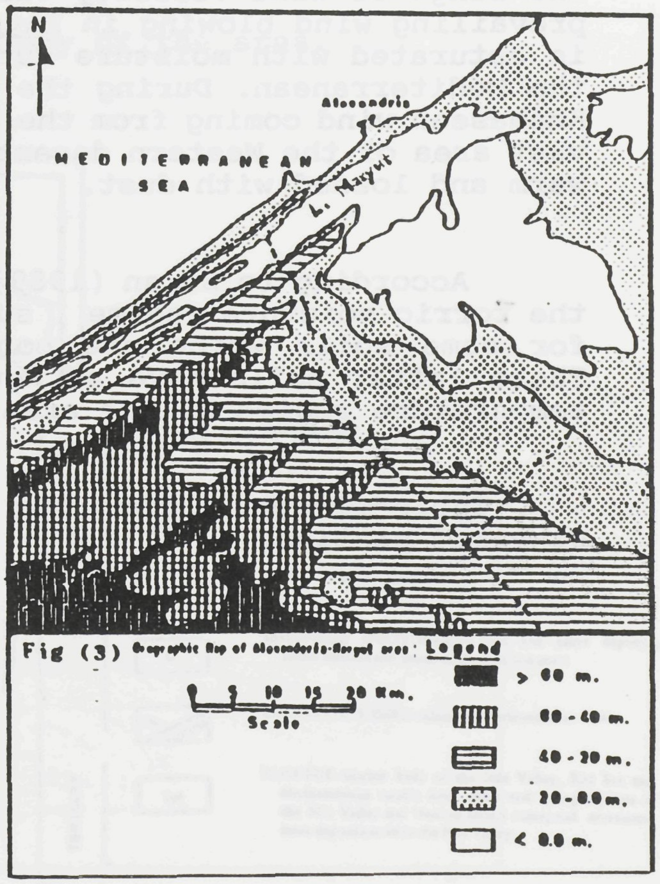


Fig (3) Orographic Map of Alexandria-Maryut area

4.2 Climate

The area has a Mediterranean climate , characterized by a rainy winter and a prolonged hot and dry summer. The amount of annual rainfall is low. It reaches about 180 mm and most of the precipitation falls in winter between October and March.

The mean annual temperature is 20.4 °C. The maximum monthly temperature is 26.6°C in August and the minimum is 13.7°C in January.

The average relative humidity over the year at El- Dekhila station (24 years of observation) is 68%. It is almost uniform throughout the year, with a minimum of 64% in March and a maximum of 72% in July..

The Potential evapotranspiration per year is 1,175 mm. The maximum evaporation rate is noticed in the warmer and dryer months, where it reaches 7.7mm per day in July. The minimum values noticed in the coldest months, i.e December and January, are about 5.5 mm per day (Erian, 1989).

The mean annual wind velocity is rather high ,i.e 8.7m/s The range of wind velocity varies from 7.4 m/s to 9.8 m/s. The prevailing wind blowing in Egypt is the North trade wind which is saturated with moisture during the summer, as it comes from the Mediterranean. During the period from February to July the Khamaseen wind coming from the South West may occur, i.e from the vast area of the Western desert. This wind is usually strong and warm and loaded with dust.

According to Erian (1989), most of the area is situated in the Torric moisture regime , subdivision " Weak Aridic" , except for some soils which are continuously saturated with water. These latter soils have an Aquic moisture regime and the soil temperature regime of the area is Thermic.

Table (7-app.) shows the climatological averages at " El-Dikhila" station.

4.3 Geology , Geomorphology and Hydrology.

4.3.1 Geology:

The geology of the coastal zone in the Western part of the Nile Delta has been studied by a number of scientists . This zone is occupied by sedimentary rocks belonging to the Quaternary and Tertiary. (after, Abd El-Rahman, 1970). The geologic map of the area is given in fig (4). According to the geological map of Egypt(1981), the major part of the area west of the Cairo - Alexandria desert road belongs to the" Miocene Era ". The Northern part is covered by "Pleistocene" and " Recent " deposits.

The Pleistocene deposits which cover the Northern part of the area are bordered by the Mediterranean sea.They are closely connected in their formation with changes of sea level, that took place during that period and they are represented by a number of successive coastal ridges. These run parallel to the present coastal line and are separated from one another by depressions. The ridges have been deposited in the form of off-shore bars in the ancient inland extension of the Pleistocene .

Table (8-app.) shows the geology of the area.

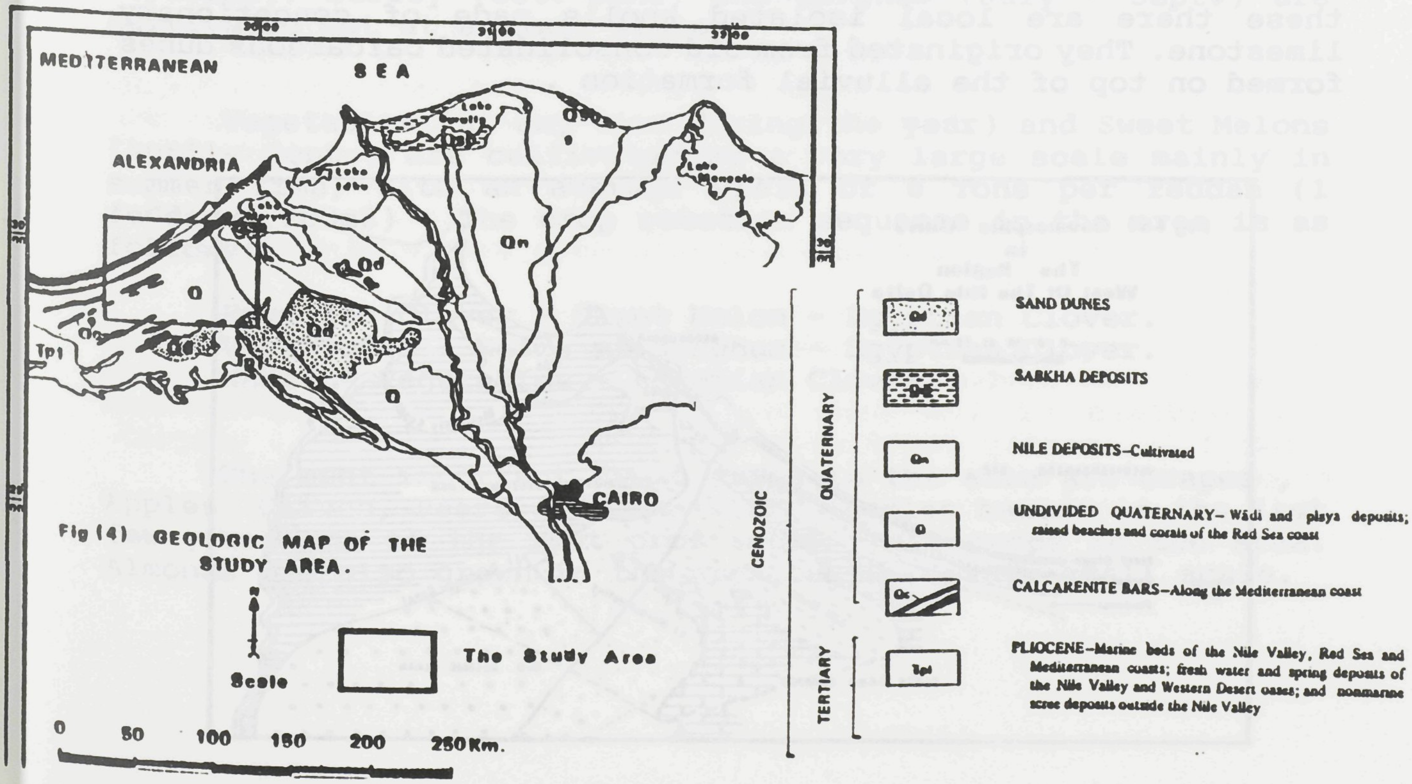


Fig (4) GEOLOGIC MAP OF THE STUDY AREA.

4.3.2 Geomorphology:

According to the Land Master Plan (PACER, 1986), the geomorphological units of the area Northwest of the Cairo - Alexandria desert road are as follows (fig 5):

- The table land which covers most of the Western part of the study area and constitutes a part of the plateau dominating the Northern portion of the Western desert (Said, 1962). The table land rises gradually in a Southward direction. It is dominantly formed of consolidated rocks or covered by a consolidated crust. Locally it is covered by loose eolian sands.

The surface of the table land is marked by scattered disconnected and irregular low lying limestone ridges. They are dissected by a number of well developed drainage ways. The surface of the " Maryut Table land " is low and undulating and it rises gradually in a Southwesterly direction to an elevation exceeding 60 m above sea level. It merges gradually into the Libyan plateau to the South and West. On the other hand, this table land slopes gradually towards the Delta basin in a Northeasterly direction. The Southwestern part of the area ,"Abu Mina Basin", forms a surface dominated by alluvial deposits (mainly calcareous loams), which are derived from the rock formations constituting the table land area. Close to the edges of this valley, the alluvial deposits are thin and are mixed with rock fragments , while, close to the edge of the Nile Delta the alluvial deposits become intermixed with the fresh water deposits of lake Maryut. The Abu Mina surface is dotted by a number of "Karmas" which are artificial clay banks, 2-3m in height, of different shapes (mainly circular, quadrant or horseshoe) and made by the Romans for soil and water conservation. Aside from these there are local isolated knolls made of concetionary limestone. They originated from old consolidated calcareous dunes formed on top of the alluvial formation .

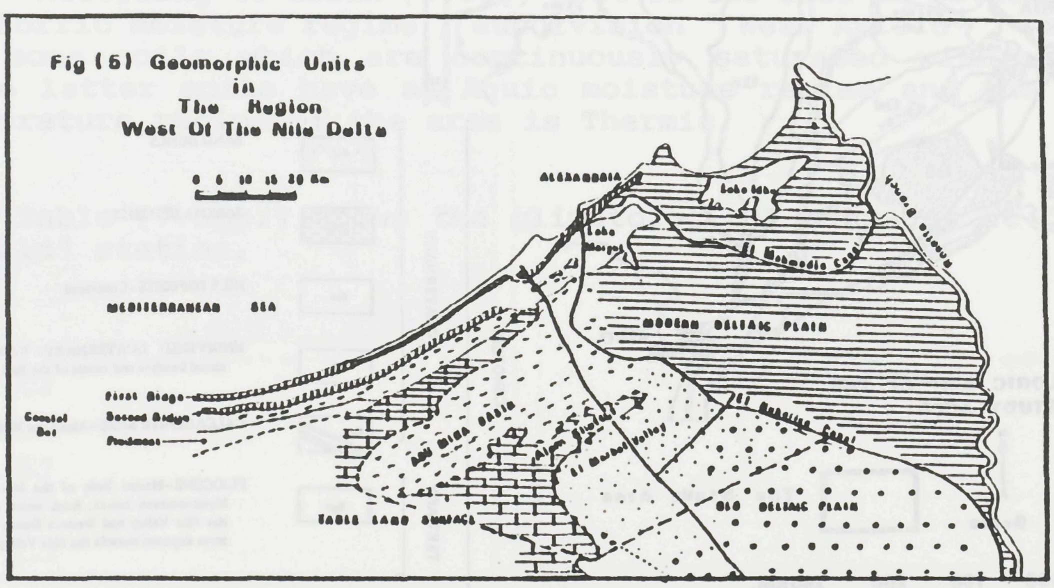


Fig (5) Geomorphic Units in The Region West Of The Nile Delta

4.3.3 Hydrology:

The study area is irrigated by El Nubariya canal and El Nasr canal which carry the Nile water through a branched system of canals and pumping stations to the different areas. The irrigation system is based on gravity (furrow and basin).

The salinity of the Nile water ranges between 1,100 ppm and 1,165 ppm. The present drainage grid in Maryut is not functioning very well due to the lack of proper maintenance. The salinity of the drainage water ranges between 2,176 ppm and 4,288 ppm. The irrigation and the drainage grids in the SBZ need more studies.

4.4 Land Use, Aspects of Agriculture and Natural Vegetation.

The total area in Maryut province is about 46,000 feddans (25,600 ha.) , which includes agricultural areas, settlements, roads, irrigation and drainage canals and other service areas. The agricultural part covers 88% of the total area (after Abd El-Motelib,1985). The main field crops in Maryut area are: Wheat (Oct.-June), with an average yield of 0.7 to 0.8 Tons per feddan (1 feddan=4,200m2), Maize (July - Sept.), with an average yield of 0.6 to 0.8 Tons per feddan (1feddan=4,200m2), and Egyptian Clover (the main fodder crop in the area, Oct.-March), with an average yield of about 12 Tons per feddan (1 feddan =4,200m2). Barley (Oct.-June) and Sorghum (July - Sept.) are cultivated but at a small scale.

Vegetables (at any time during the year) and Sweet Melons (April- Sept.) are cultivated at a very large scale mainly in summer time, with an average yield of 6 Tons per feddan (1 feddan=4,200m2) . The crop rotation sequence in the area is as follows:

Egyptian Clover - Sweet Melon - Egyptian Clover.
Vegetables - Maize or Sorghum - Egyptian Clover.
Wheat - Vegetables - Egyptian Clover.

The most important fruit crops in the area are Grapes , Apples, Olives, Pears and Date Palms. Apples became in the last few years one of the most profitable fruit crops in the area. Almonds are also grown in the area but on a very small scale.

At the SBZ , the same crop rotation than in Maryut is existing but the Sugar Beet would be considered as an important winter crop since the government is going to build a sugar factory in that area.

The natural vegetation is generally scanty and becomes denser towards the North as the rainfall increases in this direction. The most common plant is Crysanthemum ceronaricum.

4.5 The Main Soils present in the Study area:

The soil map of the FAO,1964 -surveyed 1961-, shows that the soils of the area are mainly Marine-Lacustrine soils, mainly a very shallow silt loam over a clay loam or a very deep silty clay loam. A few have a grayish subsoil with a very deep gypsiferous saline clay to loamy clay and some soils are locally shallow and underlained by rock.

The soils of the plains are of eolian origin. They consist of very coarse sand with a gently undulating topography. The groundwater is below 1.5 m depth and soils are slightly to highly saline. The soil reaction is neutral to moderately alkaline. The SAR values range from 10 to 30.

4.5.1 Description of the Mapping Units:

4.5.1.a Soils of the Table Land :

They include:

- Qaraa soil series(Qa): which are very deep to very shallow reddish, silt loam soils with many lime concretions, locally with a windblown sandy topsoil. They occupy the major part of the table land. The topsoil was washed away into the Mena valley leaving the compact reddish " B " horizon exposed at the surface.

These soils are deep loamy to clayey and reddish yellow in colour.

The topsoil contains many soft white lime segregations which form an horizon of 20 to 30 cm in depth. The number, size and hardness of the lime nodules increase with depth. The subsoil is locally mixed with gypsum crystals and has a grayish green colour.

- Mena soil series(Me): which are very shallow to moderately deep, yellowish silty loams over a reddish loamy subsoil with many lime nodules. The Mena soils can be considered as a transitional soil between the reddish Qaraa soils of the slopes and the yellowish colluvial soils of Abu Mena Valley. They are gently sloping. The topsoil is formed of yellowish silt loam deposits with high lime contents. This layer is of colluvial origin washed down from the higher Qaraa soils. The subsoil is similar to the Qaraa soils, except that they are less hard and have more soft lime concretions.

4.5.1.b Soils of the Abu Mena Basin :

- Ameriyah soil series (Am) : which are very shallow to moderately deep, silty loams over a loamy subsoil with soft lime pockets,

- karm soil series (K) : which are very deep yellowish calcareous silty loams.

Ameryiah and Karm soil series will be described together because of their similarity. They are formed of colluvial deposits consisting of hillwash from the slopes of the Maryut table land deposited in the Abu Mena Basin. These deposits attain a considerable depth. The profile is deep, uniform and loamy, showing only faint signs of lime accumulation in specific horizons. The topography is flat and almost level, with a slope of about 1m per km towards the Northeast. The soils are used by the beduins who plough and sow the entire area with Barley before the rainy season in the winter time. Ground water is at a depth of approximately 15 m and there are several wells. Underground cisterns are also used to store the rainfall in winter. Some of these cisterns date from Roman times.

The soils of Ameriyah series are deep, uniform loamy, with horizons of soft lime segregations formed in old colluvial materials. On the top more recent loamy materials have been deposited.

The Karm soils are found inside the ruined walls of the Roman karms. They were cultivated areas, surrounded by high earth banks. They were carefully chosen sites and designed to catch the runoff from the slopes. This system of water conservation has entirely disappeared in Egypt. The once high walls have collapsed and are now irregular ridges. However, they still enclose rectangular, circular or horseshoe shaped areas.

The soils of the Karm is a deep clayey loam. A very faint horizon of lime is locally observed but lime segregations are generally absent.

The texture of the karm soils is nearly the same as that of the Ameriyah.

4.5.1.c Soils of the limestone hills :

They include:

- Bahig soil series (Bg) :

The (Bg) soils found on the slopes and crests of the limestone hills are stony and shallow gravelly loams over disintegrated limestone. The topography is nearly level to gently sloping. The soils occur in small isolated areas and their agricultural value is very low.

4.5.1.d Miscellaneous land types :

They are identified as :

(Rs) - very stony soils or bare limestone,

(Kw) - loamy, eroded Karm walls, remnants of manmade origin.

Fig (6) presents the schematic cross section Cairo-Alexandria from km 157 to km 200.

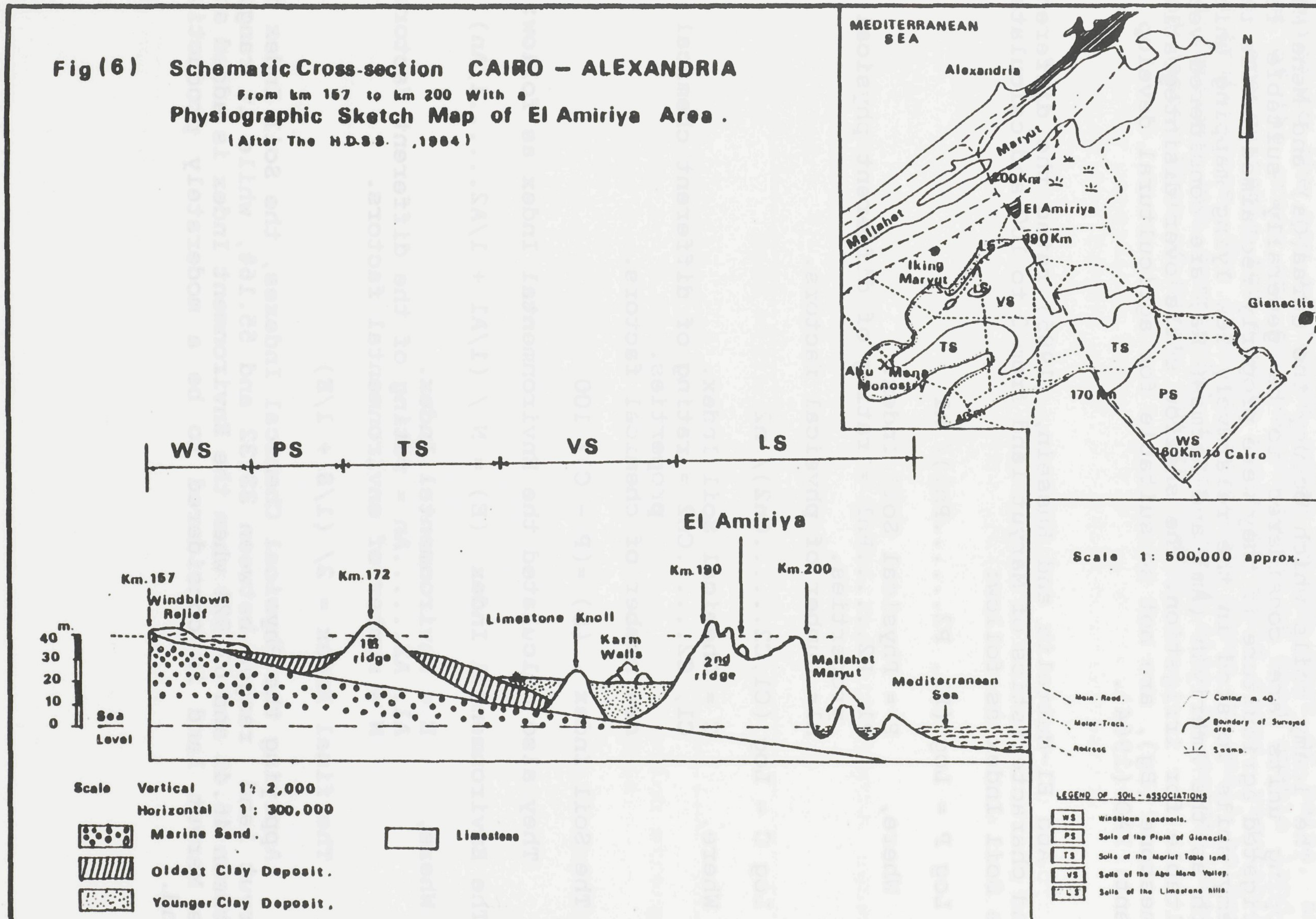


Fig (6) Schematic Cross-section CAIRO – ALEXANDRIA From km 157 to km 200 With a Physiographic Sketch Map of El Amiriya Area. (After The H.D.S.S. ,1984)

4.6. Land Evaluation.

The loamy soils which occupy the Qaraa(Qa) and Mena(Me) mapping units are considered to be generally suitable for irrigated agriculture if they were properly reclaimed, while the loamy soils located in the relatively low lying mapping units such as the Ameriyah (Am) and Karmas(Ka) are considered very suitable for irrigation. The shallow soils over disintegrating limestone (Bg), are not so suitable for agricultural develop -ment, FAO (1964).

Abd El-Muttelib and Hussein, (1985) rated the different land characteristics of Maryut land from 0 to 100 and calculated the Soil Index as follow:

- $\text{Log } P = \text{Log } (P1, P2......Pn1)/ n1$

Where, P = Physical Soil Index.
$P1, P2......Pn1$ = rating of different physical properties.
$n1$= number of physical factors.

- $\text{Log } C = \text{Log } (C1,C2......Cn2)/ n2$

Where, C = Chemical Soil Index.
$C1, C2......Cn2$ = rating of different chemical properties.
$n2$= number of chemical factors.

- The Soil Index $(S) =(P - C)/ 100$

They also calculated the Environmental Index as follow:

- The Environmental Index $(E) = N / (1/A1 + 1/A2......1/An)$

Where, E = Environmental Index.
$A1, A2......An$ = rating of the different factors.
N = number of environmental factors.

The final Index $= 2/ (1/S + 1/E)$

Applying the Physical Chemical Indexes, the Soil Index of Maryut land ranges between 33.32 and 55.16%, while it ranges between 46.41 and 67.92% when the Environment Index is added and the Maryut land is considered to be a moderately productive land.

The modified Egyptian system within the frame of the Land Master Plan of Egypt for land capability classification has been applied to the new reclaimed areas in the West of Delta, and most of the areas are considered to be of good arable land.. They are suitable for a wide range of field crops, vegetables and fruit trees. The land is preferably given to small holders and families but commercial farms could also be established, Land Master Plan of Egypt, (PACER, 1986).

5. MATERIALS AND METHODS

5.1 Materials used:

a) A Landsat Thematic Mapper Computer Compatible Tape (CCT) of 16 Sept. 1989 which covers the 2nd quarter of track number: 178, frame number :39 has been acquired . The images on the computer compatible tapes (CCT's) were already geometrically corrected at the Fucino receiving station (Telespazio).

The Thematic Mapper data are sensed in seven (7) spectral bands, the information about the bands characteristics is given in table (9). The selection of the date was based on the need to have a maximum area of bare soil.

Table (9) The wavebands recorded by the Thematic Mapper sensor carried by Landsat 4 and 5.

Band No.	Band name	Band width(μm)	Points
1	**Blue/Green**	**0.45-0.52**	**Good water penetration strong vegetation absorbance.**
2	**Green**	**0.52-0.60**	**Strong vegetation reflectance.**
3	**Red**	**0.63-0.69**	**Very strong vegetation absorbance.**
4	**Near infrared**	**0.76-0.90**	**High land/water contrasts, very strong vegetation reflectance.**
5	**Near-middle infrared**	**0.55-1.75**	**Very moisture sensitive.**
6	**Thermal infrared**	**10.4-12.5**	**Very sensitive to soil moisture and vegetation.**
7	**Middle infrared**	**2.08-2.35**	**Good geological discrimination.**

Sources: NASA 1982.

b) Other data and available information :

- The topographic maps of the area sheets NH.35.L6d "Nubariya" and NH.35.L6c " Burg El Arab", scale 1:50,000 and NH.35.L6, scale 1:100,000 produced by the Military Survey Department, 1983 El-Amiriya.

- The soil map of the area, FAO 1964 scale 1:50,000.

- The geological map of Egypt, scale 1:2,000,000 , produced by the Ministry of Industry and Mineral Resources, 1981.

- Semi-detailed soil survey by the High Dam Soil Survey Project in cooperation with the FAO, scale 1:50,000.

c) Equipment used

- The Integrated Land and Watershed Management System (ILWIS) developed in ITC has been used as the main software for this study.

The general objective in using ILWIS is to contribute to the improvement of the availability and quality of information on which watershed management can be based, a watershed being the best delineable unit for which human and natural resources inter relationships could be observed and modelled, Valenzuela, (1988).

The system provides users with state-of-the-art data gathering, data input, data storage, data manipulation/analysis and data output capability by marrying and integrating conventional geographic information system (GIS) Procedures with image-processing capabilities. Interface operations with a relational database management system (DBMS) like Oracle (Oracle Corporation Inc.) is also possible, Bedendo,(1990).

Fig (7) presents the schematic representation of ILWIS.

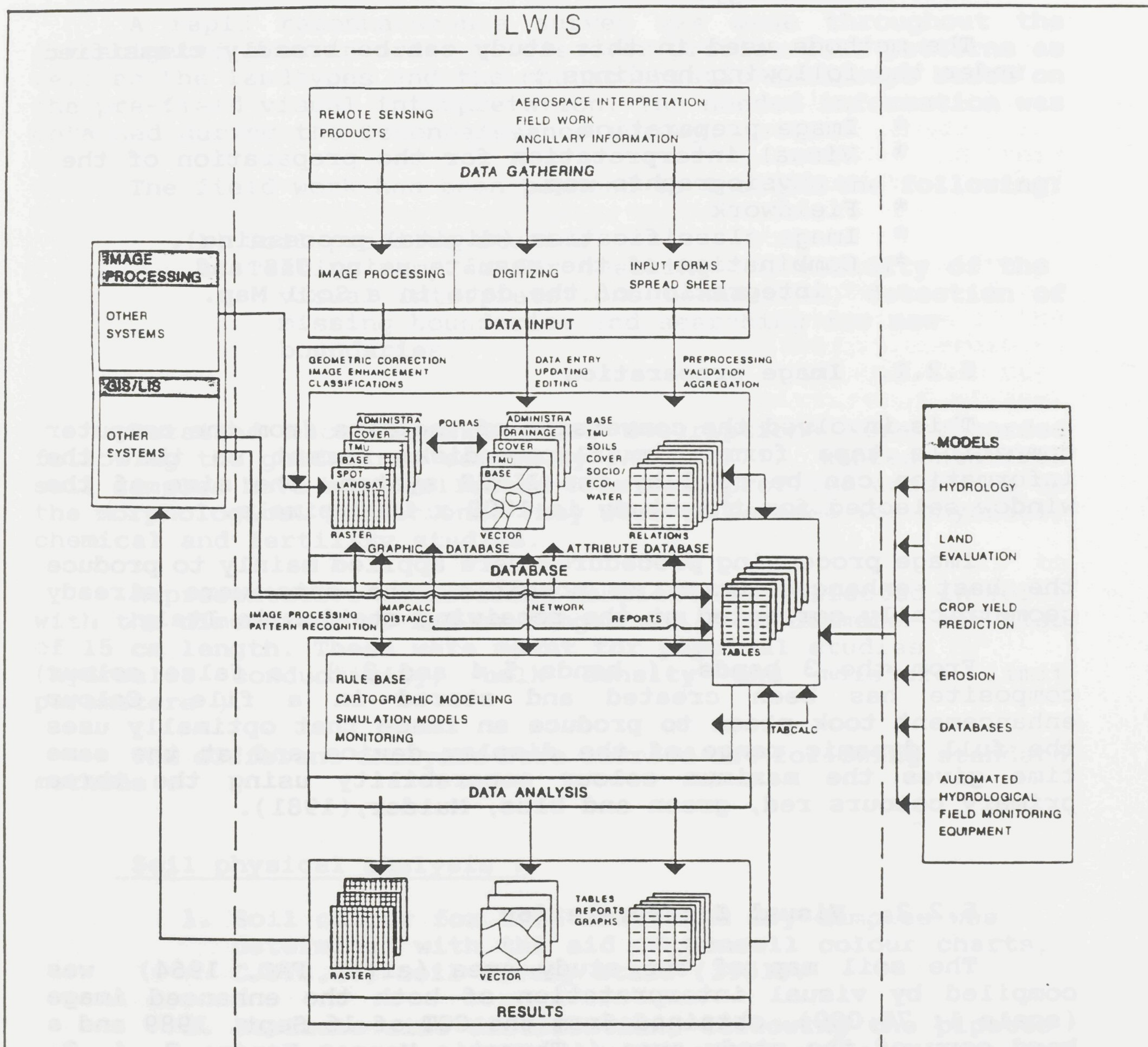


Fig (7) (schematic representation of ILWIS)

5.2. Methodology:

The methods used in this study can be broadly classified under the following headings :

* Image preparation
* Visual interpretation for the preparation of the physiographic map.
* Fieldwork
* Image classification (digital processing).
* Combination of the results using GIS and integration of the data in a Soil Map.

5.2.1. Image preparation

This involved the conversion of the data from the computer compatible tape format to floppy disks format so that the information can be read by the ILWIS system. The size of the window selected for the study is 1000 x 1200 pixels.

Image processing procedures were applied mainly to produce the best enhanced image as possible. The data were already geometrically corrected at the receiving station in Italy.

From the 3 bands ,(bands 5,4 and 3), a false colour composite has been created and stored in a file. Colour enhancement took place to produce an image that optimally uses the full dynamic range of the display device and at the same time gives the maximum colour separability using the three primary colours red, green and blue, Mulder,(1981).

5.2.2. Visual Interpretation

The soil map of the study area (after FAO, 1964) was compiled by visual interpretation of both the enhanced image (scale 1: 75,000) obtained from the CCT of 16 Sept. 1989 and a hard copy of the study area (Thematic Mapper Bands: 7, 4, 3, and 5), of the date 22 Dec. 1986(scale 1:100,000).

During this procedure all the available information such as geological map, topographical maps, available soil data, and the reference information about the area before and during the fieldwork, helped in identifying the landtypes.

5.2.3. Fieldwork

A rapid reconnaissance survey was made throughout the investigated area in order to discover precise soil patterns as well as the landtypes and the characteristic landscape based on the pre-field visual interpretation. The needed information was obtained during the reconnaissance survey.

The field work had been planned to include the following:

1) Soil profiles studies.
2) Testing samples for checking the validity of the visual interpretations boundaries, detection of missing boundaries and searching for new boundaries.

Detailed macro-morphological descriptions were recorded following the guidelines edited by FAO (1977). Representatives soil samples have been collected from soil profiles according to the morphological variations. They were to be used for physical, chemical and fertility studies.

Representative undisturbed samples were collected in cores with the dimensions of 2.5 cm length and 4 cm diameter and also of 15 cm length. These were meant for physical studies (hydraulic conductivity, bulk density and moisture limit parameters).

The different analyses were carried out following standard methods .

Soil physical analysis :

1. Soil colour for both moist and dry samples was determined with the aid of Munsell colour charts, C.U.S.D., soil survey staff (1951).

2. Particle size distribution, following the pipette method, using sodium hexameta-phosphate, Kilmer and Mullins (1954).

3. Hydraulic conductivity was carried out according to the method by USSL staff (1954).

4. Moisture retained at field capacity, permanent wilting percentage and interval points, were determined by the pressure membranes apparatus, Richards (1954).

Soil chemical analysis :

1. Calcium carbonate content in soil determined by Collin's Calcimeter, Wright (1939).
2. Gypsum percent was determined by acetone method, Bower and Huss (1948).
3. Organic matter using the modified Walkley and Black method, Jackson (1967).
4. The electrical conductivity of the saturated soil extract was carried out according to Jackson (1967).

Soil fertility analysis :

1. Phosphorus determination
   Available phosphorus was extracted by 0.5N $NaHCO_3$ (pH 8.5) and determined according to Olsen (1954).
2. Potassium determination
   Exchangable potassium was extracted by 1N NH_4OAC solution (pH7), Jackson (1967) for determination by Flame Photometer.
3. Available Fe, Cu and Zn were obtained by DTPA after Lindsay and Norvell (1978), and determined using Atomic Absorbtion.

Spectrometer :

The Spectrometer has been used in the field to measure the spectral differences for the different mapping units, soils. The radiometric field data - calculated and printed by a Sharp 1600 pocket computer- are based on comparison of measurements with a pure white $BaSO_4$ plate used as reference.

$$\left(\frac{BaSO_4}{100} = \frac{Object}{X} \right)$$

$$X = \frac{100 \times Object\ (reading)}{BaSO_4\ (reading)}$$

The bands (1, 2, 3 and 4) used in the study are bands 4, 5, 6 and 7 if compared with the MSS bands on Landsat 1,2 and 3.

5.2.4. Image Spectral Classification.

The main objective of this procedure is to automatically categorize all pixel values of an image into classes. The application of statistically based decision rules is used for determining the identity of each pixel in the image. The spectral pattern recognition procedures included in this research is so called a " supervised " approach used to classify spectral differences on the image.

The supervised classification requires a good reference knowledge about at least some training sets for the use of the maximum likelihood (MLHD) decision functions. The purpose of the training sets is to assist the computer program in determining the statistical relationships between the data and the user defined classes in order not to contain a mixture of classes when running the classifier.

5.2.5. The Use Of A GIS.

The wide possibilities of the GIS of ILWIS would be applied to improve the spectral classification results, and to transform them into a physiographic soil map and a potential land suitability map.

5.2.6. General Overview of the Methodology .

The different stages of data input, transformation and output applied in this study have been grouped into four sets of processing functions or activities:

* Data input procedures.
* Data pre-processing.
* Data processing.
* Data integration.

These steps have been represented in a Flow chart in fig (8), in which the sequence, integration and interrelationships among the four processing steps are easily overviewed. in table (10) a summary of the data-processing operations is given together with their corresponding purpose of use (based on the model of Phillips and Swain,1978 and Bedendo,1990).

Table (10) Summary of processing steps and purposes.

Processing Function	Purpose
1. Data input procedures.	Input in band data into the processing system.
ERDAS to ILWIS transform.	Convert input data into the ILWIS format.
2. Data pre-processing. (data compression)	Improve efficiency of transmitting, storing or manipulating data.
Image enhancement	Accentuate the characteristic of data for visual display and interpretation.
Feature extraction data-redundancy reduction	Decorrelate multichannel information to reduce data dimensionality, enhance discriminability and improve subsequent classification.
3. Data processing	Transform image information into meaningful map information.
Visual interpretation	Manually categorize image information into landform types.
Image Classification	Digitally characterize classes, select training samples and classify data into landform types.
4. Data integration	Combine processed (interpreted) data with cartographic expertise.
Geometric transformation	Resample the derived data set into a common raster base for future multiple analysis; change to map projection required by user
Data merging	Overlay, analyze and reclassify the derived data set.
MCALC transformation	Drive thematic maps from the (re) classified data.
Data output	Visualization of data relationships in hard-copy map-like format.

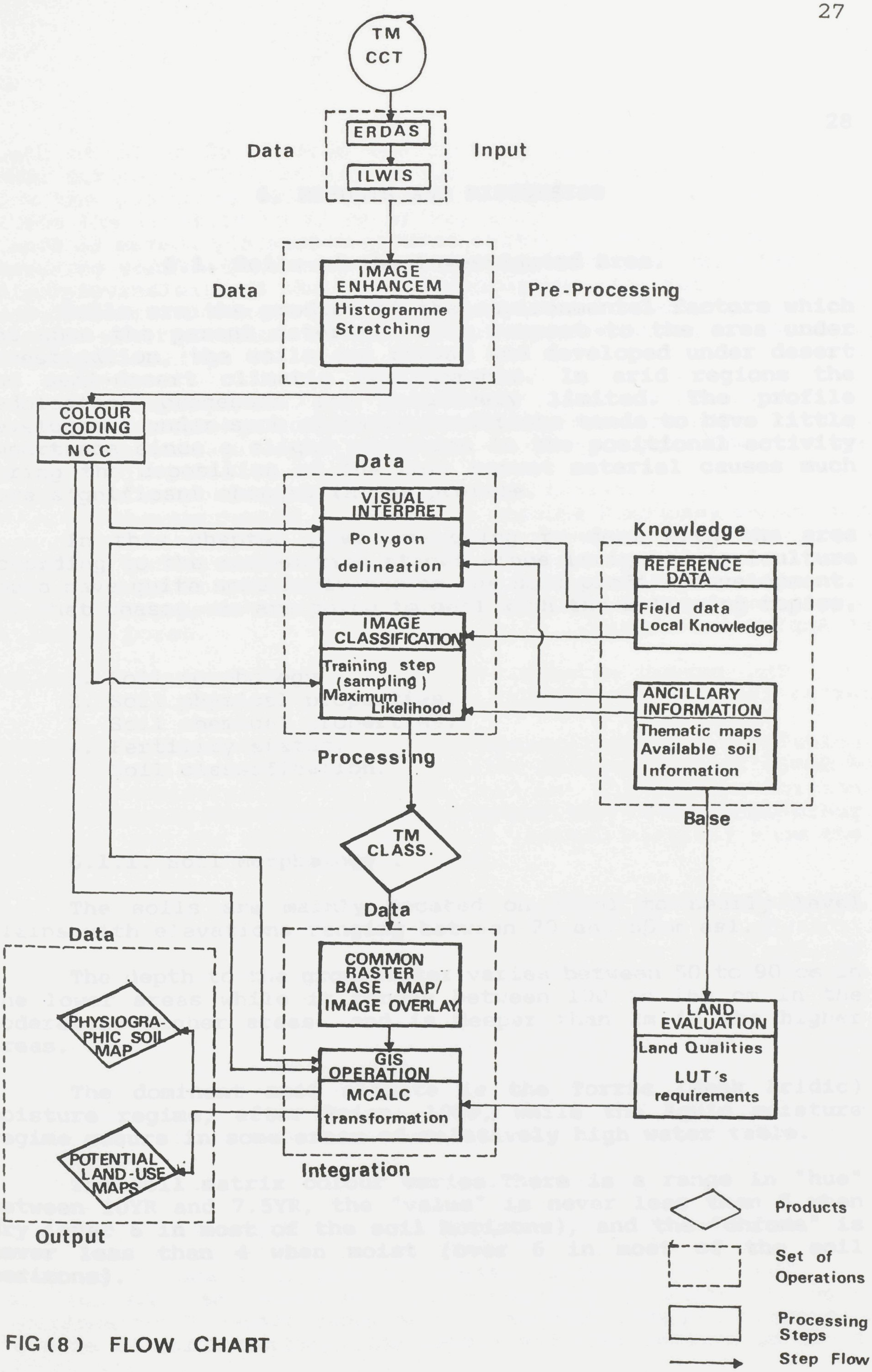


FIG (8) FLOW CHART

6. RESULTS AND DISCUSSION

6.1. Soils of the Investigated Area.

Soils are the product of the environmental factors which act upon the parent material. With respect to the area under investigation, the soils are formed and developed under desert and semi-desert climatic environments. In arid regions the pedological processes are relatively limited. The profile development under such climatic conditions tends to have little importance since a slight variation in the positional activity during the deposition of the soil parent material causes much more significant changes in the profile.

In this chapter , we are going to deal with the area according to the reclamation stages since irrigated agriculture could have quite some influence on the soil profile development. For that reason, we are going to deal with the following topics.

1. Soil morphology .
2. Soil physical properties.
3. Soil chemical properties.
4. Fertility status.
5. Soil classification.

6.1.1. Soil Morphology .

The soils are mainly located on level to nearly level plains with elevations ranging between 20 and 50 m asl.

The depth to the groundwater varies between 50 to 90 cm in the lower areas while it ranges between 100 to 160 cm in the moderately higher areas and is deeper than 2m in the higher areas.

The dominant soil climate is the Torric (Weak Aridic) moisture regime, after Erian, 1989, while the Aquic moisture regime occurs in some areas of relatively high water table.

The soil matrix colour varies.There is a range in "hue" between 10YR and 7.5YR, the "value" is never less than 5 when dry (over 6 in most of the soil horizons), and the "chroma" is never less than 4 when moist (over 6 in most of the soil horizons).

The soil texture varies between moderately coarse to fine, the majority of the soils are moderately fine textured especially for the deeper horizons of the relatively old reclaimed soils, and medium to moderately coarse textured in the case of the relatively recent reclaimed soils and the virgin soils.

Most of the soil structures are either weak blocky or massive . The soils are mostly friable when moist, some of them are hard when dry.

All soil horizons show a strong effervescence with HCl, and the pH reaches 8 in most of the soils except some soils with higher salinity values or gypsum content.

The land use of these soils is mainly Grapes, Pears, Clover and vegetables with some new introduced fruit crops, such as Apples and Almonds.

The parent material of these soils is constituted of marine-lacustrine deposits.

Table (11 -app.) presents the main morphological features of the different mapping units.

Fig(9) shows the location of the observation points.

6.1.2. Soil Physical Properties

6.1.2.1. Particle Size Distribution.

Table (12 - app.) presents complete particle size data for some of the observations, and table (13 - app.) shows the textural variation for the different profiles. These data indicate that the soil textures range from moderately coarse to fine. These textural variations are a result of the effect of both lake and sea action during the sedimentation of these recent deposits.

6.1.2.2. Soil Porosity and Permeability

The total porosity ranges between 30 % and 61 % This range is generally acceptable and indicates that the soil is moderately compact. However, in the older stage of reclamation, it can be noticed that the second soil horizon which is at a depth of 20 or 25 cm from the surface, exhibits a relatively lower porosity. This is mainly due to the compaction resulting from the ploughing which is usually done by tractor and does affect the first 15 to 20 cm of the soil.

The soil is generally characterized by a poor distribution of pores, while it is noticed that the micropores (water holding pores) are the dominant ones present in most of the investigated samples. The presence of such a dominant pore size has two different meanings :

1. although the quantity of water is high, the water available for the plants is low (this is shown by the higher wilting percentage value, moisture constant at 15 bar as presented in table 14 - app.).

2. the hydraulic conductivity is low, which ocurred for most of the samples of the cultivated areas. However, the higher hydraulic conductivity values which ocurred for some of these samples could be related to the relatively lower proportion of water holding pores in comparison to the amount of large quickly drainable pores.

6.1.2.3. The Hydraulic Conductivity.

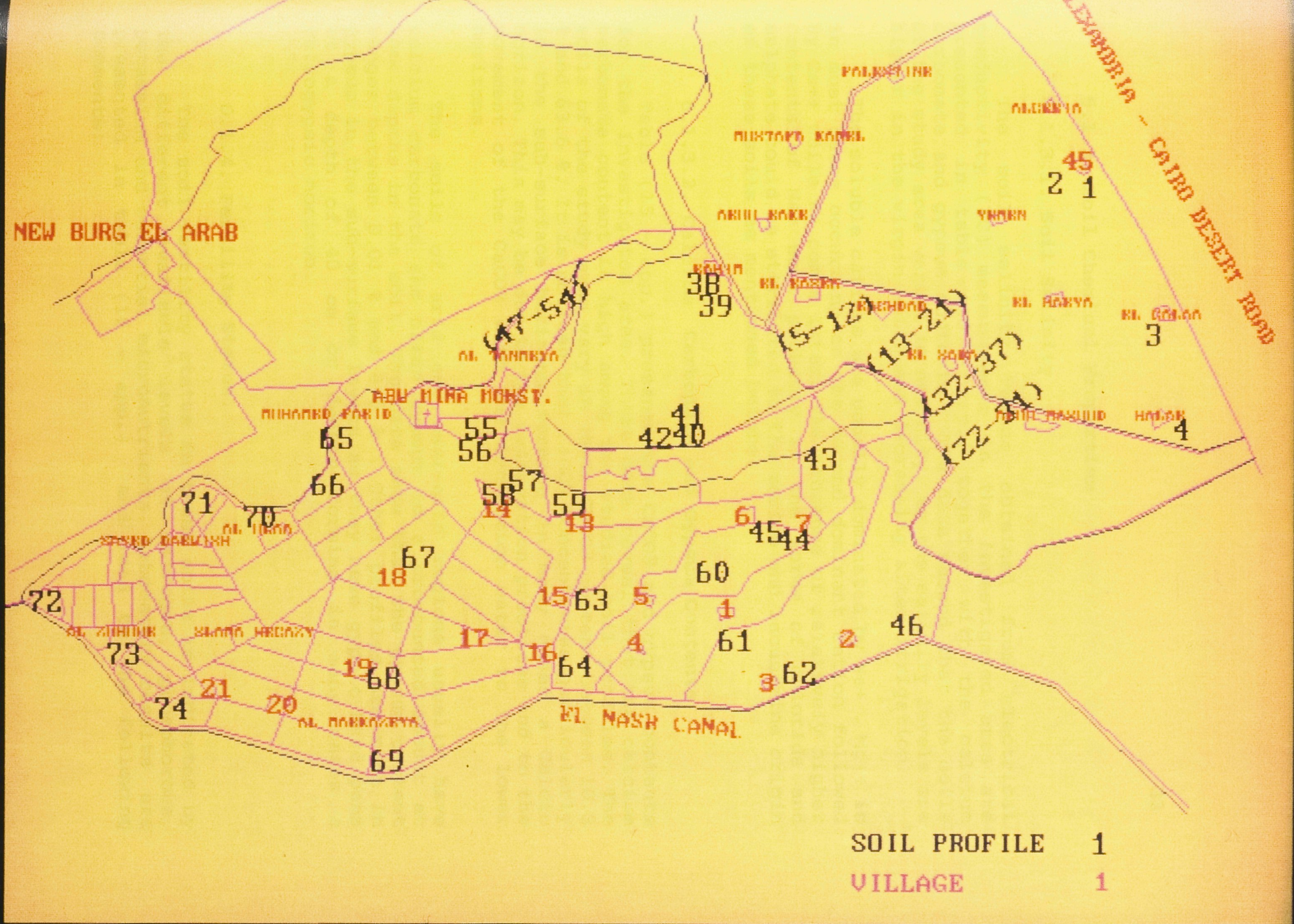
The hydraulic conductivity ranges between 0.2 cm/h which is considered as very slow hydraulic conductivity and 73 cm/h which is considered as very rapid. However, the surface horizon show relatively higher hydraulic conductivity values than other horizons, and the compacted horizons (second horizon) show the lowest hydraulic conductivity values.

According to the previous situation, it could be concluded that the soil under investigation suffered, from the physical point of view, from the bad distribution of the pores and the relatively lower hydraulic conductivity in most of the studied samples.

To overcome these difficulties, it is recommended to add organic fertilizers of to cultivate leguminous plants, such as Broad Beans, Green Beans, Clover and Alfalfa etc.. This will help in improving the soil structure by means of aggregating the single particles and/or enlarging the size of the present aggregates, which in turn will increase the hydraulic conductivity and lower the wilting point value.

Table (14 - app.) show the soil moisture bulk density and water holding capacity values.

FIG. (9) THE LOCATION MAP OF THE OBSERVATION POINTS.



6.1.3. Soil Chemical Properties

6.1.3.1. Soil Salinity

The soil salinity values obtained from electrical conductivity (EC) measurements in the investigated area are presented in table (15 - app.) together with the calcium carbonate and gypsum contents . The data showed that the soils of the study area varied in salinity, as the salinity levels are higher in the virgin soils and decreasing after irrigation.

The soluble cations are usually dominated by Na+ . Mg++ is in most cases occurring as the second dominant cation followed by Ca++ while K+ comes later. The presence of relatively higher contents of Na+ most probably in the forms of chloride and sulphate could be attributed to the marine and lacustrine origin of these soils as mentioned before.

6.1.3.2. Calcium Carbonate and Gypsum Contents

Table (15 - app.) presents the CaCO3 and gypsum contents for the investigated area. These data reveal that the calcium carbonate content is high among the studied soil profiles. The soils of the study area vary in their CaCO3 content between 10.3 % and 63.6 %. It is noticed that CaCO3 concentrates particularly in the sub-surface horizons forming in many cases a Calcic horizon. This may be due to the cultivation practices and to the movement of the CaCO3 with the irrigation water to the lower horizons.

The soils of arid and semi-arid regions usually have calcium carbonate and often gypsum in a pronounced amount at some depths in the soil. The data show that the gypsum content ranges between 0.01 % and 8.0 % . Other profiles are rich in gypsum in the sub-surface layers as they have gypsic hard pans at a depth of 40 cm or deeper forming in many cases a Petrogypsic horizon.

6.1.4. Fertility Status.

The soil fertility status in these soils is indicated by the different available levels of nitrogen, phosphorous, potassium and essential micronutrients. Laboratory results are presented in table (16 - app.) and lead to the following comments:

6.1.4.1. Organic Matter.

The organic matter percentages presented in table (16 - app.) show that most of the studied soils have a quite low organic matter content if we compare with soils in the area which have been cultivated for some time. This is a natural characteristic since the region is under arid conditions, which are encouraging the decomposition of the organic matter. Also most of the studied soils are not yet intensively cultivated. In the first and second stages of reclamation the organic matter content will be relatively high in the uppermost horizons and it will decrease rapidly with depth.

This relatively higher organic matter content is mainly occurring in the soils which receive high amounts of farmyard manure as has been recognized in the field.

6.1.4.2. Nitrogen

The Nitrogen content of the soils is almost entirely a function of the organic matter content. The organic matter content in these soils as mentioned above is low. The available nitrogen is positively correlated with clay and organic matter. Under irrigation conditions and intensive crop production a crop rotation including leguminous crops beside the practices of the inorganic fertilizer applications are nearly required everywhere for maximum yields.

6.1.4.3. Phosphorus

Phosphorus takes the second position after nitrogen in the frequency of use as a fertilizing element. The phosphorus supply can be even more critical than the nitrogen supply in some natural environments such as the calcareous soils.

The inorganic phosphorus occurs mainly as calcium phosphate in the alkaline and calcareous soils. Thompson and Troeh (1975),(after Ismaeil, 1988) stated that soils developed from marl, chalk or other material containing calcareous skeletal material contain generally more phosphorus than most other soils. Skeletons and shells have higher contents in both calcium and phosphorus than most of other calcic compounds. Black (1957), mentioned that the phosphorus percentage of the soil as a whole usually increases as the texture becomes finer, if all other conditions remain similar.

The data of available phosphorus show that it varies between 0.7 and 58.0 ppm. The values of 58, 28 and 20 ppm occur at the depth 0-30 cm of profiles 1,2 and 39 and these high values could be attributed to the effect of the recent heavy application of P fertilizers since these soils have been under irrigated cultivation for more than 25 years. The deficiency limit of phosphorus defined by Olsen (1954) is < 5 ppm available P. Accordingly it could be considered that the soils represented by profiles No. 8, 9, 12, 16, 17, 19, 20, 21, 22, 23, 27, 29 and 31 are poor in available P.

6.1.4.4. Potassium

Soils in arid or semi-arid areas have more than sufficient available potassium to meet the nutritional requirements of irrigated crops. This is because of the relatively small impact of chemical weathering and leaching on soils in dry areas.

The available K values show that the available K in the majority of these soils is over the value of 0.3 meq % which is considered to be the critical level of K deficiency (Soil Compendium 1989).

6.1.4.5. Micronutrients

The data for the micronutrients show a very low content of iron and a medium level of zinc and copper if we apply the critical levels of 4.5 ppm for iron, 0.20 ppm for zinc and 0.8 ppm for copper, Lindsay and Norvell (1978).

As Chlorosis (lack of iron) of crops is often associated with higher calcareous soils and related more to the active lime Yaalon (1957), further study about the relation between the active lime and the micronutrients should take place in the future.

6.1.5. Soil classification in the investigated area

Based on the American Soil Taxonomy (1975), the studied soils could be classified at the subgroup level.

The diagnostic horizons occuring in the studied area are the Salic, Calcic, Petrocalcic, Gypsic and Petrogypsic horizons.

The dominant soil moisture regime is the Torric regime . The Thermic regime is the major soil temperature regime.

The soils represented by profile: 1, 2, 3, 6, 7, 8, 9, 17, 18, 19, 20, 21, 23, 24, 26, 28, 29, 30, 31, 54, 55, 58, 59, 62, 64, 68, 70, 71 and 74 are mineral soils without any diagnostic horizons. They could be classified as **Typic Torrifluvents**, while the soil represented by profile 69 could be classified as a **Typic Torripsamment**. The soil represented by profile 74 could be classified as a **Typic Torriorthent**.

The soils represented by profile 5, 40, 51, and 57 are mineral soils with a Salic horizon. These soils could be classified as **Aquollic Salorthids**.

The soils represented by profile 39, 48, 49 and 67 are mineral soils with a Petrocalcic horizon. These soils could be classified as **Typic Paleorthids**.

The soils represented by profile 4, 72 and 73 are mineral soils with a Gypsic horizon. These soils could be classified as **Cambic Gypsiorthids**.

The soils represented by profile 11, 15,22, 36, 38, 41, 45 and 60 are mineral soils with a Petrogypsic horizon. These soils could be classified as **Petrogypsic Gypsiorthids**.

The soils represented by profile 10, 12, 13, 14, 16, 25, 27, 32, 33, 34, 35, 37, 42, 43, 44, 46, 47, 50, 52, 53, 56, 61, 63, 65 and 66 are mineral soils with a Calcic horizon. These soils could be classified as **Typic Calciorthids**.

Table (17) shows the correlation scheme and soil sets for the investigated area.

Table (17) Soil Correlation scheme and Soil Sets.

			Entisols			Aridisols					Soil Sets
			Fluvents	Psamments	Orthents	Salorthids	Calciorthids	Gypsiorthids		Paleorthids	
			Typic	Typic	Typic	Aquollic	Typic	Petrogypsic	Cambic	Typic	
T	T1	T1	62	----	----	----	43,46,63	----	----	----	Typic Torrifluvents Typic Calciorthids
	T2	T2	----	----	74	----	----	----	----	----	Typic Torriorthents.
B	B1	B11	54	----	----	47,51	44,50,52,53	----	72	----	Aquollic Salorthids Typic Calciorthids
		B12	1,55	----	----	----	27,32	15,36	73,4	----	Typic Torrifluvents Typic Calciorthids
	B2	B21	64,68	----	----	56	----	----	----	----	Aquollic Salorthids
		B22	2,3,7,8,18, 19,20,21,22, 23,24,26,28, 29,30,31,55, 70,71	----	----	----	13,14,16,25, 33,34,35,37, 42,65,66	----	----	----	Typic Torrifluvents Typic Calciorthids
	B3	B3	9,17,58,59	----	----	----	10,12	11	----	----	Typic Torrifluvents,Typic Calciorthids, Petrogypsic Gypsiorthids
W		W	----	69	----	----	----	----	----	----	Typic Torripsamments
k		K	----	----	----	5,57	----	----	----	----	Aquollic Salorthids
L		L	----	----	----	40	----	38,41,45,60	----	39,67,48,49	Typic Paleorthids Petrogypsic Gypsiorthids

6.2. Pedogenesis and soil formation in relation to reclamation practices :

From the previously mentioned presentation one could easily point out the following :

1. All the soils of the survey area are extremely calcareous, the calcium carbonate content ranges between 10.3 and 63.6 percent, and the subsoil contains more calcium carbonate than the topsoil.

2. The high content of calcium carbonate causes a special problem in the texture determination of the loam and clay loam soils. As a result of the insufficient dispersion of the calcareous soils suspension, according to the FAO (1964), some calcium carbonate is present in all particle size fractions. Silt contains the highest amount, followed by the clay fraction, then by the coarse sand fraction and the fine sand fraction contains the least.

3. It has been noted that the calcareous parent material of the soils is not young and that the pedogenetical action of rainfall is not inconsiderable. These factors are reflected in the pedogenesis of the area; other factors such as topography, vegetation and man have played a minor role.

4. The pedogenesis is in fact limited mainly to the movement and precipitation of lime and gypsum, through the alternate seasonal wetting and drying of the soil profile. In the transported soils of the Abu Mena Basin, only a weak development of a calcic horizon can be seen and lime has not been precipitated in the form of segregations.

5. The calcium carbonate responsible for the great abundance of hard lime segregations in some of the soils was probably washed in from eroded older pliocene formations further inland.

6. Visible gypsum is found in most of the sub-horizons , as layers of white crystals.

7. The influence of man and vegetation on soil formation has been slight to moderate. A weak Ap horizon has developed in areas which are seasonally cultivated, and it is only moderately developed in areas under cultivation for long time.

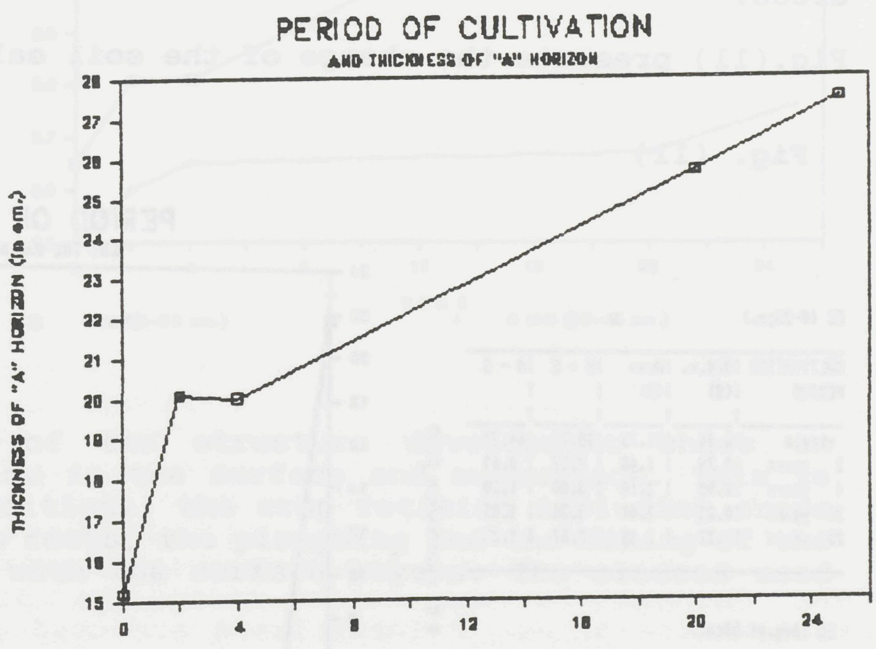
The influence of cultivation on the evolution of soil characteristics can be discussed in further detail, through the study of the soils morphology and of the results of the chemical analysis of the different soil samples taken either from the virgin land or from soils under different stages of reclamation and crop rotation. (it is very important to mention that the number of observations taken from the soils under more than 20 years after reclamation is very limited in comparison to the number of observations taken from the soils under other stages of reclamation. Each stage of reclamation has been treated as a whole without any separation in mapping units).

The following conclusions apply to the development of soils under reclamation:

a. The thickness of the "A" horizon tends to increase with the time of reclamation (in fig (10)). This might be due to the additions of manure, the extensive use of the land, the ploughing of the topsoil ,and all other tillage practices.

Fig.(10)

CULTIVATION PERIOD	Std.v. (S)	Mean (M)	M + S	M - S
virgin	5.60	15.20	20.80	9.60
2 years	6.07	20.10	26.17	14.03
4 years	7.07	20.00	27.07	12.93
20 years	8.03	25.70	33.73	17.67
25 years	2.50	27.50	30.00	25.00



b. The second horizon in all cultivated profiles contains relatively higher amount of clay than that of the virgin soils. This indicates that the second horizon is an illuviated "B" horizons . A micromorphological study should be done to follow up the illuviation with time.

c. All the profiles contain appreciable amounts of calcium carbonate, which increase in the second horizon. Therefore, the second horizon might be considered an illuviated horizon with respect to the movement of calcium carbonate also.

d. With time, the amount of soluble salts also decreases sharply in the surface and subsurface horizons. In the saturation extract the soluble salt decreases in the second horizon. This is because chloride is the principal salt in the surface horizons whereas sulphate is the principal salt in the subsoil. Due to the low solubility of gypsum, the saturation extract does not bring all the sulphate into solution.

The effect of reclamation is evident for the cultivated profiles where the soluble salts contents are smaller than for the uncultivated soil. The decrease in salt content is quite clearly related to the increase in the leaching period. The amounts of salts leached from the surface are relatively more important than those leached from the deeper horizons due to the consequent downward movement of salts. Most of the salt leaching took place in the first years of reclamation. The slight difference in leaching may be rendered to the differences in initial salt content and soil texture within the investigated areas.

Fig.(11) presents the change of the soil salinity with time.

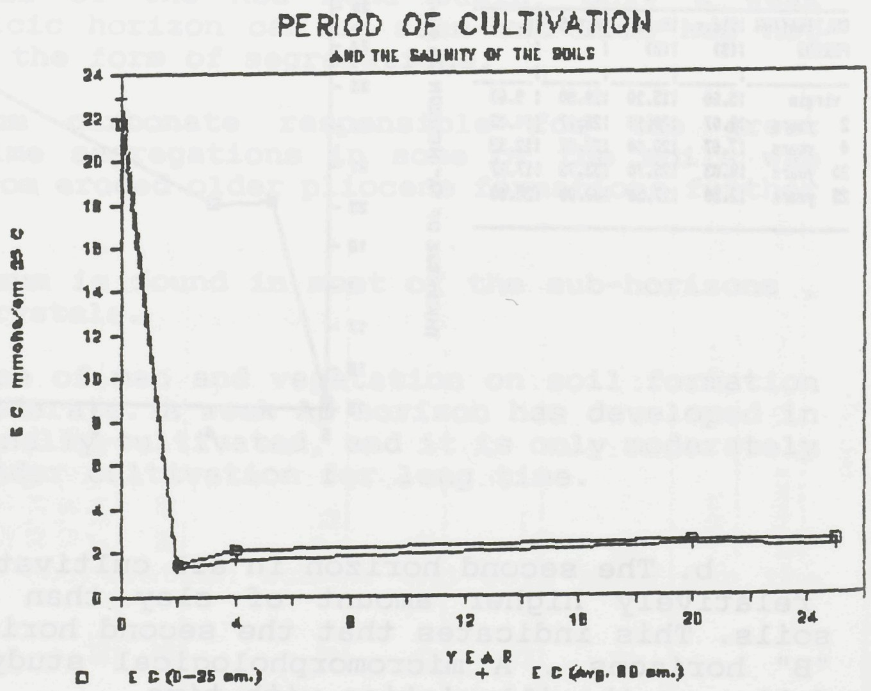
Fig. (11)

EC (0-25cm.)

CULTIVATION PERIOD	Std.v. (S)	Mean (M)	M + S	M - S
virgin	6.98	21.73	28.71	14.75
2 years	0.79	1.48	2.27	0.69
4 years	0.90	2.10	3.00	1.20
20 years	0.85	2.51	3.36	1.66
25 years	1.22	2.45	3.67	1.23

EC (Avg.of 80cm.)

CULTIVATION PERIOD	Std.v. (S)	Mean (M)	M + S	M - S
virgin	5.81	22.92	28.73	17.11
2 years	0.71	1.31	2.02	0.60
4 years	0.88	1.62	2.50	0.74
20 years	1.10	2.26	3.36	1.16
25 years	1.30	2.17	3.47	0.87



e. The organic matter tends to increase in the "A" horizons with the time of reclamation. The causes are the additions of manure and the mixing of the stubble and remnants of the plants with the surface horizons. A relative increase of organic matter content has taken place also in the second horizons although statistically not significant (this may be due to the deep manuring with the Sweet Melon cultivation in some fields) as shown in fig.(12).

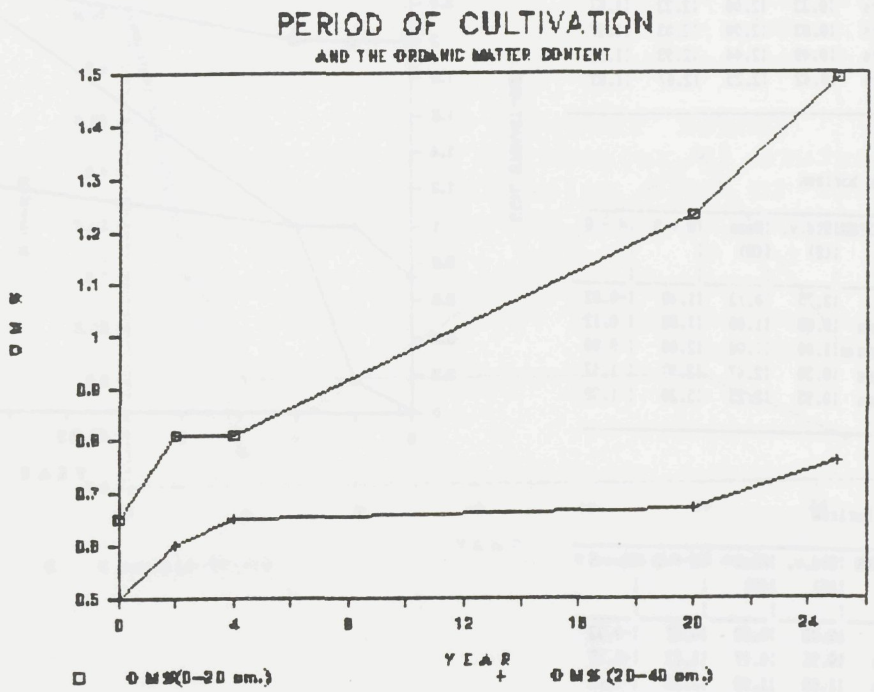
Fig. (12)

O.M. (0-20cm.)

CULTIVATION PERIOD	Std.v. (S)	Mean (M)	M + S	M - S
virgin	0.32	0.65	0.97	0.33
2 years	0.28	0.81	1.09	0.53
4 years	0.04	0.81	0.85	0.77
20 years	0.42	1.23	1.65	0.81
25 years	0.68	1.49	2.17	0.81

O.M. (20-40cm.)

CULTIVATION PERIOD	Std.v. (S)	Mean (M)	M + S	M - S
virgin	0.22	0.50	0.72	0.28
2 years	0.32	0.60	0.92	0.28
4 years	0.03	0.65	0.68	0.62
20 years	0.37	0.67	1.04	0.40
25 years	0.62	0.76	1.38	0.14



f. The study of the structure development shows an increase with the time in the surface and subsurface. This is due to the manure additions, the crop rotation including crops with shallow and deep roots, the ploughing and the mixing of the rests of the plants with the surface layers. The classes used are as follow:

- 0 structureless "massive" if coherent and "single grains" if not coherent.
- 1 very weak.
- 2 weak.
- 3 moderate.
- 4 strong.
- 5 very strong.

Fig.(13) shows the changes of the structure development with the time of reclamation.

Fig. (13)

Str. 1st horizon

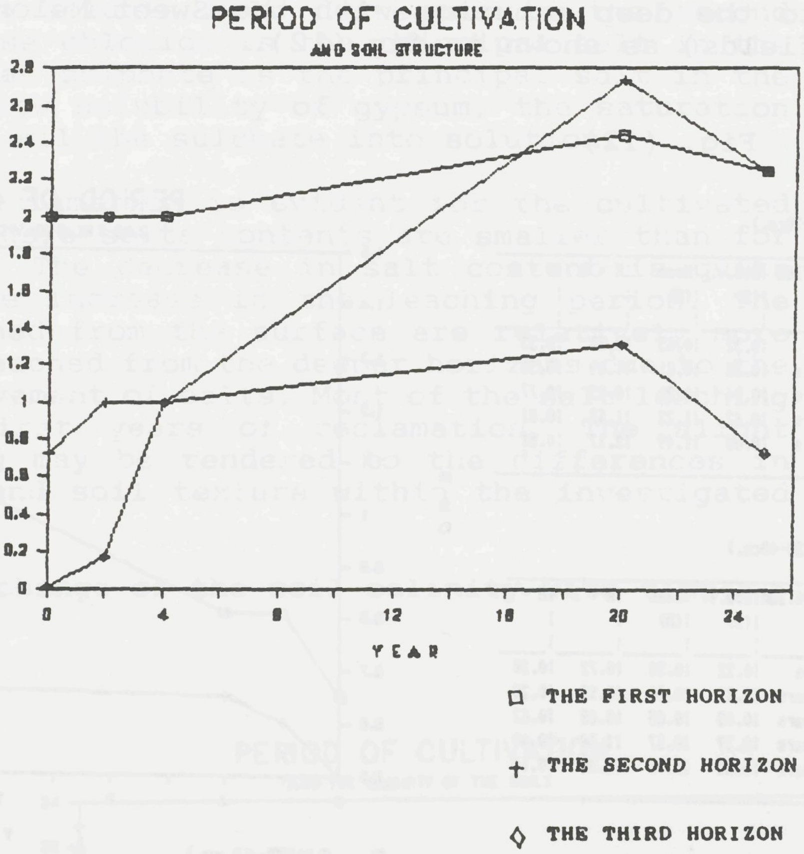
CULTIVATION PERIOD	Std.v. (S)	Mean (M)	M + S	M - S
virgin	0.93	2.00	2.93	1.07
2 years	0.33	2.00	2.33	1.67
4 years	0.03	2.00	2.03	1.97
20 years	0.49	2.44	2.93	1.95
25 years	0.42	2.25	2.67	1.83

Str. 2nd horizon

CULTIVATION PERIOD	Std.v. (S)	Mean (M)	M + S	M - S
virgin	0.75	0.73	1.48	-0.02
2 years	0.88	1.00	1.88	0.12
4 years	1.00	1.00	2.00	0.00
20 years	0.50	2.47	2.97	1.97
25 years	0.95	2.25	3.20	1.30

Str. 3rd horizon

CULTIVATION PERIOD	Std.v. (S)	Mean (M)	M + S	M - S
virgin	0.03	0.00	0.01	-0.03
2 years	0.95	0.17	1.12	-0.78
4 years	1.00	1.00	2.00	0.00
20 years	0.66	1.31	1.97	0.65
25 years	1.12	0.75	1.87	0.37



g. The available phosphorus can not be used for detecting the changes in the soils under the different stages of reclamation since P fertilizers are used on a large scale in all the cultivated areas. But we can recognise that most of the soils have a relatively high level of available phosphorus in the virgin soils. On the other hand it is clear in all cases that the exchangeable-K decreases with the longer use of the soils, since the K fertilizers are not commonly used on the area. And because of the balance in the ratio between the different K phases in the soil (total , available and exchangeable), we can recognize that there is a relation between the sharp decrease in the soil salinity and the decrease in exchangeable-K in the first years of reclamation. Fig.(14) show the decrease in exchangeable-K with time.

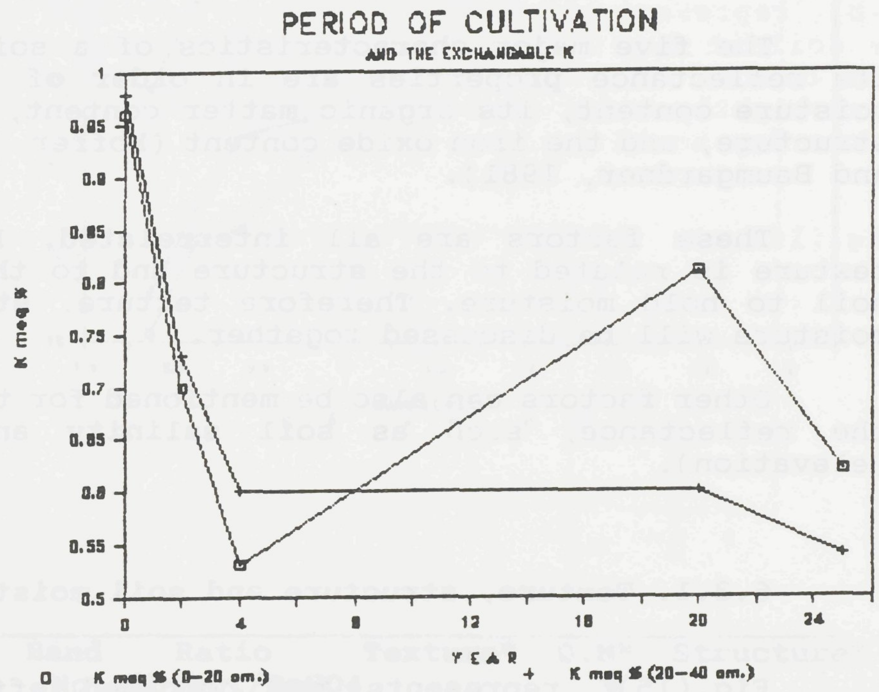
Fig. (14)

K (0-20cm.)

CULTIVATION PERIOD	Std.v. (S)	Mean (M)	M + S	M - S
virgin	0.50	0.96	1.46	0.46
2 years	0.35	0.70	1.05	0.35
4 years	0.24	0.53	0.77	0.29
20 years	0.17	0.81	0.98	0.64
25 years	0.30	0.62	0.92	0.32

K (20-40cm.)

CULTIVATION PERIOD	Std.v. (S)	Mean (M)	M + S	M - S
virgin	0.57	0.98	1.55	0.41
2 years	0.28	0.73	1.01	0.45
4 years	0.32	0.60	0.92	0.28
20 years	0.03	0.60	0.63	0.57
25 years	0.32	0.54	0.86	0.22



h. Since there are no sufficient data available concerning the micronutrients, we cannot evaluate their evolution with time. This may require a special study comprehending the active calcium carbonate and the micronutrient levels in the area. The use of micronutrients fertilizers is not common although there is a clear shortage (frequent Chlorosis in the field) in most of the soils under consideration.

6.3. Spectrometric Measurements.

At the soil surface, most of the incident flux is either reflected or absorbed and little is transmitted. The reflectance properties of the majority of soils are similar, with a positive relationship between reflectance and wavelength.

The five major characteristics of a soil that determine its reflectance properties are in order of importance : Its moisture content, its organic matter content, the texture, the structure, and the iron oxide content (Hoffer, 1978) and (Stoner and Baumgardner, 1981).

These factors are all interrelated. For example, the texture is related to the structure and to the ability of the soil to hold moisture. Therefore texture, structure and soil moisture will be discussed together.

Other factors can also be mentioned for their influence on the reflectance, such as soil salinity and soil position (elevation).

6.3.1. Texture, structure and soil moisture

Fig.(15), represents the combined effect of texture, structure and soil moisture on the reflectance for different stages of reclamation and for the same mapping unit.

The curves are representative of soils with about 20 years of cultivation and also of a virgin soil for comparison. The ratio between (object/$BaSO_4$) and the main soil characteristics are given in table(18-a).

The result of the comparison is as follows:

The cultivated soils tends to have finer texture and a stronger structure which leads to a rough surface. After ploughing, it also tends to have a high moisture content according to its finer texture and better ability to hold water. As a result it has a fairly low (diffuse) reflectance. The virgin soil tends to have a slightly coarser texture and a weaker structure and besides that it has a low moisture content and as a result a fairly high reflectance.

Fig.(15)

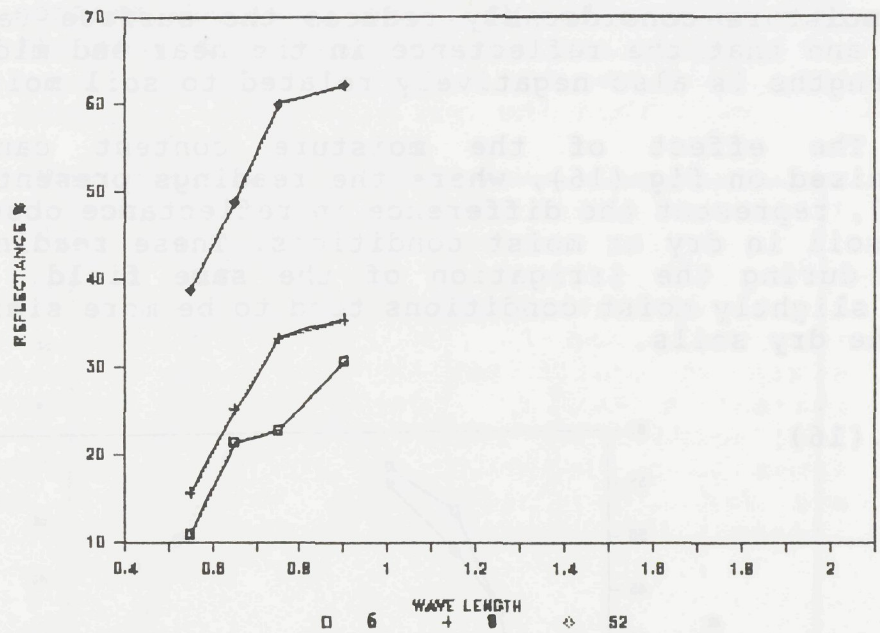


Table (18-a)

Profile No.	Mapping unit	Band No.	Ratio Object/BaSO4	Texture*	O.M* %	Structure*
6	I12	1	10.8	CL	2.88	wk,fn,sb
(20 years)		2	21.4			
		3	22.7			
		4	30.7			
8	I12	1	15.6	SCL	2.24	wk,fn,sb
(20 years)		2	25.0			
		3	33.3			
		4	35.4			
52	I11	1	38.8	SiL	0.8	mo,md,sb
(virgin)		2	48.8			
		3	60.0			
		4	62.1			

* for the surface horizon

Jensen (1983), mentioned that in the visible wavelengths, soil moisture considerably reduces the surface reflectance of soil, and that the reflectance in the near and middle infrared wavelengths is also negatively related to soil moisture.

The effect of the moisture content can easily be recognised on fig (16), where the readings presented in table (18-b), represent the difference in reflectance observed for the same soil in dry or moist conditions. These readings have been taken during the irrigation of the same field. The readings under slightly moist conditions tend to be more similar to those for the dry soils.

Fig.(16)

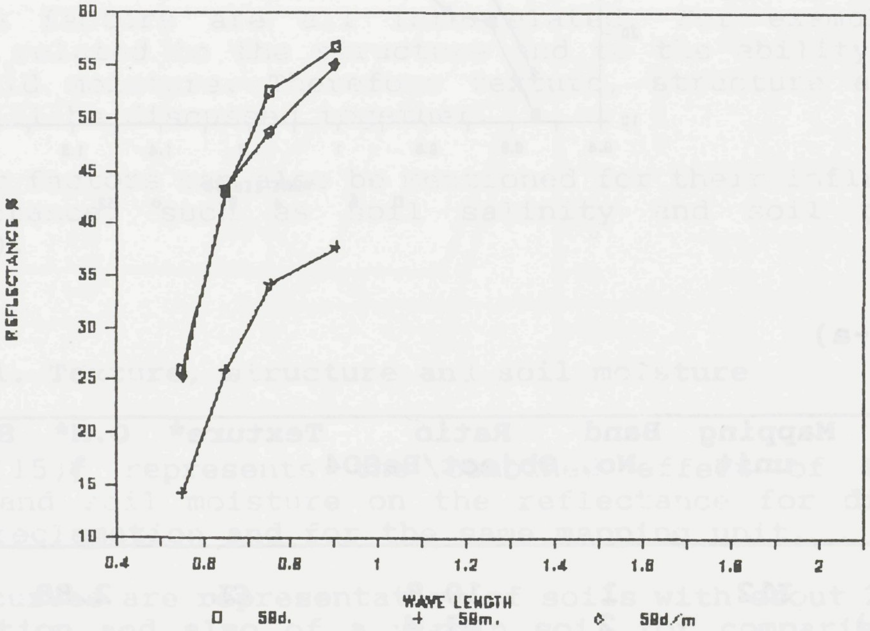


Table (18-b)

Profile No.	Band No.	Ratio (Object/BaSO4) dry	moist	slightly moist
59	1	26.1	14.2	25.5
	2	43.1	26.1	43.4
	3	52.6	34.2	48.7
	4	56.7	37.8	55.2

6.3.2. Organic matter content.

Fig(17), presents two soils, which are similar in texture and structure but differ in organic matter content. The higher the organic matter content the lower the soil reflectance Table (18-c,), presents the main soil data for the two soils.

Fig. (17)

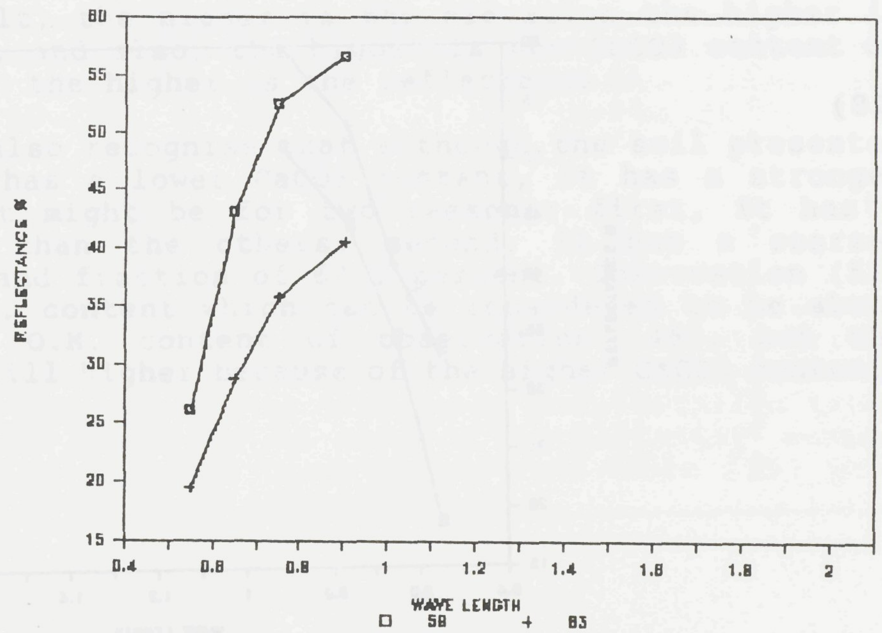


Table (18-c)

Profile No.	Band No.	Ratio Object/BaSO4	Texture	O.M %	Structure
59	1	14.2	SCL	0.31	wk,fn,sb
	2	26.1			
	3	34.2			
	4	37.8			
63	1	19.5	SCL	1.25	wk,fn,sb
	2	28.8			
	3	35.8			
	4	40.5			

6.3.3. Salinity.

The scattered white salty patches which appear at the soil surface also affect the reflectance from the soils. Fig (18), shows two soils within the same mapping unit and almost simillar in all the different soil properties except for the soil salinity content and the apperance of white patches at the surface. As a result the soil with more salt at the surface reflects more than the one with low salt content, table (18-d) .

Fig.(18)

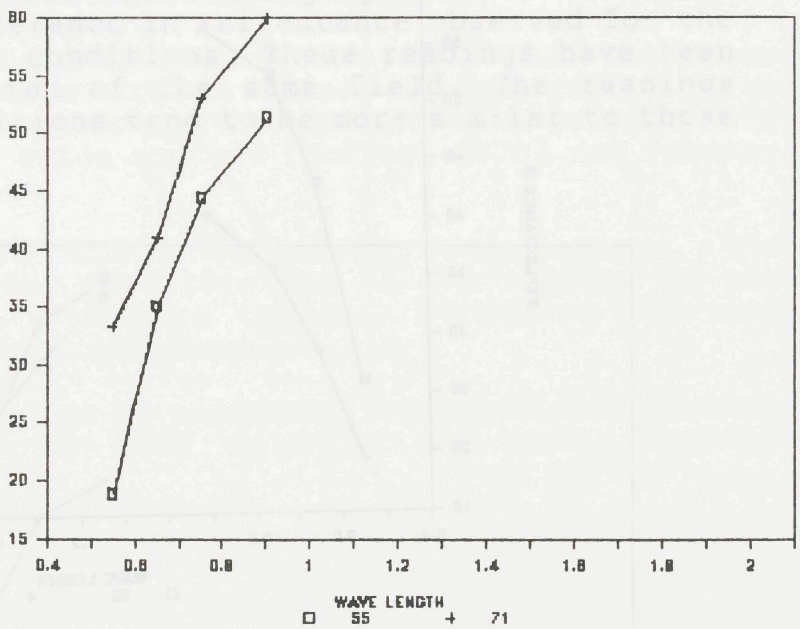


Table (18-d)

Profile No.	Mapping Unit	Band No.	Ratio Object/ BaSO4	Texture	O.M %	Ec mmhos/ cm 25 C	Structure
55	I22	1	18.9	CL	1.07	1.94	wk,fn,ab
		2	35.0				
		3	44.4				
		4	51.4				
71	I22	1	33.3	SCL	1.06	15.6	wk,vfn,ab
		2	41.0				
		3	53.1				
		4	60.0				

6.3.4. Physiographic Position and CaCO3 Content.

The physiographic position and the CaCO3 content together play an important role in the reflectance from the soil. Fig (19) , shows four different mapping units with different elevations and CaCO3 contents. Table (18-e) presents the main soil data for these different soils.

As a result, the higher is the elevation the higher is the reflectance , and also, the higher is the CaCO3 content at the soil surface, the higher is the reflectance .

We could also recognise that although the soil presented by profile (60) has a lower CaCO3 content, it has a stronger reflectance. That might be for two reasons: first, it has a higher position than the others; second, it has a coarser texture with a sand fraction of 64.3 percent. Observation (52) has a higher O.M. content which can be considered to be about seven times the O.M. content of observation (46), but the reflectance is still higher because of the higher CaCO3 content.

Fig. (19)

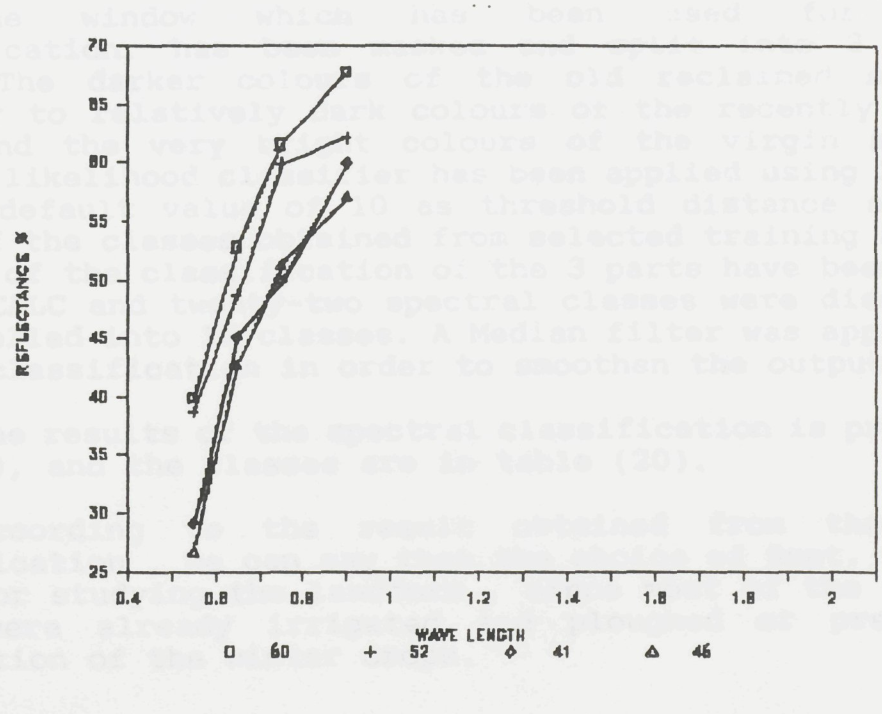


Table (18-e)

Prof. No.	Elev. m.ASL	Band No.	Ratio Object/ BaSO4	Tex.	O.M %	Ec mmohs/ cm 25C	CaCO3 %	Structure
60	51	1	40.0	SL	0.37	3.0	30.0	st,md,sb
		2	52.8					
		3	61.6					
		4	67.8					
52	45	1	38.8	SiL	0.8	1.4	39.6	mo,md,sb
		2	48.8					
		3	60.0					
		4	62.1					
41	28	1	29.2	SL	0.44	0.44	37.8	wk,md,sb
		2	45.0					
		3	50.0					
		4	60.0					
46	36	1	26.8	L	0.12	1.38	28.3	st,md,sb
		2	42.8					
		3	51.3					
		4	57.1					

6.4. Digital Image Classification

6.4.1. Image Enhancement.

Map (1) represents the best false colour composite obtained for the TM bands 5,4 and 3, where the red colour was assigned to band 5, the green for band 4 and the blue for band 3. This combination was giving the best colour coding alternatives for soils, vegetation and water information for the area. Digital values used for the histogramme linear stretch ranged from 50-250, 50-160 and 50-240 for bands 5, 4 and 3 respectively.

6.4.2. Visual Interpretation.

Map (2) shows the visual interpretation map of the TM images of 22 Dec. 1986 and 16 Sept.1989 at the scale 1:100,000. It is important to mention that the visual interpretation map was realized with the aim of showing as many detailed landforms as possible in order to be able to subsequently assess the accuracy of the computer classifications. Table (19) presents the legend of the visual interpretation.

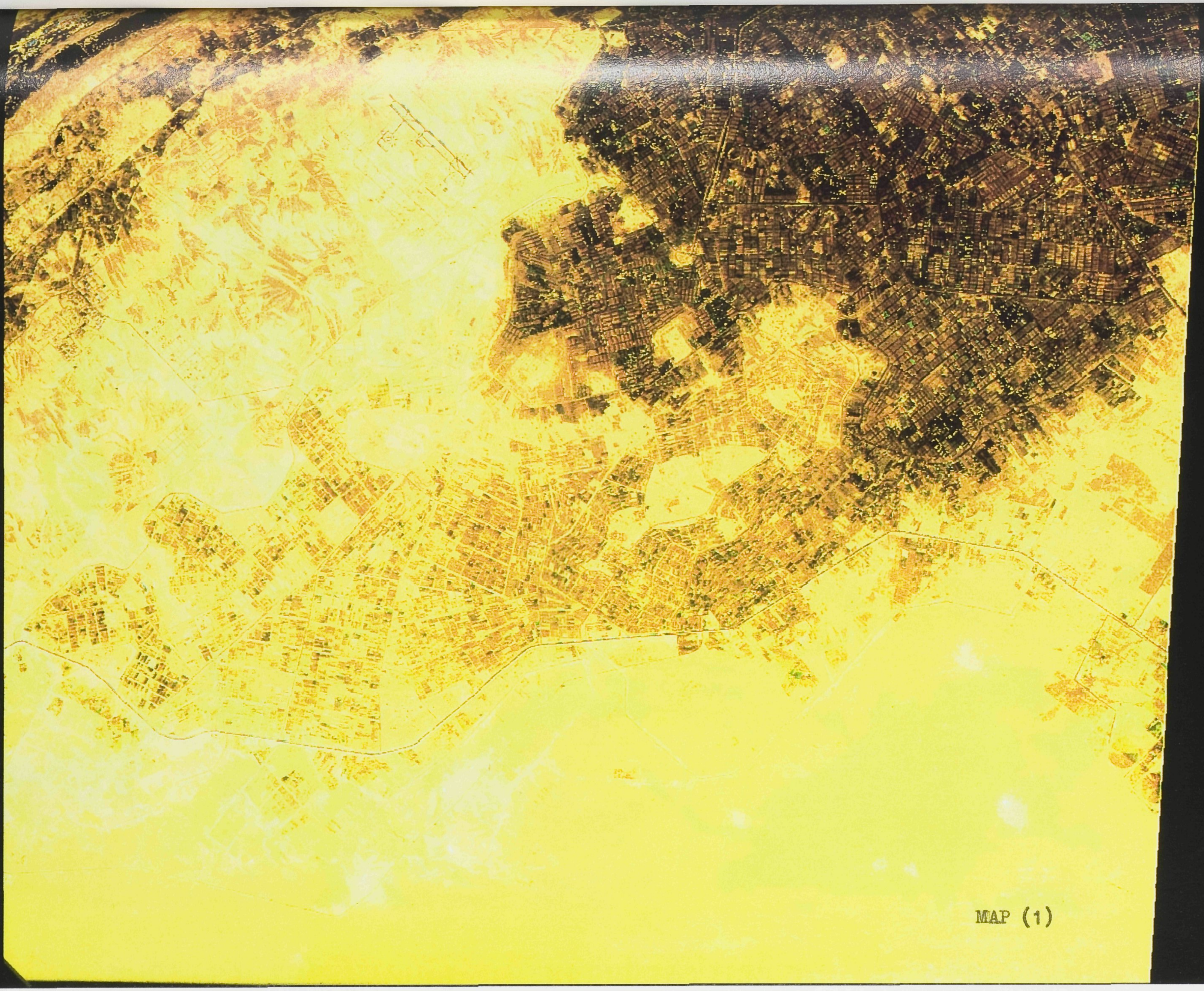
6.4.3. Multispectral Classification.

The window which has been used for spectral classification, has been masked and split into 3 different parts. The darker colours of the old reclaimed soils, the brighter to relatively dark colours of the recently reclaimed soils and the very bright colours of the virgin soils. The maximum likelihood classifier has been applied using 22 instead of the default value of 10 as threshold distance and on the basis of the classes obtained from selected training areas. The results of the classification of the 3 parts have been combined using MCALC and twenty-two spectral classes were discriminated and labelled into 12 classes. A Median filter was applied twice to the classification in order to smoothen the output .

The results of the spectral classification is presented on map (3), and the classes are in table (20).

According to the result obtained from the spectral classification , we can say that the choice of Sept. was a good month for studying the landform , since most of the cultivated lands were already irrigated and ploughed or prepared for cultivation of the winter crops.

It is also very important to mention that both the virgin lands and the very recently reclaimed -but not prepared for cultivation- are interacting together in the classes since there is high similarity in their very high reflectances due to the high $CaCO_3$ content of the surface horizons.



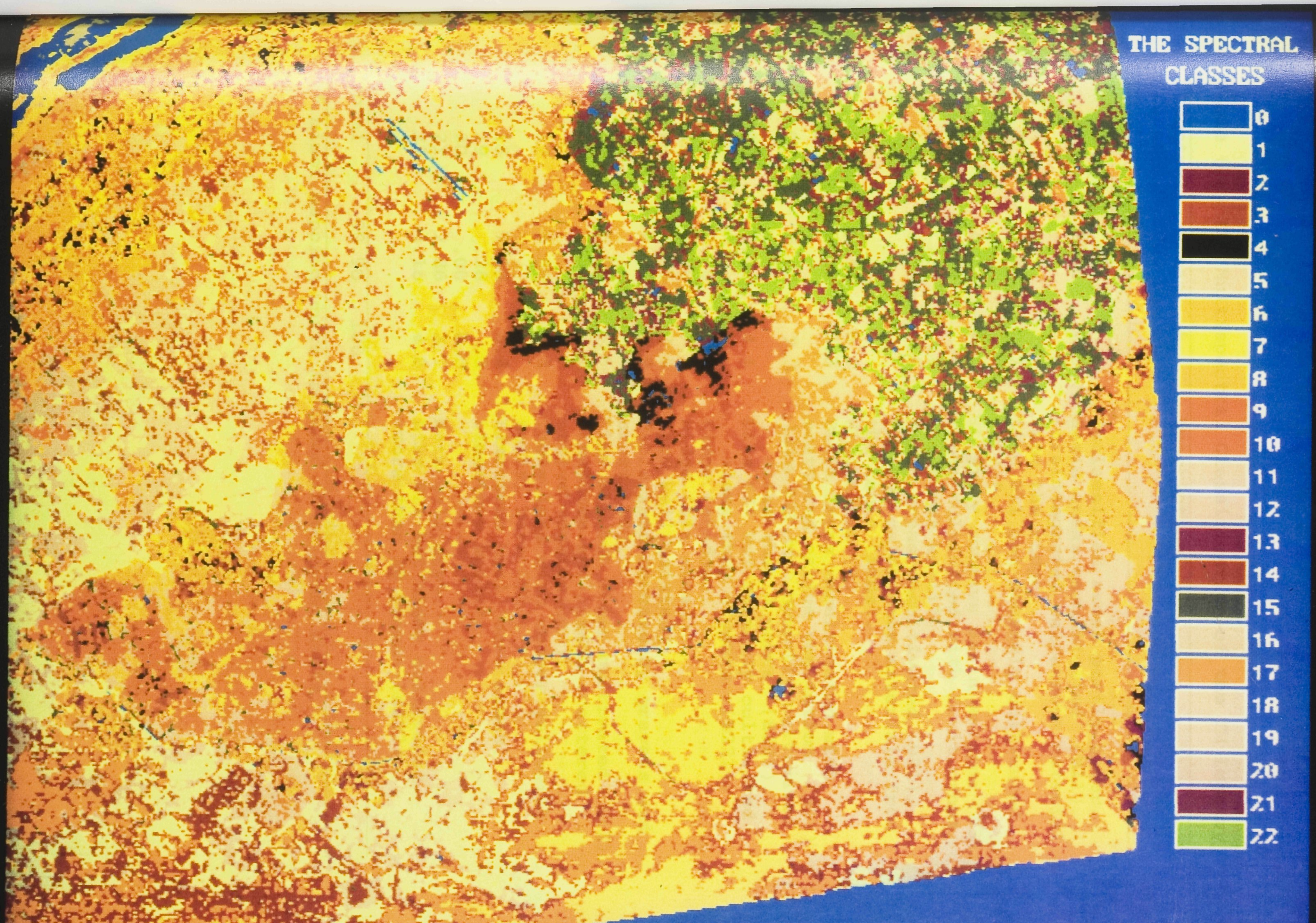
MAP (1)

MAP (2) THE VISUAL INTERPRETATION OF THE STUDY AREA.

Table(19) The visual interpretation legend of the study area.

Mapping unit symbol	Area '000 ha.	%	Description
R	22.65	28.16	Ridge.
T1	6.12	7.61	Table land (with deeper yellowish soils, bare.)
T2	3.82	4.75	Table land (with shallower yellowish soils, covered by gravels and crust).
W	4.15	5.17	Wind blown.
B11	11.09	13.79	Basin uncultivated. (disintegrated calcareous material from the ridge).
B12	10.96	13.63	Similar to B11 but cultivated.
B21	9.54	11.87	Basin uncultivated. (eroded calcareous material from the table lands).
B22	5.87	7.30	Similar to B21 but cultivated.
B3	2.52	3.14	Margins of the Basin (slightly concave).
L	2.39	2.98	limestone knoll.*
K	1.26	1.57	karm wall.
Total	80.41	100	

* for cartographic reasons, on the hardcopy page 53," L" was represented included in the neighbouring mapping units



MAP (3) THE SPECTRAL CLASSIFICATION.

Table (20) The Multispectral Classification of the TM Imagery

Spectral Class	Areas '000 ha	%	Description
0	--	--	Unclassified areas partly Water.
1	6.85	7.5	Basin areas uncultivated (B11). (disintegrated calcareous material from the ridge).
2	.60	.7	Like B11 but recently cultivated (B12)*.
3	4.02	4.4	Slightly concave Basin margins (B3).
4	1.42	1.6	Areas cultivated with fruit crops.
5	.36	.4	Limestone knoll*.
6	5.06	5.6	Basin areas uncultivated (B21). (eroded calcareous materials from the table lands).
7	7.44	8.2	Wind blown (W).
8	2.10	2.3	Basin areas uncultivated with scattered native vegetation (B21).
9	6.64	7.3	Like B21 but recently cultivated -less than 4 years -(B221).
10	3.70	4.1	Like B21 but recently cultivated -less than 4 years -(B221).
11	3.70	4.1	Ridge (shadow).
12	6.50	7.1	Ridge (lit areas).
13	1.85	2.0	Karm wall(moisted).
14	8.92	9.8	Table land covered by gravels and crust (T2).
15	5.96	6.6	Like B11 but older cultivated (B12).
16	2.52	2.8	Limestone knoll(with scattered native vegetation).
17	8.56	9.4	Table land with deeper yellowish soils, bare (T1).
18	7.68	8.4	Limestone knoll(bare areas).
19	.28	.3	Limestone knoll*.
20	.00	0.0	----*
21	2.86	3.1	Karm wall(dry).
22	4.16	4.6	Like B21 but older cultivated -more than 20 years- (B222).
Total	90.96	100	

* minor mapping units included in adjacent units.

6.5. Digital Image Classification Combined with a GIS

In order to improve the spectral classification and to transform it into a "soil map", and "potential land suitability maps", additional information had to be incorporated. This can be done using GIS procedures.

The first step in order to work with a GIS system was to transform the spatial data from analog to digital form by digitizing maps and observation points. As the remote sensing image is in raster format it can be directly inputed into the GIS system. Then the various foles had to be geometrically registered in order to be able to superimpose them.

The input data were:

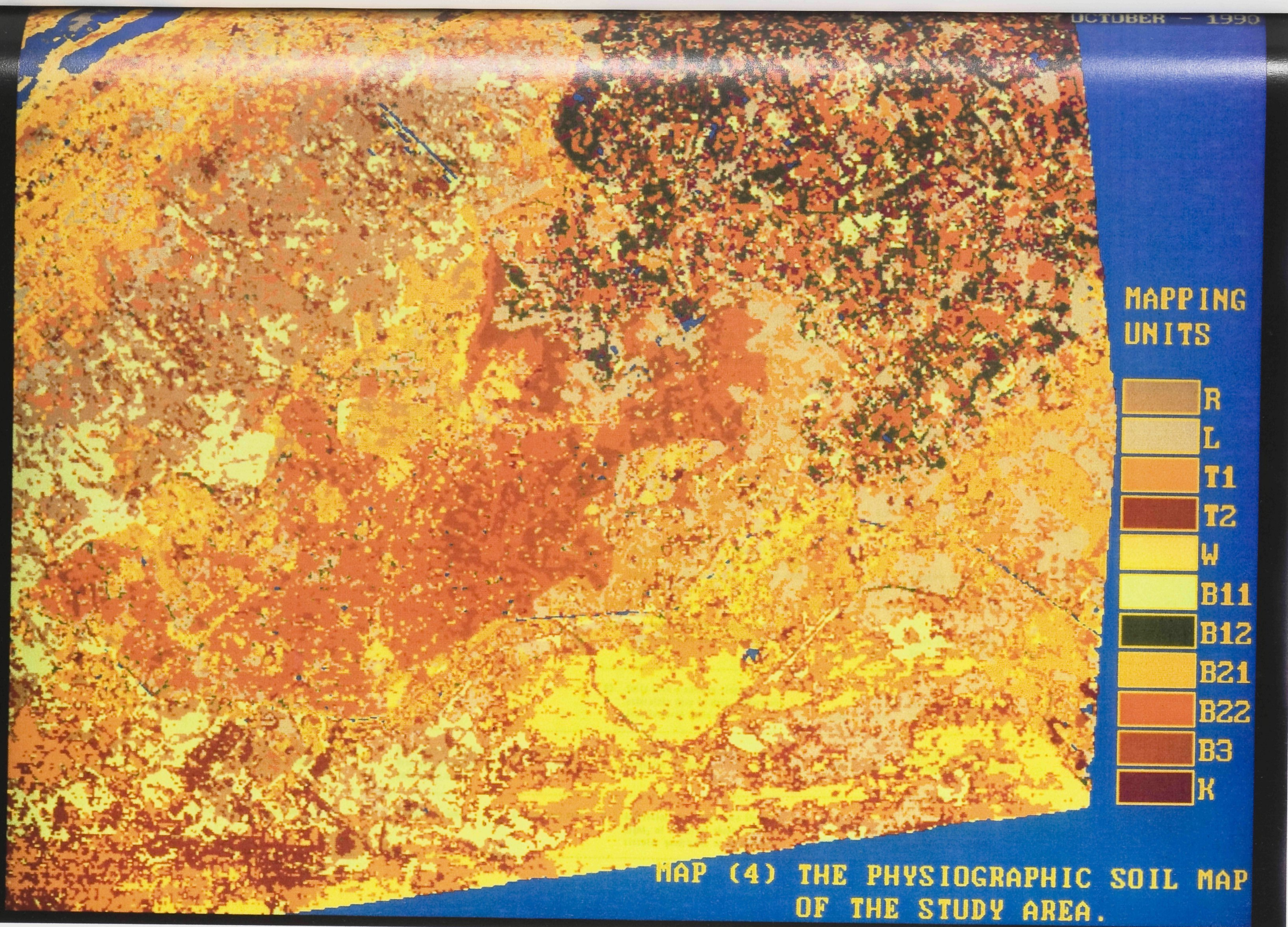
- The spectral classification map ,
- The visual interpretation map,
- The road, canals and villages map, and
- The soil data.

The MCALC transformation programme was used to obtain thematic maps.

The first attempt was to obtain a soil map from the final spectral classification results. A set of decision rules was manually applied to the data to integrate classes into soil classes. The spectral classification has been evaluated as good, having in mind the difficulty of a visual separation particularly within the soils of the basin. Because most of the soils were bare when classified, the resulting classes did correspond to the data collected from the field and have related to the changes in the soils with the time of cultivation. To put more emphasis on this point, unit "B22", for example, the cultivated soils of the Abu Mina Basin, derived from the eroded calcareous soils of the table land, can be spectrally subdivided into two mapping units namely, "B221", the recently cultivated soils (less than 4 years) and the "B222", the older cultivated soils (more than 20 years). It was difficult to subdivide the soils of unit the "B12", the cultivated soils of the Abu Mina Basin, derived from the disintegration of the calcareous soils of the ridge, because most of the soils have been under cultivation for more than 20 years although there are minor recently cultivated areas in this unit. For that and in order to keep the same level of information on the final soil map the mapping units (B221 and B222) were grouped together as "B22".

All the other spectral classes have been evaluated in the same way on the light of all the available information about the area and using the GIS facilities. The final result is the physiographic soil map of the study area as shown on Map (4). The legend is also presented In table (21).

The second attempt was to obtain potential land suitability maps for the different LUT's using the soil map and all the needed data with the help of the GIS. To obtain that result all the potential suitability classes for the different LUT's will be presented on a table and will be linked to the physiographic soil map through the use of MCALC where the mapping units will be matched with the tables by means of their key attributes.



MAP (4) THE PHYSIOGRAPHIC SOIL MAP OF THE STUDY AREA.

TABLE (21) THE LEGEND OF THE PHYSIOGRAPHIC SOIL MAP.

LAND SCAPE	RELIEF	LITHOLOGY	LAND FORM	MAPPING UNIT SYMBOL	MAPPING UNIT DESCRIPTION	AREAS '000 ha	AREAS %	MAIN SOILS
Ridge	Hummocky surface, sloping to both North and South, elevation ranging between 30 and 70 m. ASL.	Calcareous bars of Pleistocene.	Off-shore bars	R	Dissected ridge of limestone covered by shallow silty loam soils.	10.20	11.2	Rock outcrops
Table land	Flat to gentle slope in the NE direction, elevation ranging between 30 and more than 60 m. ASL.	Pliocene, marine beds of the Mediterranean coasts.	Maryut Table land	T1	Moderately to deep, calcareous, well drained medium textured soils.	8.56	9.4	Typic Calciorthids. Typic Torrifluvents.
				T2	Shallow to moderately deep, calcareous, well drained, moderately coarse textured soils, predominantly covered by consolidated crust and stones.	8.92	9.8	Typic Torriorthents.
Wind blown deposits	Flat to gently undulating.	Recent deposits, sand dunes.	Sand dunes.	W	Moderately deep to deep, slightly gravelly coarse sand, partly very shallow sand over rock covered with a thin sand layer.	7.44	8.2	Typic Torripsamments.
Basin	Almost flat in the central portion,gently undulating at the edges	Recent colluvial to alluvial calcareous deposits.	Erosional basin.	B11	Colluvial and alluvial deposits derived from the disintegration of the ridges, deep, yellowish, medium textured soils.	6.85	7.5	Aquollic Salorthids.
				B12	Like "B11" but with a moderately fine textured soil, containing common coarse fragments with depth, reclaimed and cultivated .	7.98	8.9	Typic Torrifluvents. Typic Calciorthids.
				B21	Colluvial and alluvial deposits derived from the eroded calcareous of the table land, deep, shallow yellowish over reddish , moderately fine textured soils.	7.17	7.9	Aquollic Salorthids. Typic Torrifluvents
				B22	Like "B21" but with a moderately coarse textured soil, reclaimed and cultivated.	14.50	16.0	Typic Torrifluvents. Typic Calciorthids.
				B3	Soils with a concave slope, moderately deep to deep, moderately fine textured soils.	4.03	4.4	Petrogypsic Gypsiorthids. Typic Calciorthids.
Limestone knoll	almost flat to gently undulating.	Pleistocene, originated from old consolidated calcareous dunes.	limestone knoll.	L	shallow soils, very stony or bare limestone rockland.	10.59	11.6	Typic Paleorthids. Petrogypsic Gypsiorthids.
Karm wall	man made	Recent man made.	Eroded karm wall.	K	Artificial clay banks more than 2 m. in hight, of different shapes (mainly circular quadrantic or horseshoe).	4.71	5.1	Aquollic Salorthids.

6.6 LAND EVALUATION

6.6.1. Physical Evaluation of The Studied Area.

The suitability for a given land utilization type in a particular area is based on the most limiting factors.

The "current suitability" means the present condition of soils in a certain area with minor improvements while the "potential suitability" means the soils condition after using major improvements. Matching is simply the process in which the land qualities are compared to the land utilization type (LUT) requirements expressed in terms of ratings.

This part of the study aims to find the improvement possibilities in order to increase the yields in the studied area, and to introduce the most suitable crops and fruit crops to optimally match the land qualities of the different mapping units.

The most important information about the land utilization types and their characteristics is given in table(22), listing the key attributes of different land utilization types, after Beek and Bennema (1972).

The LUT's description and requirements are given in table (23), after Vink (1975) and FAO (1979).

The main soil characteristics of the area are presented in table (24).

The soil characteristics are expressed in terms of land qualities and rated from 1 to 5.

The following are the land qualities studied in the area :

- **Availability of foothold for Roots (d).**
- **Soil moisture storage capacity (m).**
- **Oxygen availability for roots (o).**
- **Salinity (z).**
- **Nutrients availability (n).**
- **Workability (w).**
- **Temperature regime (t).**

All the ratings are based on selective readings in land evaluation, after USDA Soil Survey Manual (1981), Sys (1982) , Siderius (1985), FAO (1985), Erian (1986), Erian (1990), ILACOB (1989) and presented in table (25).

TABLE (22) KEY ATTRIBUTES OF LAND UTILIZATION TYPES

LUTs	PRODUCE	LABOUR INTENSITY	TECHNICAL KNOWLEDGE AND ATTITUDE	CAPITAL INTENSITY		YIELD	INCOME	REMARKS
				INVESTMENT	RECURRENT	(Ton/ha)	(1000 LE/ha)	
APPLES	fresh fruit	medium to high	medium to high	high (7,500LE/4years	medium (3,750LE/year)	12.5 -	12.5	crops can be cultivated for 3 years under the trees
PEARS	fresh fruit	medium to high	medium to high	medium (3,750LE/4years	medium (2,500LE/year)	3.0	3.0	crops can be cultivated for 3 years under the trees
ALMONDS	fruit	medium to high	medium	medium (3,000LE/4years	medium (2,000LE/year)	1.0	3.0	
GRAPES	fresh fruit	medium to high	medium to high	high (12,500LE/4year	medium (2,500LE/year)	7.5	6.0	crops can be cultivated for 2 years under the trees
DATE PALMS	fresh fruit	low	high	high (7,500LE/4years	medium (1,500LE/year)	2.0	2.0	crops can be cultivated for any time under the trees
OLIVES	fruit , oil	medium to high	medium	high (2,500LE/4years	medium (1,750LE/year)	5.0	6.0	crops can be cultivated for 3 years under the trees
WHEAT	grain , hay	medium to high	medium	medium (750LE/season)	---	3.0 -	2.0	
BARLEY	grain , hay	low to medium	medium	low (500LE/season)	---	2.5	1.0	
BROAD BEANS	seeds	medium	medium	medium (1,000LE/season)	---	1.3	1.6	
CLOVER	fodder	medium	low	low (450LE/season)	---	(4 - 5 cuts)	2.0	
MAIZE	seeds , hay	medium	medium	medium (600LE/season)	---	4.0	1.2	
SUGAR BEETS	sugar , fodder	medium to high	medium to high	---	---	---	---	no informations is available, since not yet cultivated in the area
SWEET MELONS	fruit	medium	high	medium to high (1,200LE/season)	---	15.0	5.0	the main summer cash crop in the area

prices collected from the markets and the users in the area in 1989.

LE = 0.37 US $

TABLE (23) CROPS AND FRUIT CROPS REQUIREMENTS.

CROPS, OR FRUIT CROPS	TOTAL GROWING PERIOD (days)	TEMPERATURE REQUIREMENTS FOR GROWING PERIOD	SPECIFIC CLIMATE CONSTRAINTS and REQUIREMENTS	WATER REQUIREMENTS mm	WATER TOLERANCE	DROUGHT TOLERANCE	TEXTURE REQUIREMENTS	HEAVY TEXTURE TOLERANCE	SOIL STRUCTURE REQUIREMENTS	SALINITY TOLERANCE (Ec mmhos/cm)	SOIL DEPTH REQUIREMENTS	FERTILIZ. REQUIREM.
APPLES	270-300 Feb. - Nov.	Opt. : 20 - 25 Range : (10-35)	------	700-1000	LOW	LOW/MEDIUM	COARSE TO MOD. FINE TEXTURED SOILS	LOW	MODERATE TO STRONG	LOW (0-2)	DEEP > 100 cm	HIGH
ALMONDS	180-270 Jan. - Sept.	Opt. : 20 - 25 Range : (15-30)	------	700-1000	LOW	LOW	MOD. COARSE TO MOD. FINE TEXTURED SOILS	MEDIUM	MODERATE TO STRONG	LOW (0-2)	DEEP > 100 cm	HIGH
PEARS	180-270 Mar. - Oct.	Opt. : 20 - 25 Range : (10-35)	------	800-1000	MEDIUM	LOW	MOD. COARSE TO MOD. FINE TEXTURED SOILS	MEDIUM TO HIGH	MODERATE	LOW (0-2)	MOD. DEEP > 80 cm	HIGH
GRAPES	180-270 Mar. - Oct.	Opt. : 20 - 25 Range : (15-30)	Long, warm to hot, dry summer and cool winter preferred/required	500-1200	MEDIUM	LOW	COARSE TO MOD. FINE TEXTURED SOILS	LOW	WEAK	LOW (0-2)	MOD. DEEP > 80 cm	HIGH
DATE PALMS	200-300 All the year	Opt. : 25 - 35 Range : (10-40)	------	500-800	MEDIUM	MEDIUM	COARSE TO MOD. FINE TEXTURED SOILS	LOW TO MEDIUM	WEAK TO MODERATE	HIGH (0-6)	DEEP > 100 cm	MEDIUM
OLIVES	210-300 All the year	Opt. : 20 - 25 Range : (15-35)	Low winter temperature required(<10 C) for flower initiation	600-800	LOW	MEDIUM	MOD. COARSE TO MOD. FINE TEXTURED SOILS	MEDIUM	MODERATE	MEDIUM (0-4)	MOD. DEEP > 80 cm	MEDIUM
WHEAT	180-250 Oct. - May	Opt. : 15 - 20 Range : (10-25)	Requires a cold period for flowering during early growth. Dry period required for ripening.	450-650	LOW	MEDIUM	MOD. COARSE TO MOD. FINE TEXTURED SOILS	MEDIUM	STRONG	V. HIGH (0-7)	MOD. DEEP > 80 cm	HIGH(N
BARLEY	180-250 Oct. - May	Opt. : 15 - 20 Range : (10-25)	Requires a cold period for flowering during early growth. Dry period required for ripening.	350-500	LOW	MEDIUM/HIGH	MOD. COARSE TO MOD. FINE TEXTURED SOILS	MEDIUM	MODERATE	V. HIGH (0-10)	MOD. DEEP > 80 cm	MEDIUM
BROAD BEANS	140-165 Nov. - April	Opt. : 15 - 20 Range : (10-25)	------	500-800	LOW	LOW	MOD. COARSE TO MOD. FINE TEXTURED SOILS	MEDIUM TO HIGH	MODERATE TO STRONG	MEDIUM (0-3)	DEEP > 100 cm	LOW
CLOVER	120-160 Oct. - Mar.	Opt. : 15 - 20 Range : (10-25)	------	500-800	MEDIUM	LOW	MOD. COARSE TO MOD. FINE TEXTURED SOILS	MEDIUM TO HIGH	MODERATE TO STRONG	MEDIUM (0-3)	MOD. DEEP > 80 cm	LOW
MAIZE	100-140 May - Aug.	Opt. : 24 - 35 Range : (15-35)	------	500-800	HIGH	LOW	MOD. COARSE TO MOD. FINE TEXTURED SOILS	MEDIUM	MODERATE	MEDIUM (0-3)	MODERATE > 50 cm	HIGH
SUGAR BEETS	240-270 Sept. - Jan.	Opt. : 15 - 20 Range : (10-25)	------	750-1000	MEDIUM	LOW	MOD. COARSE TO MOD. FINE TEXTURED SOILS	HIGH	MODERATE	V. HIGH (0-8)	DEEP > 100 cm	MEDIUM
SWEET MELON	120-150 April - Aug.	Opt. : 22 - 30 Range : (18-35)	------	400-600	MEDIUM	MEDIUM	COARSE TO MOD. FINE TEXTURED SOILS	LOW	WEAK	MEDIUM (0-3)	MODERATE > 50 cm	HIGH (MANUF

TABLE (24) THE MAIN SOIL CHARACTERISTICS OF THE DIFFERENT MAPPING UNITS.

MAPPING UNIT	DEPTH OF GROUND WATER TABLE (in cm.)	DEPTH OF HARD PAN (in cm.)	AVAILABLE SOIL MOISTURE mm./dm	SOIL DRAINAGE CLASS	SOIL SALINITY (Ec mmhos/cm 25C) *1	ORGANIC MATER % *2	AVAILABLE PHOSPHORUS (ppm) *2	EXCHANGEABLE POTASSIUM (Meq %) *2	MICRO-NUTRIENTS(ppm)*2 Fe	Zn	Cu	SOIL CONSISTANCE (A HORIZON)	SOIL STRUCTUEE (A HORIZON)	SOIL TEXTURE (A HORIZON)	COARSE FRAGMENTS % VOLUME (A HORIZON)
T1	not hit	-----	139	well drained	1.0	0.12	14.0	0.43	1.35	0.82	0.59	hard (dry)	mo, md, sb	medium	-----
T2	not hit	-----	120	well drained	1.1	0.81	14.0	0.64	0.66	0.75	0.30	friable (moist)	mo, md, ab	mod. coarse	20
B11	not hit	-----	145	well drained	25.0	0.52	8.0	2.15	2.00	0.30	0.20	slightly hard (dry)	mo, md, ab	medium	-----
B12	75 - 100	75 - 100	115	well drained	2.6	2.74	11.2	0.54	0.98	0.81	0.74	slightly hard to hard (dry)	vk, fn, sb	mod. fine	-----
B21	not hit	-----	144	well drained	17.0	0.30	11.1	1.32	***	***	***	slightly hard to hard (dry)	mo, md, ab	mod. coarse	5
B22	not hit	-----	118	well drained	3.0	1.56	8.0	0.59	1.35	0.77	1.06	friable (moist)	vk, fn, sb	mod. fine	12
B3	100	80 - 100	122	mod. well drained to well drained	3.2	1.44	7.0	0.68	0.65	0.60	0.75	slightly hard (dry)	vk, vfn, cb	mod. fine	-----
W	not hit	-----	97	well drained	1.5	0.75	14.0	0.39	***	***	***	loose (moist)	sg to vk, fn, ab	coarse	-----
K *3	not hit	-----	148	well drained	38.3	0.43	7.6	2.18	***	***	***	friable (moist)	vk, fn, sb	mod. fine	-----
L *4	-----	10 - 40	48	-----	16.6	0.44	8.0	0.61	***	***	***	hard (dry)	st, md, sb	mod. coarse	39

*1 Calculated till the depth of 80 cm.
*2 Calculated till the depth of 25 cm.
*3 Needs special system of irrigation.
*4 Rock outcrops.
*** data not available

Table (25) The Ratings of The Major Land Qualities Related to Plant Growth and that might constitute Land Suitability Classification.

1. Availability of foothold for roots (d)

Could be evaluated either from the level of the ground water table or from the depth of the hard pans and rocks as follow.

R	Ground Water Table	Hard Pans or Rocks	
	depth in cm	**fruit crops**	**crops and vegetables**
1	>150	>150	>100
2	100-150	100-150	80 -100
3	80 -100	80 -100	50 - 80
4	50 - 80	50 - 80	25 - 50
5	< 50	< 50	< 25

R = Rating

2. Soil moisture storage capacity (m)

There are two different ways for calculating the soil moisture storage capacity ;

a. Using the pF curve data:

AMC= SUM [(Fc-Wp) * Horizon depth]

Where, AMC = Available Moisture Content.
Fc = Field capacity.
Wp = Wilting point.

b. Using the soil texture if the pF curve data are not available:

AMC= SUM [AM * Horizon depth]

Where, AM = Available moisture percent by volume.

(Note : the depth used for the calculation is 80 cm.)

Texture	Available moisture by volume (AM%) average	range
Sandy and Loamy sand	8	6 - 10
Sandy loam	12	9 - 15
Loam	17	14 - 20
Clay loam	19	16 - 22
Sandy clay loam	18	15 - 21
Silty clay loam	21	18 - 23
Clays	23	20 - 25

The rating is as follows:

R	AMC
1	160 - 250 mm
2	120 - 160 mm
3	80 - 120 mm
4	40 - 80 mm
5	< 40 mm

R= Rating

3. Availability of Oxygen for roots (o)

R	Description	Soil drainage classes	Matrix colour and mottling
1	very high	-excessively drained, -somewhat excessively drained, -well drained	No reduced colours within 150 cm of the surface. no distinct mottling within 90 cm of the soil surface
2	high	-moderately well drained	No reduced colours within 120 cm from the surface. no distinct mottling within 50 cm from the soil surface.
3	moderate	-imperfectly drained	No reduced colours or distinct mottling within 50 cm from the soil surface
4	low	-poorly drained	Partly reduced colours or distinct mottles within 150 cm from the soil surface
5	very low	-very poorly drained	Predominantly reduced colours throughout

R= Rating

4. Salinity (z)

The ratings are based on the first 80 cm measured from the surface.

R	Soil Salinity Ece mmhos/cm 25 °C	Description
1	0 - 2	non saline soils
2	2 - 4	slightly saline soils
3	4 - 8	moderately saline soils
4	8 - 15	strongly saline soils
5	>15	very strongly saline soils

R= Rating

5. Nutrients Availability (n)

The ratings are based on the first 25 cm measured from the surface. The most limiting factor gives the rank for the final rating.

R	Description	O.M. %	Availab. P ppm (Olsen)	Exchange. K Meq%	Micro-nutrients Fe ppm	Micro-nutrients Zn ppm	Micro-nutrients Cu ppm
1	very high	>3.0	>20	>1.2	>21	>5.3	>3.0
2	high	1.5-3.0	15-20	0.6-1.2	16-21	4.2-5.3	2.2-3.0
3	medium	0.8-1.5	10-15	0.3-0.6	10-16	3.1-4.2	1.5-2.2
4	low	0.5-0.8	5-10	0.1-0.3	5-10	2.1-3.1	0.8-1.5
5	very low	<0.5	<5	<0.1	<5	<2.1	<0.8

6. Workability (w)

The ratings are based on the plough layer. The most limiting factor gives the rank for the final rating.

R	Soil Consistence dry	moist	wet	Structure	Texture	Coarse fragment %
1	Sl. hard	Loose - friable	Non sticky and non plastic	Single grains or crumb	Coarse	<3
2	Hard	Friable - firm	Sl. sticky and sl. plastic	Fine to medium blocky	Mod. coarse to medium	3-15
3	Very hard	Very firm	Sticky and plastic	Coarse blocky	Mod. fine	15-50
4	Extr. hard	Extr. firm	Very sticky sticky and very plastic	Platy or massive	Fine	>50
5			Rock Outcrops			

R. = Rating

Sl. = Slightly

Mod.= Moderately

Ext.= Extremely

7. Temperature Regime (t).

R.	Winter Crops*1 °C	Summer Crops*2 °C	Annual Crops and Fruits*3 °C
1	16	24	20
2	14-16 or 16-18	22-24 or 25-27	15-17 or 23-26
3	12-14 or 18-20	20-22 or 27-29	13-15 or 26-28
4	10-12 or 20-22	18-20 or 29-31	11-13 or 28-30
5	<10 or >22	<18 or >31	<10 or >31

*1 the average of the winter months(October till April).
*2 the average of the summer months(May till September).
*3 the annual mean.

All the major LUT's requirements ratings are matched to five suitability classes, The first three are suitable and two are not suitable. They correspond to yields of 100%, 80%, 60%, 40% and 20% of the potential yield respectively.

The suitability classes are defined as follows :

- S1 : Highly suitable.
- S2 : Moderately suitable.
- S3 : Marginally suitable.
- N1 : Currently not suitable.
- N2 : Most of the time permanently not suitable.

The ratings for each mapping unit was matched and classified following the same suitability classes.

The land qualities of the different mapping units were rated as shown in table (26).

The current suitabilities show that almost all the mapping units have: a highly suitable rooting space except for the mapping units (B3), (B12) and (L); a highly suitable oxygen availability and a moderately suitable soil moisture storage capacity except for mapping units (B12), (B22), (W) and (L); a highly suitable to moderately suitable salinity level except for mapping unit (B11), (B21), (k) and (L); a very low level of nutrients availability and a moderately to marginally suitable workability.

The matching of LUT's requirements with the ratings are presented in table (27).

The matching between the different land utilization type requirements with the land qualities results in the determination of the land suitability classification for each mapping unit in the study area.

As a result of the matching between the suitabilities of the different LUT's and the current suitabilities of the different mapping units , we can nominate the land improvements and inputs needed to reach the potential suitability for the different mapping units and different LUT's. As a tentative comparison between the different LUT's, a summary of the cost of the main management and improvement practices, is presented in table(28). The table is based on interviews with the users in the area during the fieldwork and on the information available from different sources. Table (29) is summarizing the approximated net income for all the LUTs in a 7 years period of time. These tables are based on interviews with the users .

The final land suitability of the different mapping units and the potential land suitabilities are given in tables (30 - a, b, c, d, e, f) and maps (5, 6, 7, 8, 9, 10).

Table (31) summarizes the most recommended LUT's for the different mapping units.

TABLE (26) LAND QUALITY RATING OF SOIL MAPPING UNITS

LAND QUALITIES			T1	T2	B11	B12	B21	B22	B3	W	k	L
Availability of foothold for roots	(d)	I	1	1	1	4	1	1	3	1	1	4/5
		II	1	1	1	2	1	1	1	1	1	4/5
Availability of water	(m)		2	2	2	3	2	3	2	3	2	4
Oxygen avilability	(o)		1	1	1	1	1	1	1/2	1	1	1
Salinity	(z)		1	1	5	2	5	2	2	1	5	5
Availability of nutrients	(n)		5	5	5	5	5	5	5	5	5	5
Workability	(w)		2	2	2	3	3	2	3	1	3	3
Temperature regime	(t)		1	1	1	1	1	1	1	1	1	1

I For The Fruits
II For The Crops

TABLE (27) THE RATING OF THE MAIN LUTs

Land Suitability	Class	Almond	Apple	Date Palm	Grape	Olive	Pear	Wheat	Sugar Beets	Sweet Melon	Broad Beans	Barley	Maize	Clover
Availability of foothold for roots (d)	S1	2	2	2	3	3	3	3	2	3	2	3	3	3
	S2	2	2	2	3	3	3	3	2	3	2	3	3	3
	S3	3	3	3	3	3	3	3	3	3	3	3	3	3
	N1	4	4	4	4	4	4	4	4	4	4	4	4	4
	N2	5	4	5	5	5	5	5	5	5	5	5	5	5
Availability of water (m)	S1	2	2	3	2	3	2	3	2	3	2	3	2	2
	S2	2	2	3	2	3	2	3	2	3	2	3	2	2
	S3	3	3	3	3	3	3	3	3	3	3	3	3	3
	N1	4	4	4	4	4	4	4	4	4	4	4	4	4
	N2	5	5	5	5	5	5	5	5	5	5	5	5	5
Availability of oxygen for root growth (o)	S1	1	1	2	2	1	2	1	2	2	1	1	2	2
	S2	2	2	2	2	2	2	2	2	2	2	2	3	2
	S3	3	3	3	3	3	3	3	3	3	3	3	3	3
	N1	4	4	4	4	4	4	4	4	4	4	4	4	4
	N2	5	5	5	5	5	5	5	5	5	5	5	5	5
Salinity (z)	S1	1	1	3	1	2	1	3	3	2	2	3	2	2
	S2	2	2	3	2	2	2	3	3	2	2	3	2	2
	S3	3	3	3	3	3	3	3	3	3	3	3	3	3
	N1	4	4	4	4	4	4	4	4	4	4	4	4	4
	N2	5	5	5	5	5	5	5	5	5	5	5	5	5
Availability of nutrients (n)	S1	1	1	2	1	2	1	1	2	1	3	2	1	3
	S2	2	2	2	2	2	2	2	2	2	3	2	2	3
	S3	3	3	3	3	3	3	3	3	3	3	3	3	3
	N1	4	4	4	4	4	4	4	4	4	4	4	4	4
	N2	5	5	5	5	5	5	5	5	5	5	5	5	5
Workability (w)	S1	2	2	2	2	2	2	2	2	1	2	2	2	3
	S2	2	2	2	2	2	2	2	2	2	2	2	2	3
	S3	3	3	3	3	3	3	3	3	3	3	3	3	3
	N1	4	4	4	4	4	4	4	4	4	4	4	4	4
	N2	5	5	5	5	5	5	5	5	5	5	5	5	5
Temperature regime (t)	S1	1	1	2	1	1	1	1	2	1	1	1	1	1
	S2	2	2	2	2	2	2	2	2	2	2	2	2	2
	S3	3	3	3	3	3	3	3	3	3	3	3	3	3
	N1	4	4	4	4	4	4	4	4	4	4	4	4	4
	N2	5	5	5	5	5	5	5	5	5	5	5	5	5

Table (28) The Cost of the Main Management Practices in the Area.

ITEM	AREA		REMARKS
	S B Z LE*/ha	MARYUT LE*/ha	
Drainage (r)	100-200	100-200	Open new drainage canals or clean existing canals.
Subsoiling (s)	35	35	Governmental services (2x each with a distance of 1.2m, that the final is 60 cm between all the lines).
Fertilizers (f):			
Ammonium sulphate	20	20	(21% N) 500 Kg= 50 LE.
Superphosphate	20	20	(16-20% P2O5) 500 Kg= 50 LE.
Manure	50	50	10 m3/ha
Others:			
Tractor renting	15	12	For ploughing
	18	12	For levelling
Man/day work	8	6	LE/ day
Irrigation	50	50	Each irrigation interval (7 days). Number of irrigation times depends on the temperature and on the crop's needs.

Source : interviews with the users during the fieldwork.
* LE = 0.37 US $

TABLE (29) The Tentative Net Income From The Different LUTś.
(all the calculations are based on seven years of cultivation, including the investment for cultivating fruit crops).

L U T s	FRUIT CROPS						CROPS					
	APPLES*	PEARS*	ALMONDS	GRAPES*	DATE-PALM**	OLIVE*	BROAD-BEANS	CLOVER	MAIZE	SWEET-MELON	WHEAT	BARLEY
INVESTMENTS '000 LE/ha.	18.75	9.75	9	20	12	7.75	7	3.15	4.2	8.4	5.25	3.5
INCOME '000 LE/ha.	37.5	12	12	30	4	18	11.2	14	8.4	35	14	7
NET INCOME '000 LE/ha.	18.75	2.25	3	10	-8	10.25	4.2	10.85	4.2	26.6	8.75	3.5
S1 100%	18.75	2.25	3	10	-8	10.25	4.2	10.85	4.2	26.6	8.75	3.5
S2 80%	15	1.8	2.4	8	-10	8.2	3.36	8.68	3.36	21.28	7	28
S3 60%	11.25	1.35	1.8	6	-13.3	6.15	2.52	6.51	2.52	15.96	5.25	2.1
N1 40%	7.5	0.9	1.2	4	-20	4.1	1.68	4.34	1.68	10.64	3.5	1.4
N2 20%	3.75	0.45	0.6	2	-40	2.05	0.84	2.17	0.84	5.32	1.75	0.7
WITHIN ORDER	1	5	4	3	6	2	4	2	4	1	3	5

* Income from the crops cultivated under the trees in the first 3 years should be added as 50% of the normal income.

** Income from the crops cultivated under the Date palm in all the years should be added as 90% of the normal income.

LE = 0.37 US $

TABLE (30 - a) POTENTIAL LAND SUITABILITY FOR A P P L E S, A L M O N D S , G R A P E S and P E A R S.

LAND UNITS	d	m	o	z	n	v	t	CURRENT SUIT.	LIMITING FACTOR	LAND IMPROVEMENTS	INPUT REQU.	POTENTIAL SUITABILITY	LIMITING FACTOR
T1	S1	S1/S2	S1	S1	N2	S1/S2	S1	N2	m, n, v	f, s	A	S1	--
T2	S1	S1/S2	S1	S1	N2	S1/S2	S1	N2	m, n, v	f, s	A	S1	--
B11	S1	S1/S2	S1	N2	N2	S1/S2	S1	N2	m, n, z, v	l, f, s	A	S1	--
B12	N1	S3	S1	S2	N2	S3	S1	N2	d, m, z, n, v	r, l, f, s	C	S2	dw*2,m,v
B21	S1	S1/S2	S1	N2	N2	S3	S1	N2	m, z, n, v	l, f, s	A	S2	v
B22	S1	S3	S1	S2	N2	S1/S2	S1	N2	m, z, n, v	l, f, s	A	S2	m
B3	S1/S2	S1/S2	S3	S2	N2	S3	S1	N2	d, m, o, z, n, v	l, f, s	B	S3	dp,v
W	S1	S3	S1	S1	N2	S1	S1	N2	m, n	f, s	A	S2	m
K*3	S1	S1/S2	S1	N2	N2	S3	S1	N2	m, n, z, v	l, f, s	C	S2	v
L	N1/N2	N1	S1	N2	N2	S3	S1	N2	d, m, z, n, v	l, f, s	B	N1/N2	dp*1,m,v

TABLE (30 - b) POTENTIAL LAND SUITABILITY FOR D A T E P A L MS and O L I V E S

LAND UNITS	d	m	o	z	n	v	t	CURRENT SUIT.	LIMITING FACTOR	LAND IMPROVEMENTS	INPUT REQU.	POTENTIAL SUITABILITY	LIMITING FACTOR
T1	S1	S1	S1	S1	N2	S1/S2	S1	N2	n, v	f, s	A	S1	--
T2	S1	S1	S1	S1	N2	S1/S2	S1	N2	n, v	f, s	A	S1	--
B11	S1	S1	S1	N2	N2	S1/S2	S1	N2	n, z, v	l, f, s	A	S1	
B12	N1	S2/S3	S1	S1/S2	N2	S3	S1	N2	d, m, z, n, v	r, l, f, s	C	S2	dw*2,m,v
B21	S1	S1	S1	N2	N2	S3	S1	N2	z, n, v	l, f, s	A	S2	v
B22	S1	S2/S3	S1	S1/S2	N2	S1/S2	S1	N2	m, z, n, v	l, f, s	A	S2	m
B3	S1/S2	S1	S1/S2	S1/S2	N2	S3	S1	N2	d, o, z, n, v	l, f, s	B	S2	dp,v
W	S1	S2/S3	S1	S1	N2	S1	S1	N2	m, n	f, s	A	S2	m
K*3	S1	S1	S1	N2	N2	S3	S1	N2	z, n, v	l, f, s	C	S2	v
L	N1/N2	N1	S1	N2	N2	S3	S1	N2	d, m, z, n, v	l, f, s	B	N1/N2	dp*1,m,v

INPUT REQUIREMENTS		
LOW	A	less than 100 LE/ha
MEDIUM	B	100 - 250 LE/ha
HIGH	C	> 250 LE/ha

LAND IMPROVEMENTS FACTORS	
DRAINAGE	r
LEACHING	e
FERTILIZERS	f
SUB-SOILING	s

*1 dp Hard Pan
*2 dw Water Table
*3 Needs a special system of irrigation.

TABLE (30 - e) POTENTIAL LAND SUITABILITY FOR M A I Z E

LAND UNITS	d	m	o	z	n	v	t	CURRENT SUIT.	LIMITING FACTOR	LAND IMPROVEMENTS	INPUT REQU.	POTENTIAL SUITABILITY	LIMITING FACTOR
T1	S1	S1/S2	S1	S1	N2	S1/S2	S1	N2	m, n, v	f, s	A	S1	--
T2	S1	S1/S2	S1	S1	N2	S1/S2	S1	N2	m, n, v	f, s	A	S1	--
B11	S1	S1/S2	S1	N2	N2	S1/S2	S1	N2	m, z, n, v	l, f, s	A	S1	--
B12	S2	S3	S1	S2	N2	S3	S1	N2	d, m, z, n, v	r, l, f, s	B	S2	m,v
B21	S1	S1/S2	S1	N2	N2	S3	S1	N2	m, z, n, v	l, f, s	A	S2	v
B22	S1	S3	S1	S2	N2	S1/S2	S1	N2	m, z, n, v	l, f, s	A	S2	m
B3	S1	S1/S2	S1	S2	N2	S3	S1	N2	d, m, z, n, v	l, f, s	B	S2	v
W	S1	S3	S1	S1	N2	S1	S1	N2	m, n	f, s	A	S2	m
K*3	S1	S1/S2	S1	N2	N2	S3	S1	N2	m, z, n, v	l, f, s	C	S2	v
L	N1/N2	N1	S1	N2	N2	S3	S1	N2	d, m, z, n, v	l, f, s	B	N1	dp*1,m

TABLE (30 - f) POTENTIAL LAND SUITABILITY FOR S W E E T M E L O N , W H E A T and B A R L E Y.

LAND UNITS	d	m	o	z	n	v	t	CURRENT SUIT.	LIMITING FACTOR	LAND IMPROVEMENTS	INPUT REQU.	POTENTIAL SUITABILITY	LIMITING FACTOR
T11	S1	S1	S1	S1	N2	S2	S1	N2	n, v	f, s	A	S1	--
T2	S1	S1	S1	S1	N2	S2	S1	N2	n, v	f, s	A	S1	--
B11	S1	S1	S1	N2	N2	S2	S1	N2	z, n, v	l, f, s	A	S1	--
B12	S2	S1/S2	S1	S1/S2	N2	S3	S1	N2	d, m, z, n, v	r, l, f, s	C	S2	v
B21	S1	S1	S1	N2	N2	S3	S1	N2	z, n, v	l, f, s	A	S2	v
B22	S1	S1/S2	S1	S1/S2	N2	S2	S1	N2	m, z, n, v	l, f, s	A	S1	--
B3	S1	S1	S1/S2	S1/S2	N2	S3	S1	N2	d, o, z, n, v	l, f, s	B	S2	v
W	S1	S1/S2	S1	S1	N2	S1	S1	N2	m, n	f, s	A	S1	--
K*3	S1	S1	S1	N2	N2	S3	S1	N2	z, n, v	l, f, s	C	S1	v
L	N1	N1	S1	N2	N2	S3	S1	N2	d, m, z, n, v	l, f, s	B	N1	dp*1,m,v

LAND IMPROVEMENTS FACTORS	
DRAINAGE	r
LEACHING	e
FERTILIZERS	f
SUB-SOILING	s

INPUT REQUIREMENTS		
LOW	A	less than 100 LE/ha
MEDIUM	B	100 - 250 LE/ha
HIGH	C	> 250 LE/ha

*1 dp Hard Pan
*2 dw Water Table
*3 Needs a special system of irrigation.

TABLE (30 - c) POTENTIAL LAND SUITABILITY FOR B R O A D B E A N S and S U G A R B E E T S

LAND UNITS	d	m	o	z	n	v	t	CURRENT SUIT.	LIMITING FACTOR	LAND IMPROVEMENTS	INPUT REQU.	POTENTIAL SUITABILITY	LIMITING FACTOR
T1	S1	S1/S2	S1	S1	N2	S1/S2	S1	N2	m, n, v	f, s	A	S1	--
T2	S1	S1/S2	S1	S1	N2	S1/S2	S1	N2	m, n, v	f, s	A	S1	--
B11	S1	S1/S2	S1	N2	N2	S1/S2	S1	N2	m, z, n, v	l, f, s	A	S1	--
B12	S3	S3	S1	S1	N2	S3	S1	N2	d, m, n, v	r, f, s	C	S2	m,v
B21	S1	S1/S2	S1	N2	N2	S3	S1	N2	m, z, n, v	l, f, s	A	S2	v
B22	S1	S3	S1	S1	N2	S1/S2	S1	N2	m, n, v	f, s	A	S2	m
B3	S2	S1/S2	S1/S2	S1	N2	S3	S1	N2	d, m, o, n, v	f, s	B	S2	dp,v
W	S1	S3	S1	S1	N2	S1	S1	N2	m, n	f, s	A	S2	m
K*3	S1	S1/S2	S1	N2	N2	S3	S1	N2	m, z, n, v	l, f, s	C	S2	v
L	N1/N2	N1	S1	N2	N2	S3	S1	N2	d, m, z, n, v	l, f, s	B	N1/N2	dp*1,m,v

TABLE (30 - d) POTENTIAL LAND SUITABILITY FOR C L O V E R

LAND UNITS	d	m	o	z	n	v	t	CURRENT SUIT.	LIMITING FACTOR	LAND IMPROVEMENTS	INPUT REQU.	POTENTIAL SUITABILITY	LIMITING FACTOR
T1	S1	S1/S2	S1	S1	N2	S1	S1	N2	m, n	f, s	A	S1	--
T2	S1	S1/S2	S1	S1	N2	S1	S1	N2	m, n	f, s	A	S1	--
B11	S1	S1/S2	S1	N2	N2	S1	S1	N2	m, z, n	l, f, s	A	S1	--
B12	S2	S3	S1	S1	N2	S1/S2	S1	N2	d, m, n, v	r, f, s	C	S2	m
B21	S1	S1/S2	S1	N2	N2	S1/S2	S1	N2	m, z, n, v	l, f, s	A	S1	--
B22	S1	S3	S1	S1	N2	S1	S1	N2	m, n	f, s	A	S2	m
B3	S1/S2	S1/S2	S1	S1	N2	S1/S2	S1	N2	d, m, o, n, v	f, s	B	S2	dp*1
W	S1	S3	S1	S1	N2	S1	S1	N2	m, n	f, s	A	S2	m
K*3	S1	S1/S2	S1	N2	N2	S1/S2	S1	N2	m, z, n, v	l, f, s	C	S1	--
L	N1/N2	N1	S1	N2	N2	S1/S2	S1	N2	d, m, z, n, v	l, f, s	B	N1	dp*1,m

LAND IMPROVEMENTS FACTORS

DRAINAGE	r
LEACHING	e
FERTILIZERS	f
SUB-SOILING	s

INPUT REQUIREMENTS

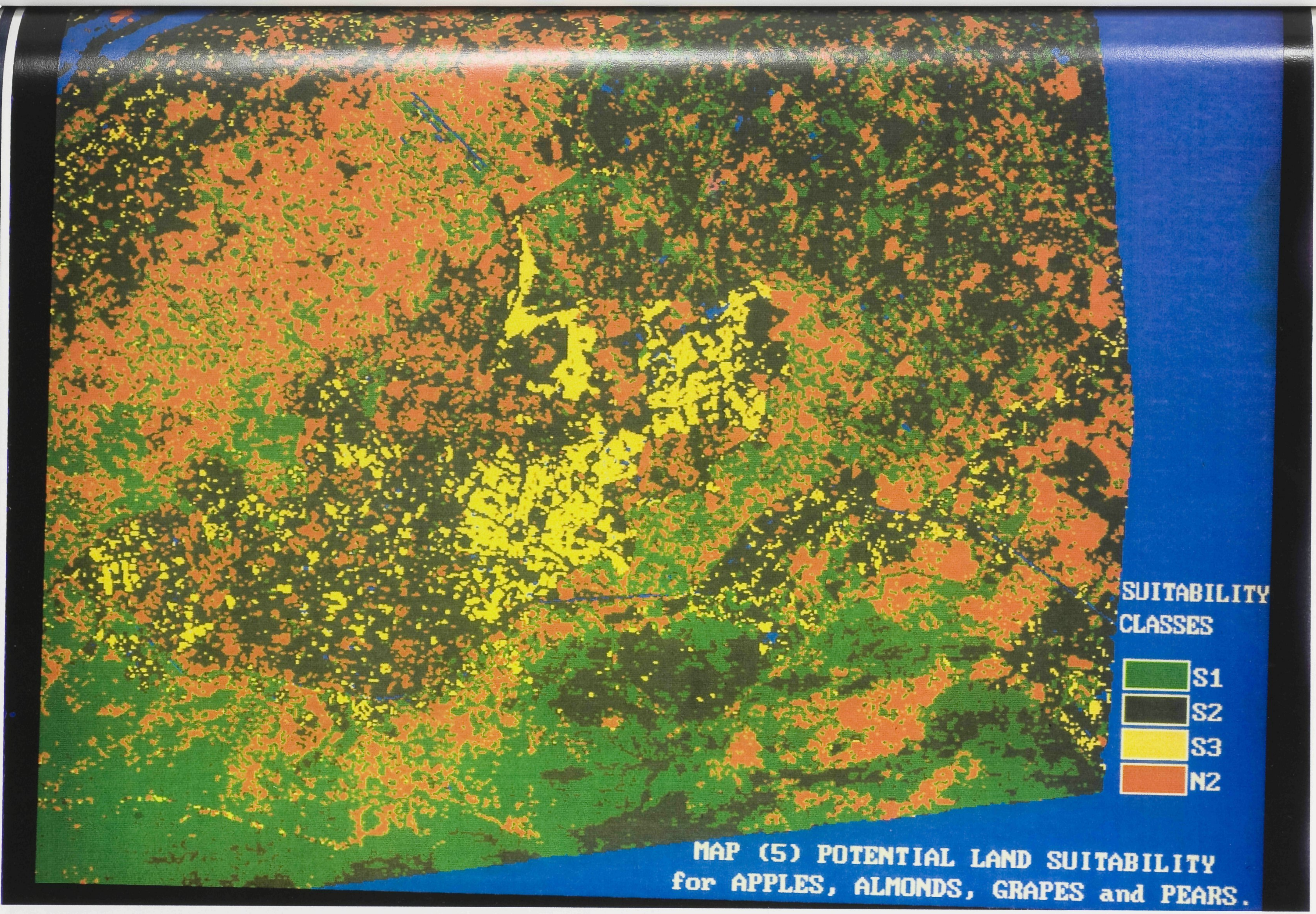
LOW	A	less than 100 LE/ha
MEDIUMB		100 - 250 LE/ha
HIGH	C	> 250 LE/ha

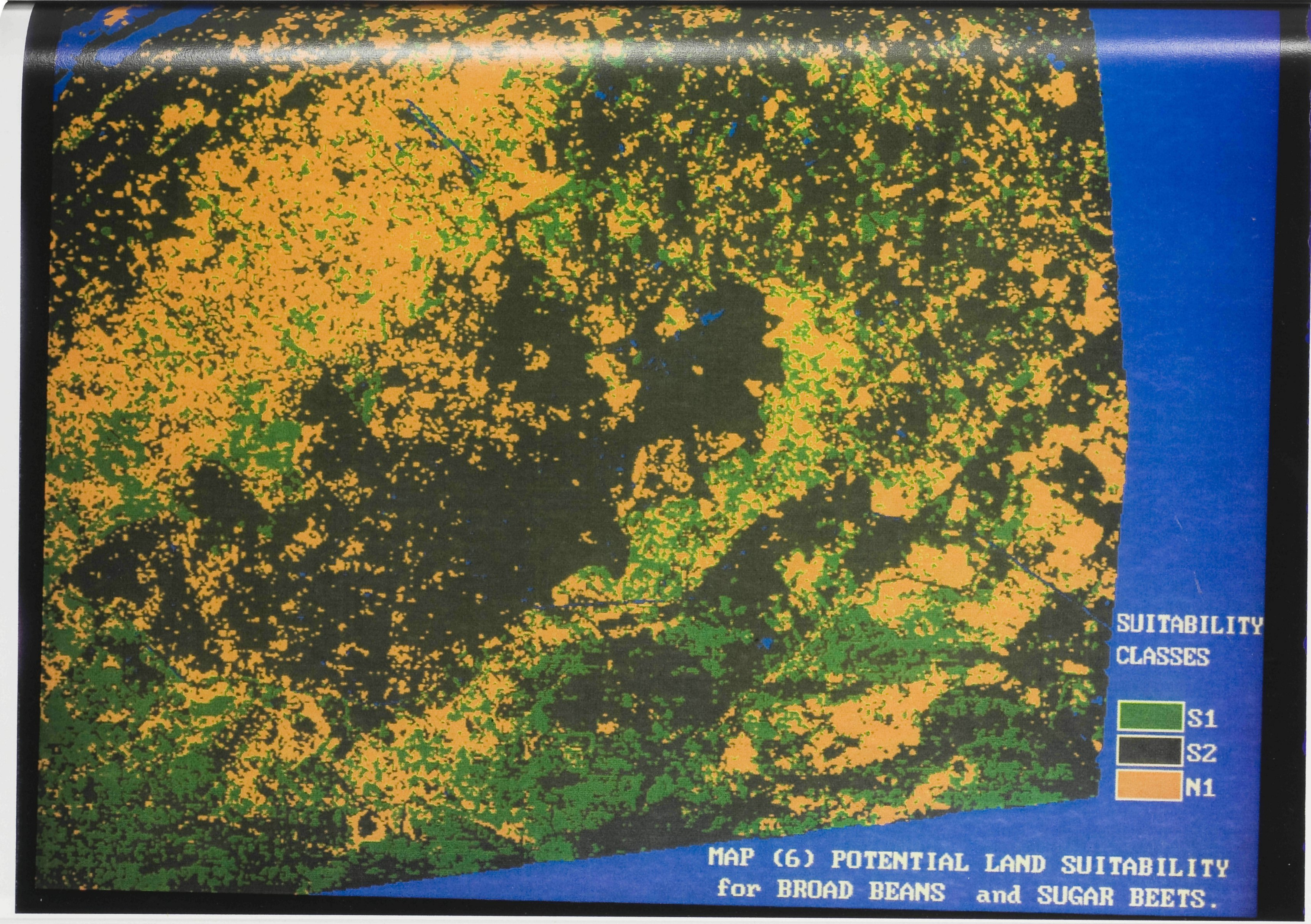
*1 dp Hard Pan
*2 dw Water Table
*3 Needs a spacial system of irrigation.

TABLE (31) THE MOST RECOMMENDED LUT's FOR THE DIFFERENT MAPPING UNITS.

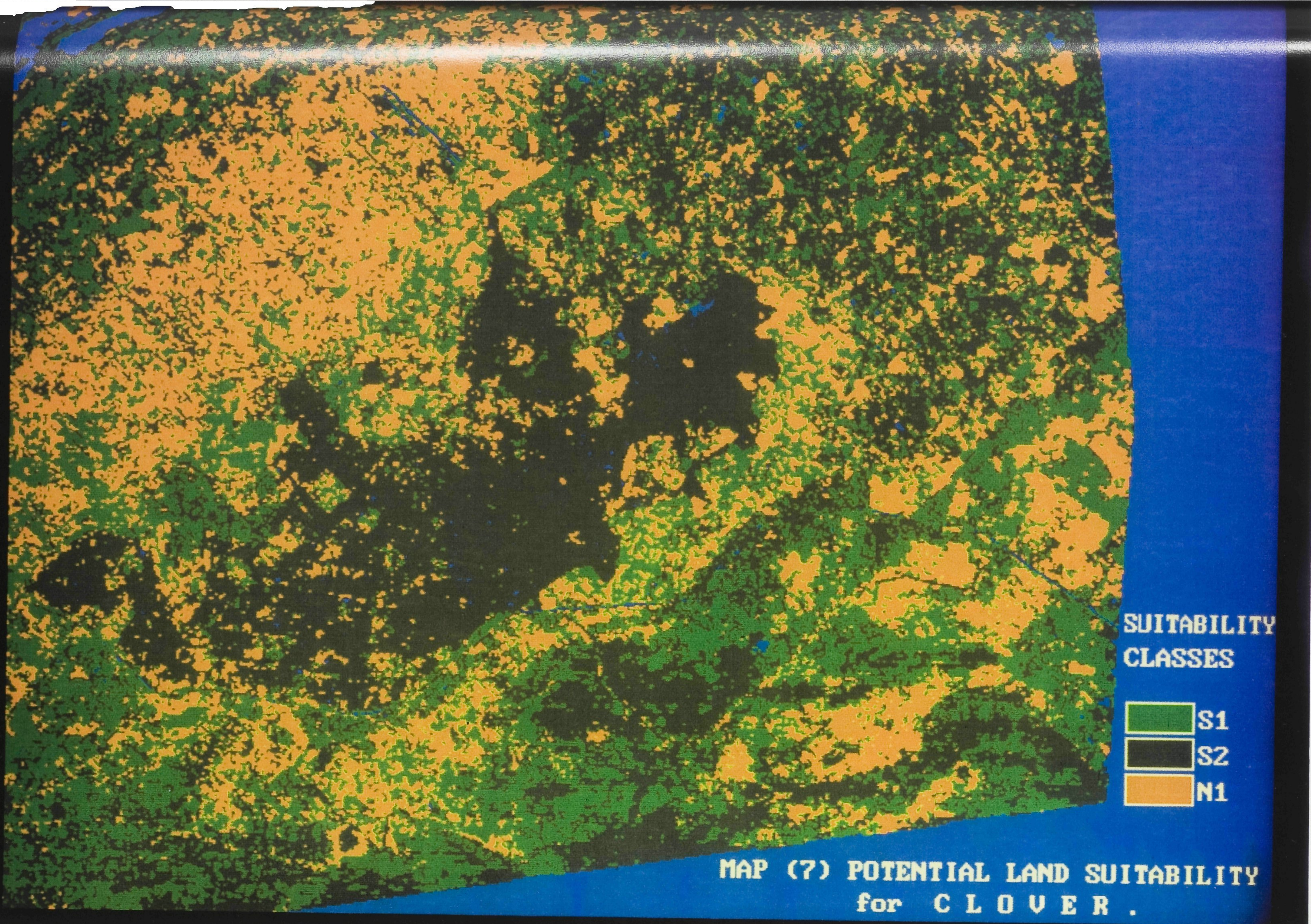
MAPPING UNITS	APPLES, ALMONDS, GRAPES & PEARS			BROAD BEANS, SUGAR BEET			CLOVER			DATE PALM, OLIVE			MAIZE			SWEET MELON WHEAT & BARLEY			RECOMMENDED LUTs (in order).
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
T1	A	S1	--	A	S1	--	A	S1	--	A	S1	--	A	S1	--	A	S1	--	apple, crop rotation, olive, grape.
T2	A	S1	--	A	S1	--	A	S1	--	A	S1	--	A	S1	--	A	S1	--	apple, crop rotation, olive, grape.
B11	A	S1	--	A	S1	--	A	S1	--	A	S1	--	A	S1	--	A	S1	--	apple, crop rotation, olive, grape.
B12	C	S2	dw,m,w	C	S2	m,w	B	S2	m	C	S2	dw,m,w	B	S2	m,w	C	S2	w	* crop rotation, apple, olive, grape.
B21	A	S2	w	A	S2	w	A	S1	--	A	S2	w	A	S2	w	A	S2	w	* crop rotation, apple, olive, grape.
B22	A	S2	m	A	S2	m	A	S2	m	A	S2	m	A	S2	m	A	S1	--	* crop rotation, apple, olive, grape.
B3	B	S3	dp,w	B	S2	dp,w	B	S3	dp	B	S2	dp,w	B	S2	w	B	S2	w	* crop rotation only.
W	A	S2	m	A	S2	m	A	S2	m	A	S2	m	A	S2	m	A	S1	--	* crop rotation, apple, olive, grape.
K	C	S2	w	C	S2	w	C	S1	--	C	S2	w	C	S2	w	C	S2	w	* crop rotation, apple, olive, grape.
L	B	N1/N2	dp,m,w	B	N1	dp,m,w	B	N1	dp,m	B	N1/N2	dp,m,w	B	N1	dp,m	B	N1	dp,m,w	not suitable for any LUT (could be used for grazing).

* mainly CLOVER , but vegetables might be also recommended.
1= inputs in LE/ha., where: A <100, B 100-250, C 250-500.
2= potential suitability , where: S1, S2, S3, N1 and N2 are suitability classes
3= limiting factor(s) after the inputs.

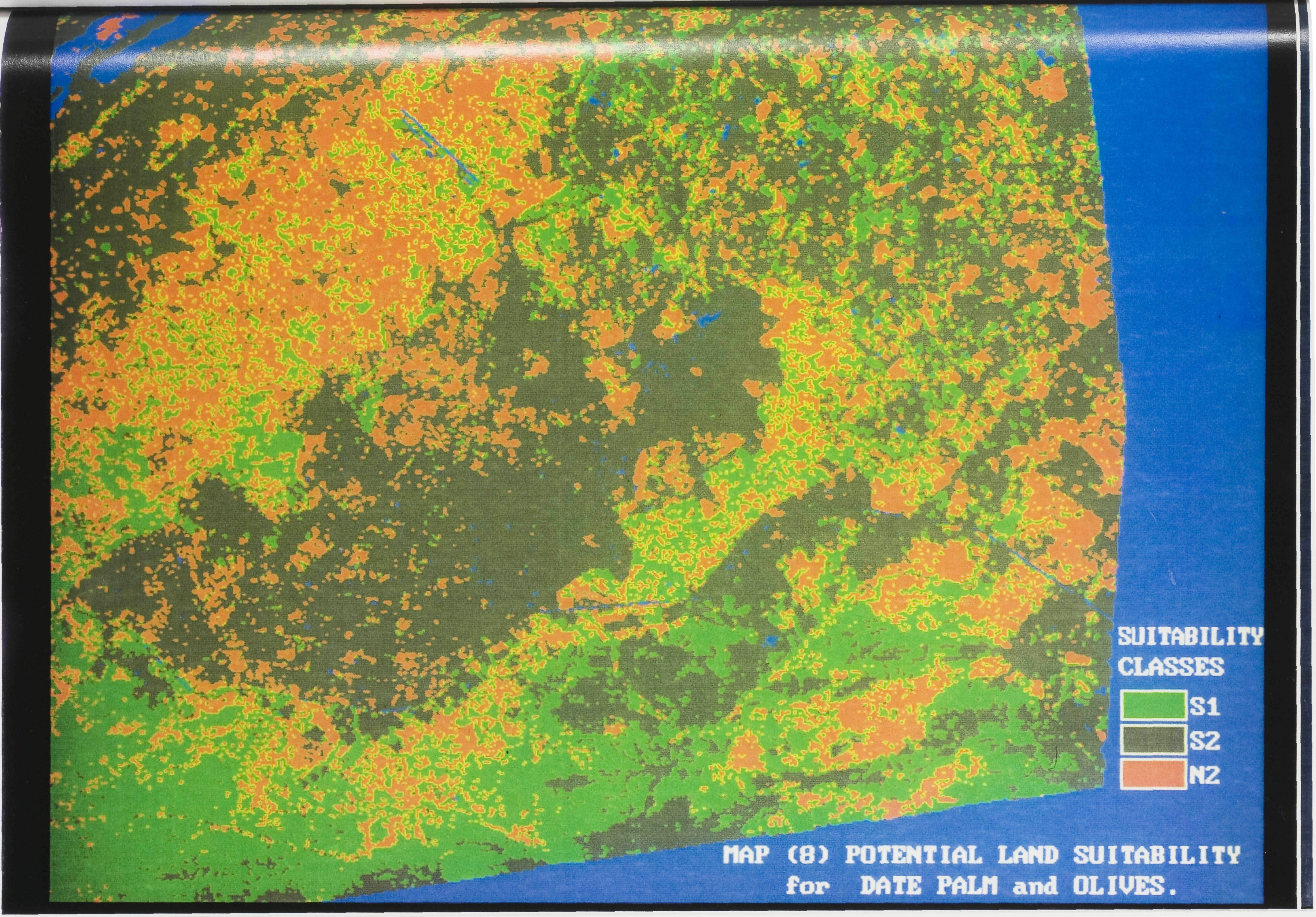

SUITABILITY
CLASSES
S1
S2
S3
N2
MAP (5) POTENTIAL LAND SUITABILITY
for APPLES, ALMONDS, GRAPES and PEARS.



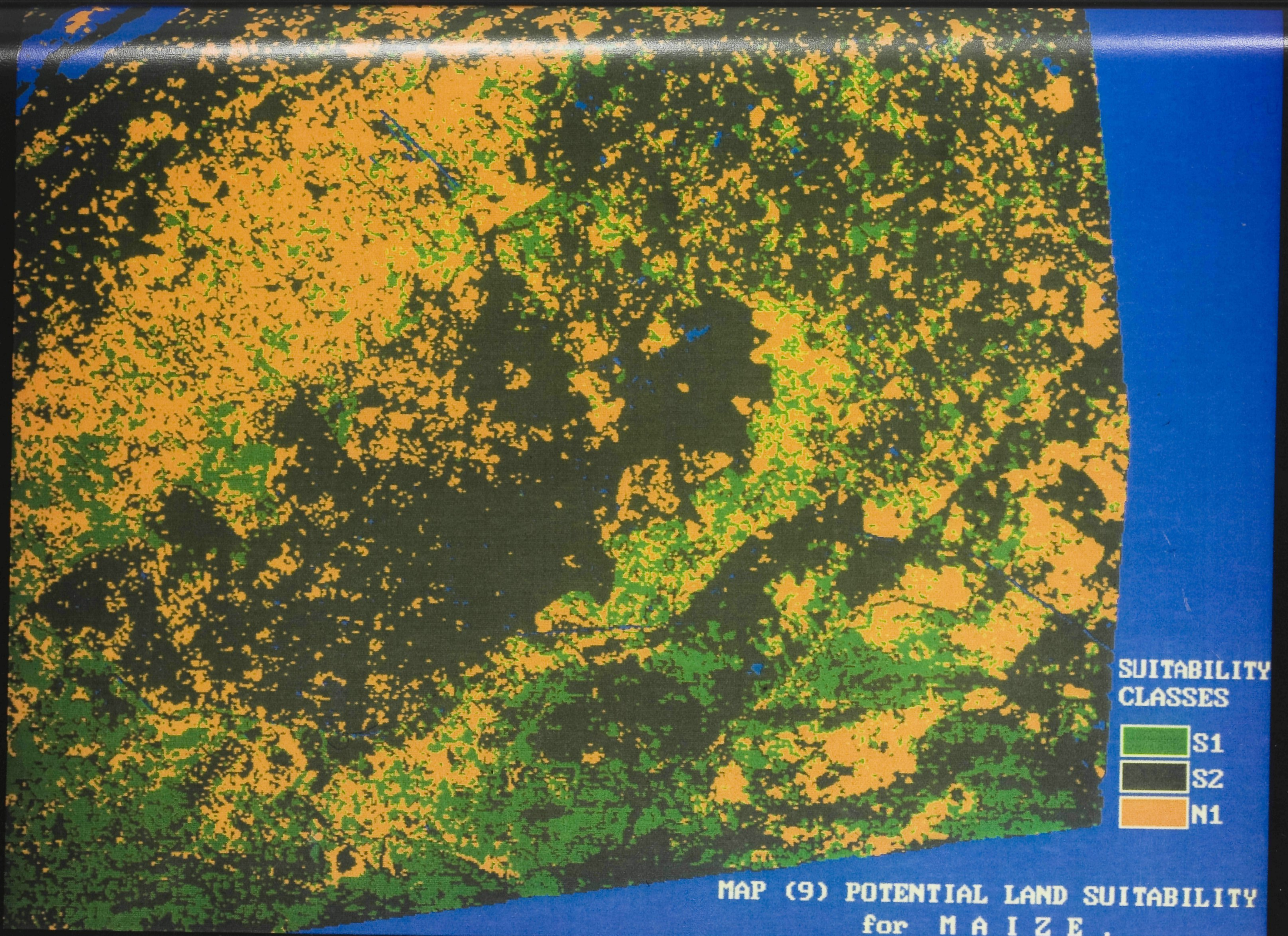
MAP (6) POTENTIAL LAND SUITABILITY for BROAD BEANS and SUGAR BEETS.



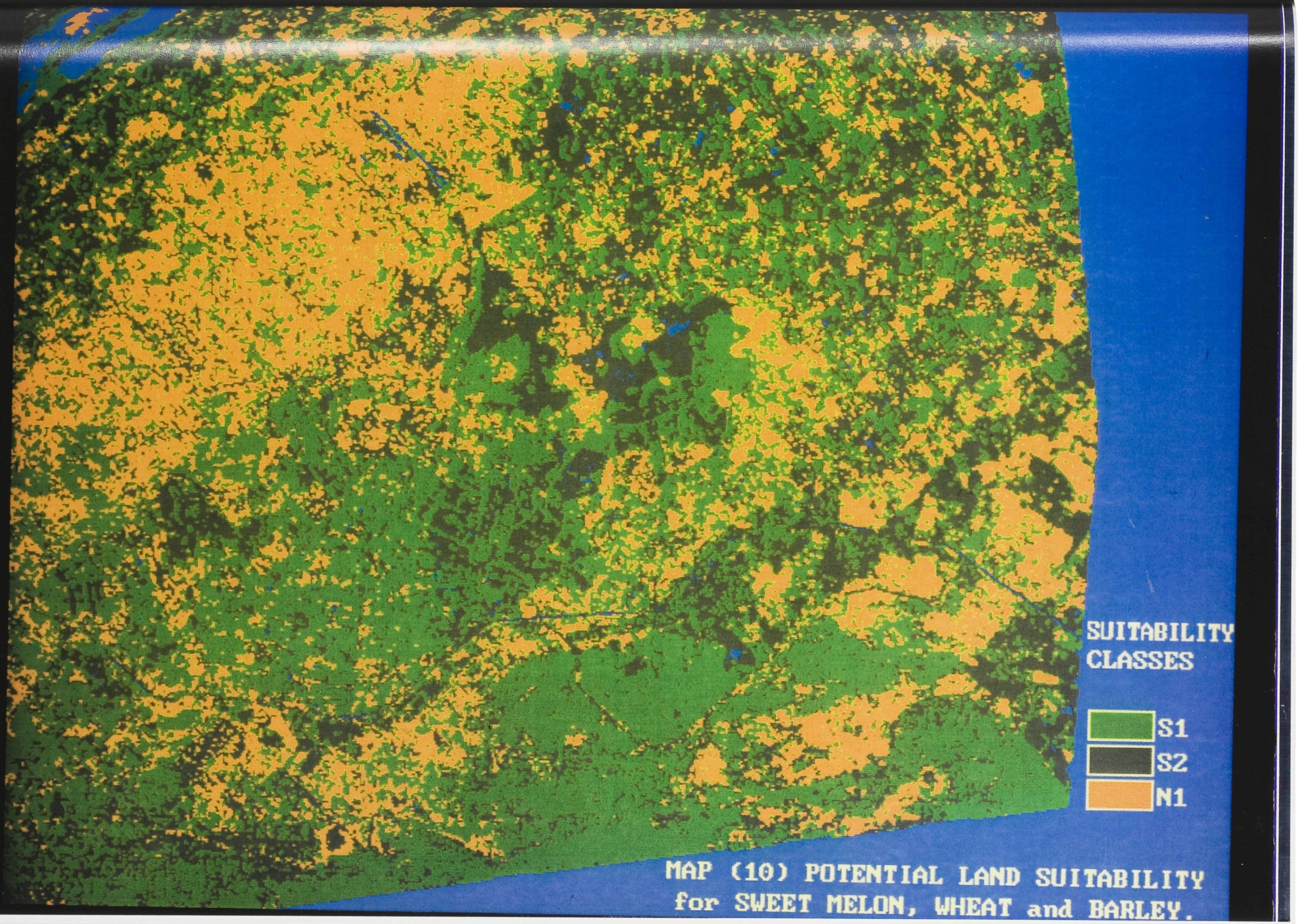
MAP (7) POTENTIAL LAND SUITABILITY for CLOVER.



MAP (8) POTENTIAL LAND SUITABILITY for DATE PALM and OLIVES.



MAP (9) POTENTIAL LAND SUITABILITY for M A I Z E .



MAP (10) POTENTIAL LAND SUITABILITY for SWEET MELON, WHEAT and BARLEY.

6.6.3. Sociological Evaluation of the Studied Area.

The study area could be subdivided into two main sub areas. The first area is " Maryut" and the second area is the " Sugar Beet Zone ".

a) Maryut area :

Maryut area consists of the following villages

1. Orabi	2. Palestine	3. Mostafa Kamel
4. Algeria	5. Yemen	6. Iraq
7. El Eza	8. Baghdad	9. El Basra
10. El Sada	11. Abou Masoud	12. El Harba
13. Rahim	14. El Garasat	15. El Galaa
16. Halab		

The following are the main remarks about these villages:

1. The inhabitants of these villages are all workers of the "Maryut Agricultural Co." except for three villages, which are "Baghdad", "El Basra" and "Abu Masoud". They comprise, beside the workers of the company, university graduates, who have been allocated an average of 10.5 Feddans (1 feddan=4,200m2) per graduate since 1980.

2. The villages are surrounded by smaller villages, which benefit from the services offered to the graduates, farmers and workers.

3. The agricultural lands as described before are producing better than those of the "Sugar Beet Zone" villages.

4. Maryut Agricultural company has a cattle raising and feeding project (feeding units). This does not exclude the individual initiative of the families in raising cattle, rabbits, ducks and poultry.

B) Sugar Beet Zone Area:

This area is part of a project financed by the World Bank. The villages in this area are the following:

1. Al Quaria El Ola (1)
2. Al Quaria El Thaneya (2)
3. Al Quaria El Thaltha (3)
4. Al Quaria El Rabea (4)
5. Al Quaria El Khamesa (5)
6. Al Quaria El Sadesa (6)
7. Al Quaria El Sabea (7)
8. Al Markazeya
9. Al Olaa
10. Al Zohour
11. Al Tanmeya
12. Mohamed Farid
13. Al Quaria El Thalesa Ashr(13
14. Al Quaria Rabea Ashr (14)
15. Al Quaria El Khamesa Ashr(15)
16. Al Quaria Sadesa Ashr(16)
17. Al Quaria El Sabea Ashr (17)
18. Al Quaria El Thamena Ashr(18)
19. El Quaria El Tasea Ashr(19)
20. Al Quaria El Eshrin (20)
21. El Quaria El Wahed Wa Eshrin (21)

The following are some remarks about these villages :

1. The villages from number (1) to (7) are still under construction and will be soon delivered to the farmers.

2. The villages from number (8) El Markazeya to village no. 21, were all delivered to graduates in between November 1987 and October 88.

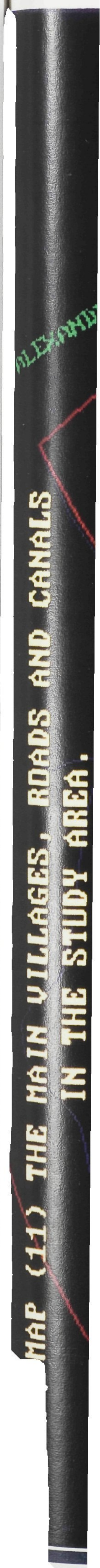
3. The average share per graduates is 6 feddans (1 feddan=4,200m2).

4. The villages which were given numbers were constructed by a chinese company.

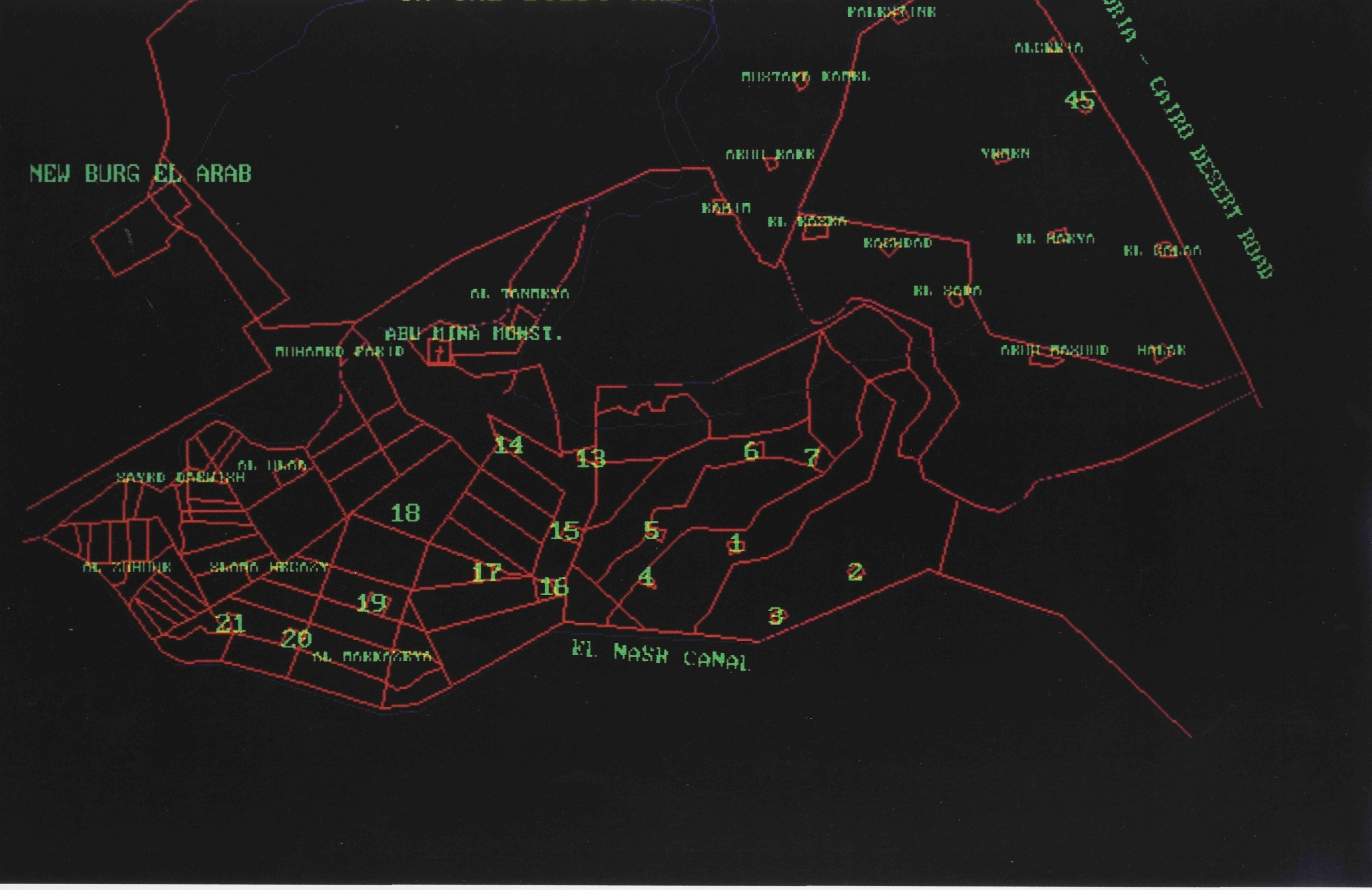
5. The villages which were given names were constructed by Egyptian companies.

6. The above mentioned villages are surrounded by smaller ones in which Farmers and Beduins are living.

Map (11) shows the main villages, roads and canals in the study area.



MAP (11) THE MAIN VILLAGES, ROADS AND CANALS
IN THE STUDY AREA.



Statistics about the " Sugar Beet Zone " Villages :

1. The average number of graduates per village is approximately 200 graduates.

2. The share of land per graduate is 6 Feddans(1 feddan= 4,200m2).

3. The Government gives each graduate a house, which consists of two rooms and services.

4. The average number of houses in each village is 210 including the ones of the staff responsible for the services. There are some exceptions where the number of houses is larger, e.g. Al Zohour (320 houses); Al Olaa (480 houses).

5. The biggest villages in terms of surface are Al Olaa and Al Zohour.

6. The biggest ratio of married couples is found in Al Zohour. There are 70 married couples out of 320 graduates.

7. The average number of married couples in 14 villages is 10% and most of them live outside the villages in the city, except in Al Zohour village.

8. The inhabitants of Al Tanmeya village are now 186 and after finishing the 3rd phase of houses the village will accomodate 466 graduate.

9. In El Markazeya village, they will also continue to finish 600 houses to accomodate 600 graduates instead of 200.

10. The total amount of university graduates living in those villages is 3,267 graduates.

11. The children who live in the villages are less than 3 years old.

12. Most of the services are not yet in action but they are already built.

13. Some depots for the nutritional aid to the graduates exist in some villages.

14. The role of agricultural cooperatives is still limited to distribute fertilizers only.

15. Each graduate gets LE 50.- (LE= 0.37 US $) monthly during the first year following reception of his land from the government.

16. The economical activity in the villages consists mostly of agriculture, poultry and rabbit raising. The latter are mainly experiments.

17. In the villages no. 15,16,17 and 19, 30% of the graduates received one cow each. The graduate has to pay one quarter of the price immediately and the rest in installments. This experience will be generalized later in all villages.

18. All the 21 villages are connected by good asphalted roads, which build a good communications network.

19. Reimbursement system :

a. The graduate will start the reimbursement of the loan after a period of three years on a basis of LE 400.- (US $ = 2.7 Le) annually.

b. The land costs LE 6,000.- and the house costs LE 6,000. which makes a total of LE 12,000.-(US $ = 2.7 LE).

20. The percentage of graduates giving the land for rent is around 50% to 60%, due to the lack of experience and financial possibilities of the graduates.

21. The percentage of graduates having sold their land does not exceed 2%.

22. The village number 21 is an exceptional case, where the graduates did not at all give their land for rent, but they cooperated and helped each other.

23. There were different opinions on the question of emigration. Those who have invested a lot of money in the land cannot give it up, others who have worked with their own hands have developed the feeling of devotion to the land, but the ones who cannot face the hard conditions wish to emigrate. Their comment was " We wish to get out of this plight ".

24. General views about the graduates :

a. Some find the project to be excellent and wish to get over the hard time until they reap the first harvest.

b. others said that the government had given them to start. Therefore, the government has to continue with them and give them training in agriculture so that they do not loose.

c. Some others said that the project had made drastic changes in their lives, their dreams and their hopes towards the positive direction.

25. The average income of the graduate is unknown because it depends on the amount of the production.

26. The real needs of the graduates are :

a. to gain experience and financial abilities.

b. marketing centers to sell their agricultural products.

Table (32 app.) summarizes the main foundation of the study area.

The Socio-economic parameters have been studied according to the following main items :

- Marketing orientation;
- Labour intensity and
- Services availability.

These main parameters used for studying the socio-economics of the studied area have been rated as shown in table (33), figures (20, 21 and 22).

Map (12) shows the environmental evaluation of the study area.

Table (33)

1. Market orientation.

Rating	Symbol	Description
1	I	**Less than 10 km from the entrance to the area, which is 40 km far from Alexandria.**
2	II	**Less than 20 km from the entrance at the km 40 from Alexandria, or less than 7 km from the second entrance to the area at Burg El- Arab city, which is 60 km far from Alexandria.**
3	III	**Less than 30 km. from the entrance at the km 40 from Alexandria, or less than 14 km from the second entrance to the area at Burg El-Arab city, or less than 5 km from the third entrance to the area at the crossing point between El-Nasr canal and Alexandria- Cairo desert road, which is 80 km far from Alexandria.**
4	IV	**Less than 40 km from the first entrance, 21 km from the second entrance, and 10 km from the third entrance.**
5	V	**Less than 50 km from the first entrance, 28 km from the second entrance, and 15 km from the third entrance.**

2. Labour Intensity.

Rating	Symbol	Description
1	1	Available Permanently in the area, with high intensity and high skill.
2	2	Available permanently in the area, with medium intensity or medium skill.
3	3	Available seasonally in the area from the near villages or with medium intensity or skill.
4	4	Available seasonally with difficulty, or with low intensity or skill.
5	5	Not available.

3. Services availability.

Rating	Symbol	Description
1	a	Excellent, with high quality level or within 5 km from the main cities in the area (Burg El -Arab and Al-Ameriya).
2	b	At least Education, Health Centre and Police station are existing in the village and the rest of the services are existing in any village which within 2.5 km
3	c	Either Education, health centre or Police station is missing but existing in any village which is within 2.5 km
4	d	Only one of the main services Education, health centre or police station is existing and the rest of the services are not available within 2.5 km
5	e	None of the services available within 2.5 km

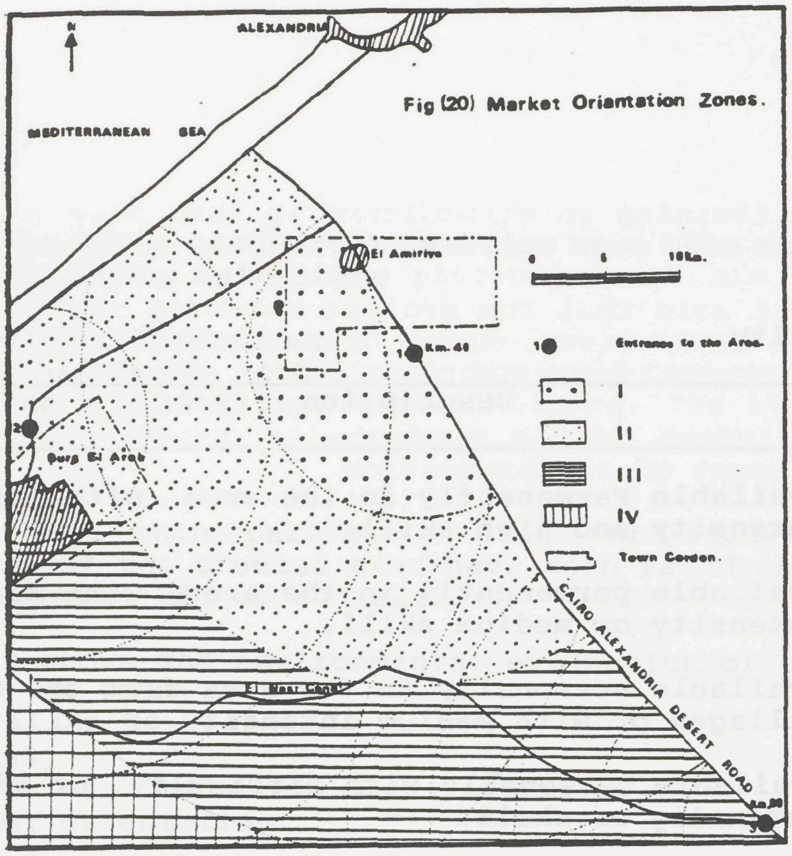


Fig (20) Market Oriantation Zones.

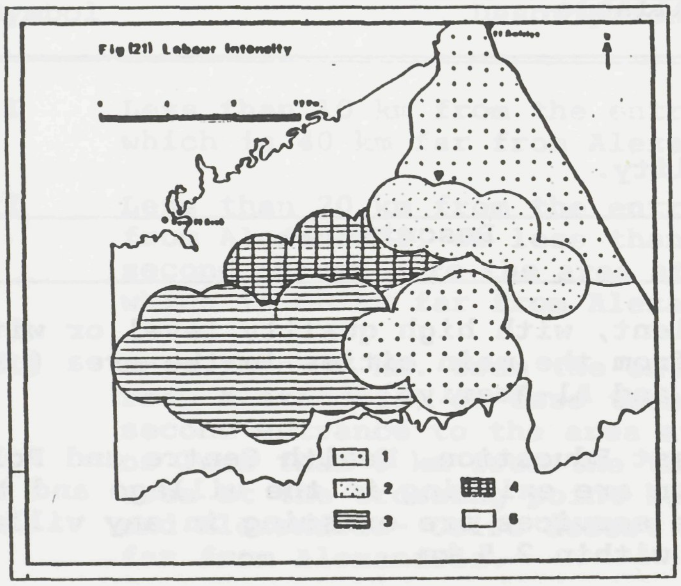


Fig (21) Labour Intensity

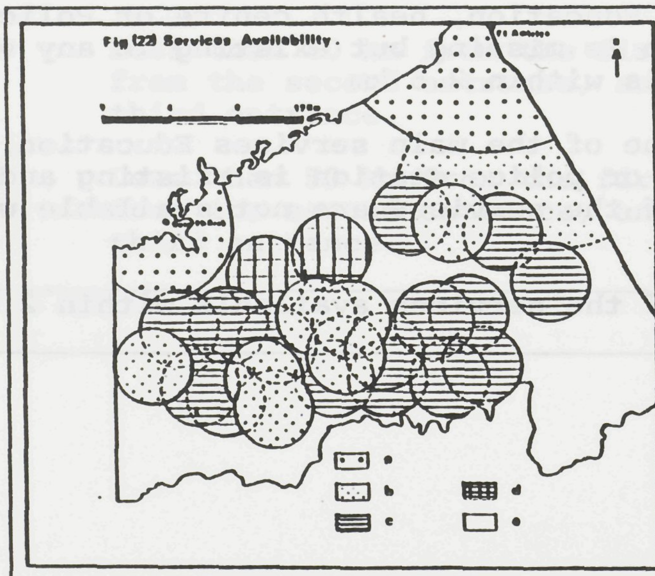
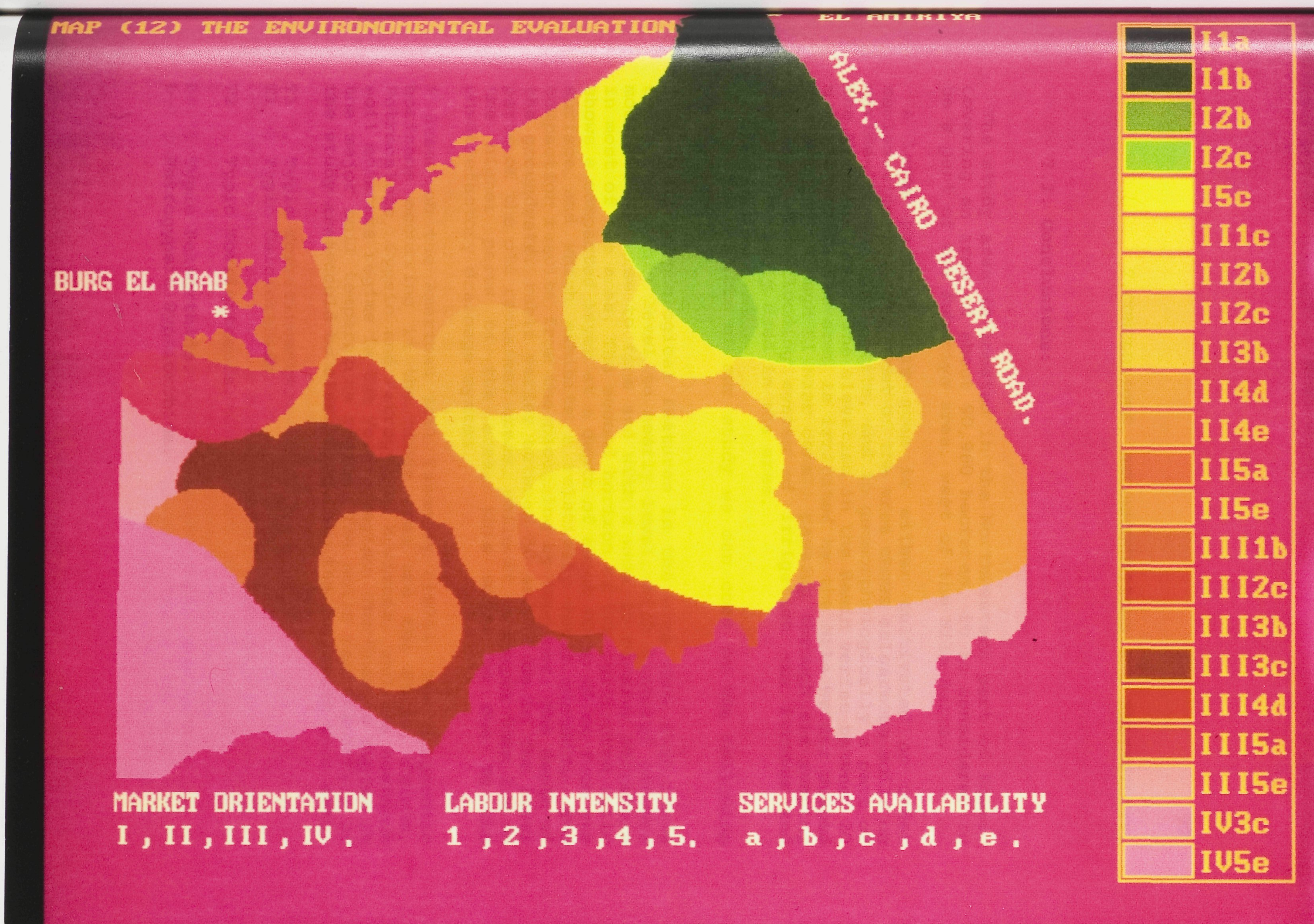


Fig (22) Services Availability


MAP (12) THE ENVIRONOMENTAL EVALUATION
EL AMIRIYA
ALEX.- CAIRO DESERT ROAD.
BURG EL ARAB
MARKET ORIENTATION
I , II , III , IV .
LABOUR INTENSITY
1 , 2 , 3 , 4 , 5.
SERVICES AVAILABILITY
a , b , c , d , e .
I1a
I1b
I2b
I2c
I5c
II1c
II2b
II2c
II3b
II4d
II4e
II5a
II5e
III1b
III2c
III3b
III3c
III4d
III5a
III5e
IV3c
IV5e

7.CONCLUSIONS, RECOMMENDATIONS AND RELIABILITY.

7.1. Conclusions:

The study area is located in the Northwestern part of Egypt. Covering an area of about 90,960 hectares, it is considered to be a part of the Nubariya area, west of the Nile Delta.

A large part of this area is either cultivated or under reclamation projects. Most of the area shows calcareous soils on marine-lacustrine deposits, and is geomorphologically a part of the Abu-Mina Basin. The elevation in the Basin varies between 20 m to 50 m asl. The area is irrigated by the Nile waters pumped and carried through El Nasr canal, passing through six pumping stations. The flooding system of irrigation -in furrows and basins- is widely used in the area.

From the results of our study we can come to the following conclusions:

* The soil morphological features in the area show that these soils are mainly level to nearly level, with textural classes moderately coarse to fine and with a weak to massive structure in most of the area. The second horizon of the cultivated soils shows a compacted layer at a depth of about 20 to 25 cm from the surface and which exhibits a relatively lower porosity. The compaction results from the ploughing by tractors. The depth of the groundwater table varies between 50 and 90 cm in the lower parts of the old reclaimed areas, while it is deeper than 2 m in the higher parts of the area, this might be due to the unsatisfactory drainage system.

* Based on the American Soil Taxonomy (1975), the diagnostic horizons occurring in the study area are the Salic, Calcic, Petrocalcic, Gypsic and Petrogypsic horizons, and the dominant soil moisture regime is the Torric regime. The Thermic regime is the major soil temperature regime. The soils representative of the study area could be classified into the following soil sets:

T1 , Typic Torrifluvents.
T1 , Typic Calciorthids.

T2 , Typic Torriorthents.

L , Typic Paleorthids.
L , Petrogypsic Gypsiorthids.

W , Typic Torripsamments.

B11 , Aquollic Salorthids.
B11 , Typic Calciorthids.

B12 , Typic Torrifluvents.
B12 , Typic Calciorthids.

B21 , Aquollic Salorthids.
B21 , Typic Calciorthids.

B22 , Typic Torrifluvents.
B22 , Typic Calciorthids.

B3 , Typic Torrifluvents.
B3 , Typic Calciorthids.
B3 , Petrogypsic Gypsiorthids.

* Many changes have occured in the soils with the duration of the cultivation.

- The thickness of the "A" horizon tends to increase.

- There is a slight increase in the clay and calcium carbonate contents in the second horizon.

- There is a sharp decrease in the soil salinity at the surface and in subsurface horizons during the first years of cultivation, but a slight increase in salinity can be recognised in the older cultivated areas as a result of the poor condition of the drainage canals and of the increase of the microporosity with the compaction resulting from the use of heavy tractors.

- The O.M. content tends to increase in the surface horizon similarly to the increase of the "A" horizon and a slight increase can be seen in the second horizon as well. Such increase is due to the manure additions and to the mixing of the rest of the plants with the soils.

- There is also a certain degree of structure development in all horizons, but the upper horizon has been affected by the salinity and water table level in the older cultivated soils.

- The exchangeable K decreases sharply during the first years of cultivation similarly to the decrease in soil salinity.

* The relations obtained from the spectrometer readings in the field were very helpful during the selection of the classes for the spectral classification.

* According to the results obtained from the spectral classification, it is very clear that the month of September was a good choice to study the landform, since most of the cultivated areas were either bare or with a low coverage percentage. The number of classes obtained was of 22 classes.

* Using the spectral classification it was possible to separate the recently reclaimed areas from the older reclaimed areas .

* According to the field data, the visual interpretation and with the use of all the available knowledge about the area, the ILWIS GIS facilities were applied and the spectral classes was grouped together into 11 classes representing the mapping units of the final physiographic soil map of the area.

* A potential land suitability for the most extended used and recommended LUT's was worked out based on the matching between the land characteristics and the LUT's requirements, and from this we can come to the conclusion that the T1, T2 and B11 mapping units covering area of about 24,330 ha (26.7 % of the total area) can be considered to be highly suitable with low inputs. The B12 mapping unit is covering an area of about 7,980 ha (8.9 % of the total area) and can be considered to be moderately suitable with medium to high inputs. The B21, B22 and W mapping units are covering an area of about 29,600 ha (28.1 % of the total area) and can be considered to be highly to moderately suitable with low inputs. The K mapping unit is covering an area of about 4,710 ha (5.1 % of the total area) and can be considered to be highly to moderately suitable but requires a high input and a special system for irrigation (drip irrigation). The B3 mapping units covering an area of about 4,030 ha (4.4 %), can be considered to be moderately to marginally suitable and requires medium inputs. The rest of the area which covers 20,790 ha (22.8 % of the total) can be considered to be not suitable.

7.2. Recommendations.

The study leads to the following recommendations:

a- a land improvement programme should start in the cultivated areas to improve the drainage system efficiency, the leaching of the salinity and avoiding the misuse of the irrigation water.

b- a deep subsoiling followed by manure additions is needed in order to form aggregates improving the oxygen availability.

c- more detailed studies should takes place in the near future in the following directions:

* studying the micronutrient and their relation with the active lime.

* more observations covering the old cultivated soils and statistical correlations should be sought in order to develop a model assessing the progress in soil development in relation to the time of cultivation.

* the socio-economical aspects have proven themselves to be of a great importance for land evaluation. For that reason more detailed studies should take place in that direction in the near future.

* the distribution of the land to the graduates is often seen as a solution to the mandatory employment of graduates by the government and as a method of disposing of portions of state farms. It is to early to judge who is willing to live on the land and who will be able to manage and cultivate his farm by himself. The majority of the graduates, however, prefers to live in Urban areas, so in the absence of the landlords their land will never be brought to full productivity. The financial reserves of the graduates are most of the time very limited. To overcome this private companies concerned mainly with marketing could help the graduates in consulting, developing and planning. Such companies can also put some effort in improving the services, the social , health and educational aspects in the area.

7.3. Reliability of the Study.

The time which has been provided for the practical part of this study was too limited and started actually in March, since the TM tape came late. For that reason, the time to prepare materials before going to fieldwork was limited. Only a low quality colour composite hard copy, which was not helpful for visual interpretation, was used as a map to indicate the direction and locate the observations in the field. As a result the total number of samples collected in the field increased but still many shortages in information remain for some areas. Also many difficulties remain in delineating some mapping units specially the Abou Mina Basin. These problems were solved by the spectral classification when compiled with the different data about the area.

The printing scale (1:100,000) of the final physiographic soil map, makes it a very good base map for potential land use and it can be also used in the future for further detailed studies.

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APPENDICES

TABLE (1) Crop Yields on Maryut , 1976-1983 (ton/hectare).

Crop	Company 1978/83 average	Settlers 1976	1978	1979/82 average	1979/82 max
Barseem	...	...	40.0	50.00	62.50
Maize	1.15	1.40	2.50	3.00	4.20
Wheat	1.67	0.85	2.50	...	...
Barley	...	...	2.25	3.40	2.22
Broad Beans	0.52	...	...	1.95	3.87
Sweet Melon	...	...	...	11.25	...

Source: Land Master Plan (1986).

TABLE (2 a) Yield Projection for New Lands(ton/hectare)

Crop		Years after reclamation 5	10	20	30	Average
Broad Bean	High	1.75	2.00	2.75	3.25	2.50
	Low	1.50	1.75	2.25	2.75	2.00
Maize	High	4.00	5.00	6.50	7.75	5.75
	Low	3.74	4.25	5.75	6.75	5.00
Sugar-beet	High	27.75	33.25	42.25	49.00	38.00
	Low	26.00	30.00	36.75	42.50	33.75
Wheat	High	2.75	3.25	4.50	5.25	4.00
	Low	2.50	3.00	3.75	4.50	3.50

Source: Land Master Plan (1986).

TABLE (2 b) INTERNATIONAL YIELD COMPARISON OF IRRIGATED CROPS (TON/HA.)

CROP	EGYPT	USA average	FAO average	L	M	H
MAIZE	4.0- 4.3	6.67	5.9- 9.0	4.0	5.9	9.0
WHEAT	3.1- 3.6	3.33(Mexico)	4.0- 5.9	3.1	4.0	5.9
SUGAR BEET	------	47.6	40.5-80.9	40.5	47.6	80.9
SWEET MELON	21.4- 2.4	------	23.8-35.7	------	23.8	------
GRAPES	9.5-14.3	------	14.9-30.0	9.5	14.3	------

Source Land Master Plan (1986).
L=LOWEST
M=MEDIUM
H=HIGHEST

TABLE (7) THE CLIMATOLOGICAL NORMALS AT EL-DIKHILA STATION
(THE AVERAGE OF 24 YEARS ,1957 - 1980).

MONTH	TEMPERATURE in°C MAX	MIN	MEAN	MEAN MONTHLY RELATIVE HUMIDITY %	MONTHLY TOTAL PRECIPITATION mm.	MEAN DAILY EVAPORATION mm./day	MEAN MONTHLY WIND SPEED m./sec.
JANUARY	17.80	9.60	13.70	68	52.70	5.50	8.90
FEBRUARY	18.70	10.40	14.55	66	23.30	6.20	9.10
MARCH	20.70	12.10	16.40	64	13.20	7.00	9.80
APRIL	23.20	14.40	18.80	65	2.80	7.40	9.50
MAY	25.30	17.10	21.20	69	1.00	6.70	9.40
JUNE	27.80	20.80	24.30	71	0.10	6.90	8.70
JULY	29.00	22.90	25.95	72	-	7.40	9.10
AUGUST	29.70	23.50	26.60	70	_	7.70	8.90
SEPTEMBER	28.80	22.10	25.45	67	1.10	7.70	8.10
OCTOBER	26.70	18.90	22.80	67	10.70	7.10	7.40
NOVEMBER	23.50	15.60	19.55	68	23.50	6.40	7.60
DECEMBER	19.80	11.30	15.55	67	47.90	6.10	8.30
MEAN ANNUAL	24.25	16.56	20.40	67.8			
TOTAL					179.30		

TABLE (8) GEOLOGY OF THE STUDY AREA.

AGE	LITHOLOGY	THICKNESS
QUATERNARY		
Holocene	- Beach deposits composed mainly of calcareous oolites and shell fragments	2 m.
	- Calcareous loamy deposits.	9 m.
	- Aeolian deposits composed of calcareous oolites and occasionally pink quartz sand.	3 m.
	- Nile silty deposits covering the present Delta and margins.	10 m.
Pleistocene	- Oolitic limestones developed to a series of successive ridges.	35 m.
	- Lagoon deposits developed essentially into clay sand gypsum.	10 m.
	_ Nile deltaic deposits composed of sands and gravels with occasionally clay lenses	300m.
Plio-Pleistocene	- Pink pseudo oolitic limestone.	60 m.
TERTIARY		
Pliocene	- Reported in the subsurface and developed in brackish water, sands and clay, and in marine pyritic clays.	50 m.

Source : Abd El-Rahman 1970.

TABLE (11) THE MAIN MORPHOLOGICAL FEATURES OF THE DIFFERENT OBSERVATION POINTS.

Profile No.	Period of Cultivation	Horizon Symbol	Depth in cm	Texture	Coarse Fragements	Matrix Colours Dry	Matrix Colours Wet	Structure	Consistency Dry	Consistency Moist	Roots	Lime	pH	Diagnostic horizons	Soil classification	Remarks
1	>25 year	Ap	0-30	SL	Sg	10 YR5/4	10 YR5/4	mo,md,ab	slightly hard	----	c,md	hc	8.0	----	Typic Torrifluvents	
		Ck1	30-80	SL	---	---	10 YR5/8	mss	----	friable	fw,fn	hc	8.1	----		
		Ck2	80-120	SCL	---	---	10 YR5/6	mss	----	friable	----	hc	8.3	----		
2	>25 year	Ap	0-30	SL	---	10 YR5/6	10 YR5/6	vk,fn,cb	----	friable	fw,fn	hc	8.3	----	Typic Torrifluvents	
		Ck1	30-60	SCL	---	---	10 YR5/8	mss	----	friable	----	hc	8.2	----		
		Ck2	60-100	SCL	---	---	7.5YR5/8	mss	----	friable	----	hc	8.2	----		
3	>25 year	Ap	0-25	SL	---	10 YR5/4	10 YR5/4	vk,fn,cb	----	friable	c,fn	hc	7.9	----	Typic Torrifluvents	
		Ck1	25-45	SCL	---	---	10 YR5/6	mo,md,sb	----	friable	----	hc	8.0	----		
		Ck2	45-60	SCL	---	---	7.5YR5/8	vk,md,sb	----	v.friable	----	hc	8.0	----		
		Ck3	60-180	SCL	---	---	7.5YR5/8	mss	----	v.friable	----	hc	8.2	----		
		Ck4	80-120	SCL	---	---	7.5YR6/8	mss	----	v.friable	----	hc	8.3	----		
4	>25 year	Ap	0-25	L	---	10 YR6/4	10 YR5/4	vk,vfn,cb	----	friable	c,fn	hc	8.2	----	Campic Gypsiorthids	
		Ck1	25-55	SL	---	---	10 YR7/4	vk,fn,ab	----	firm	----	hc	8.2	Campic		* Gypsum crystals start from the depth of 25 cm.
		Ck2	55-100	SL	---	---	10 YR7/4	mss	----	firm	----	hc	8.3	----		
5	virgin	Az	0-7	L	---	10 YR5/8	10 YR7/6	vk,fn,sb	----	friable	---	hc	7.5	Salic	Aquollic Salorthids	
		Cz1	7-25	CL	---	---	10 YR5/8	vk,md,ab	----	friable	---	hc	7.8	Salic		
		Cz2	25-50	CL	---	---	10 YR5/8	mss	----	friable	---	hc	7.9	Salic		
6	20 year	Ap	0-20	CL	sg	10 YR5/6	10 YR7/4	vk,fn,sb	slightly hard	---	fw,vfn	hc	8.1	----	Typic Torrifluvents	* All the horizons contain gypsum crystals
		Ck1	20-30	CL	sg	---	10 YR7/4	mo,md,sb	---	friable	fw,fn	hc	8.3	----		
		Ck2	30-80	SCL	sg	---	7.5YR6/8	st:mo,md,ab:s	---	firm	fw,fn	hc	8.3	----		
		Ck3	80-120	SCL	gy	---	7.5YR6/8	mss	---	firm	---	hc	8.2	----		
7	20 year	Ap	0-20	SCL	sg	10 YR7/4	10 YR6/8	vk,fn,sb	slightly hard	---	c,md	hc	8.2	----	Typic Torrifluvents	* All the horizons contain gypsum crystals
		CK1	20-30	SCL	gy	---	10 YR6/8	vk,md,sb	---	friable	---	hc	8.3	----		
		Ck2	30-80	SL	gy	---	7.5YR6/8	vk,md,sb	---	friable	---	hc	8.3	----		
		Ck3	80-120	---	vg	---	7.5YR6/8	mss	---	friable	---	hc	8.3	----		
8	20 year	Ap	0-25	SCL	sg	10 YR7/4	10 YR6/8	vk,fn.sb	slightly hard	---	c,md	hc	8.1	----	Typic Torrifluvents	
		Ck1	25-35	SCL	sg	---	10 YR6/8	mo,md,sb	---	friable	---	hc	8.0	----		
		Ck2	35-80	---	---	---	7.5YR6/8	vk,fn,sb	---	friable	---	hc	8.2	----		
		Ck3	80-140	---	---	---	7.5YR6/8	mss	---	friable	---	hc	8.2	----		
9	20 year	Ap	0-20	SCL	sg	10 YR7/6	10 YR5/6	vk,fn,cb	slightly hard	---	----	hc	8.4	----	Typic Torrifluvents	
		CK1	20-60	CL	sg	---	7.5YR6/8	mo,md,sb	---	friable	---	hc	8.3	----		
		Ck2	60-90	CL	gy	---	7.5YR6/8	vk,fn,md,sb	---	v.firm	---	hc	8.3	----		
10	20 year	Ap	0-20	SCL	sg	10 YR7/6	10 YR5/6	vk,vfn,cb	slightly hard	---	---	hc	8.3	----		* common gypsum crystals bet. the depth of 60 -140 cm.
		Ck1	20-40	SCl	sg	---	7.5YR6/8	vk,md,sb	---	friable	---	hc	8.2	Calcic	Typic Calciorthids	
		Ck2	40-60	SCL	gy	---	7.5YR6/8	Wk,fn,sb	---	friable	fw,md	hc	8.1	----		
		Ck3	60-140	SCL	vg	---	7.5YR6/8	mss	---	friable	--	hc	7.9	----		

:Ck3 :60-140 :SCL :vg :--- :7.5YR6/8 :mss :--- : friable :-- :hc :7.9 :----

TABLE (11) Cont'd

Profile No.	Period of Cultivation	Horizon Symbol	Depth in cm	Texture	Coarse Fragements	Matrix Colours Dry	Matrix Colours Wet	Structure	Consistency Dry	Consistency Moist	Roots	Lime	pH	Diagnostic horizons	Soil classification	Remarks
11	20 year	Ap	0-20	SCL	sg	10 YR7/6	10 YR6/8	wk,vfn,cb	slightly hard	---	m,co	hc	8.3	Calcic	Petrogypsic Gypsiorthids	* common gypsium crystals in all horizons
		Ck1	20-30	SCL	sg	---	10 YR6/8	wk,md,sb	---	friable	m,co	hc	8.2	Calcic		
		Ck2	30-75	SCL	gy	---	7.5YR6/8	wk,fn,sb	---	friable	---	hc	7.9	---		* Hard pan 75 cm
		Ckym	+75	---	---	---	---	---	---	---	---	---	---	Petrogypsic		
12	20 year	Ap	0-25	SCL	sg	10 YR5/8	10 YR6/6	mo,md,sb	hard	---	---	hc	8.2		Typic Calciorthids	* Compacted layer at the depth: between 25-45 cm.
		Ck1	24-45	SCL	sg	---	10 YR6/6	Wk,fn:md,sb	---	firm	---	hc	8.3			
		Ck2	45-80	SCL	gy	---	7.5YR5/8	Wk,fn,sb	---	friable	---	hc	8.3	Calcic		
		Cym	80-100	---	---	---	---									
13	20 year	Ap	0-25	SCL	sg	10 YR7/4	10 YR6/8	wk,md,sb	slightly hard	---	fw,fn	hc	8.3		Typic Calciorthids	
		Ck1	25-40	SCL	sg	---	10 YR6/8	mo,md,sb	---	firm	---	hc	8.3	Calcic		
		Ck2	40-80	SCL	sg	---	7.5YR6/8	mss	---	friable	---	hc	8.2			
14	20 year	Ap	0-30	SCL	sg	10 YR6/8	10 YR6/8	wk,md,sb	slightly hard	---	fw,fn	hc	8.3		Typic Calciorthids	
		Ck1	30-50	SCL	sg	---	10 YR6/8	mo,md,sb	---	firm	---	hc	8.4	Calcic		
		Ck2	50-85	SCL	sg	---	7.5YR6/8	mss	---	friable	---	hc	8.3			
15	20 year	Ap	0-25	SCL	sg	10 YR7/4	10 YR6/8	wk,vfn:fn,sb	hard	---	fw,fn:	hc	8.0		Petrogypsic Gypsiorthids	* Horizon 1,2 and 3 contain gypsum crystals.
		Ck	25-50	SCL	sg	---	7.5YR6/6	mo,md,sb	---	firm	vfw,fn	hc	8.0			
		Cky	50-90	SCL	gy	---	7.5YR6/6	mo,fn,ab:sb	---	firm	---	hc	7.9	Calcic		Horizon 4 cemented by gypsum
		Ckym	+90	---	---	---	---	---	---	---	---	hc	---	Petrogypsic		
16	20 year	Ap	0-25	SCL	sg	10 YR8/4	10 YR5/6	wk,fn,abisb	slightly hard	---	---	hc	8.3		Typic Calciorthids	
		Ck1	25-50	SCL	sg	---	7.5YR5/6	wk,fn,ab:sb	---	friable	---	hc	8.2	Calcic		
		Ck2	50-90	SCL	gy	---	7.5YR6/6	mss	---	friable	---	hc	8.2			
		Ck3	+90	---	---	---	---	---	---	---	---	hc	---			
17	20 year	AP	0-35	Cl	---	10 YR7/4	10 YR6/6	mo,fn:md,sb:a:hard		---	---	hc	8.0		Typic Torrifluvents	
		Cky1	35-55	SCL	gy	---	7.5YR6/6	wk,fn:md,sb	---	firm	---	hc	8.0			
		Cky2	55-75	Sl	gy	---	7.5YR6/6	wk,fn:md,sb	---	friable	---	hc	8.1			
		Cky3	75-100	SCL	vg	---	7.5YR6/6	wk,vfn,sb	---	friable	---	hc	7.9			
18	20 year	Ap	0-30	SCL	---	10 YR7/4	10 YR5/8	mo,md,sb	hard	---	---	hc	8.3		Typic Torrifluvents	* The third horizon contains gypsum
		Ck1	30-60	SCL	sg		7.5YR6/6	wk,vfn,sb	---	firm	---	hc	8.1			
		Ck2	60-120	SCL	gy		7.5YR6/6	wk,vfn,sb	---	firm	---	hc	8.1			

TABLE (11) Cont'd

Profile No.	Period of Cultivation	Horizon Symbol	Depth in cm	Texture	Coarse Fragements	Matrix Colours Dry	Matrix Colours Wet	Structure	Consistency Dry	Consistency Moist	Roots	Lime	pH	Diagnostic horizons	Soil classification	Remarks
19	20 year	Ap	0-30	SCL	---	10 YR7/4	10 YR5/8	wk,fn,ab	very hard	----	----	hc	8.1	----	Typic Torrifluvents	* the first and second horizon
		Ck1	30-55	SCL	---	---	7.5YR6/6	mo,md,ab:sb	----	friable	----	hc	8.0	----		contain gypsum crystals
		Ck2	55-100	SCL	sg	---	7.5YR6/6	mo,md,sb	----	friable	----	hc	8.2	----		
20	20 year	Ap	0-20	CL	---	10 YR7/4	10 YR6/8	wk,fn,sb	slightly hard	----	fw,md	hc	8.4	----	Typic Torrifluvents	
		Ck1	20-50	CL	---	---	7.5YR6/8	mo,md,sb	----	friable	fw,vfn	hc	8.2	----		
		Ck2	50-75	SCL	---	---	7.5YR6/8	mo,md,sb	----	friable	fw,vfn	hc	8.2	----		
		Ck3	75-90	---	gy	---	7.5YR6/8	wk,fn,sb	----	friable	----	hc	----	----		
21	20 year	Ap	0-25	CL	sg	10 YR8/3	10 YR6/4	mo,md,ab:sb	hard	----	----	hc	8.0	----	Typic Torrifluvents	* the first horizon contains
		Ck1	25-45	SCL	sg	---	7.5YR6/6	mo,fn:md,sb	----	firm	----	hc	8.3	----		gypsum crystals.
		Ck2	45-90	SL	gy	---	7.5YR6/6	wk,fn,sb	----	firm	----	hc	8.3	----		
22	20 year	Ap	0-25	SL	sg	10 YR7/6	10 YR5/6	mo,fn:md,sb	hard	----	c,vfn	hc	8.3	----	Petrogypsic Gypsiorthids	* cemented with gypsum at a
		Ck1	25-55	SL	sg	---	10 YR5/4	mo,md,sb	----	firm	fw,vfn	hc	8.2	----		depth of 100 cm.
		Ck2	55-100	SCL	gy	---	7.5YR6/8	wk,fn:md,sb	----	firm	----	hc	8.0	----		
		Ckym	+100	---	gy	---	7.5YR6/8	---	----	----	----	hc	---	Petrogypsic		
23	20 year	Ap	0-20	SL	sg	10 YR7/6	10 YR5/6	wk,fn,sb	hard	----	---	hc	8.3	----	Typic Torrifluvents	
		Ck1	20-40	SL	sg	---	10 YR6/8	mo,md,ab	----	firm	---	hc	8.3	----		
		Ck2	40-120	SCL	sg	---	7.5YR6/8	wk,fn:md,sb	----	firm	---	hc	8.1	----		
		Ckym	+120	---	---	---	---	---	----	----	---	hc	---			
24	20 year	Ap1	0-15	SCL	sg	10 YR7/4	10 YR5/8	mo,fn,sb	---	friable	---	hc	7.9	----	Typic Torrifluvents	* All the horizons contain
		Ap2	15-50	SCL	sg	---	10 YR5/8	mo,fn:md,sb	---	firm	---	hc	7.9	----		gypsum crystals
		Ck	50-120	SCL	gy	---	7.5YR6/8	wk,fn,sb	---	firm	---	hc	7.8	----		
25	20 year	Ap	0-20	SC	sg	10 YR7/4	10 YR6/8	mo,md,sb	hard	---	c,md	hc	8.1	----	Typic Calciorthids	
		CK1	20-35	SC	sg	---	7.5YR7/8	mo,md,sb	---	friable	c,md	hc	8.2	Calcic		
		Ck2	35-100	SL	gy	---	7.5YR6/8	wk,fn,ab	---	friable	---	hc	8.2	----		
26	20 year	Az	0-10	CL	sg	10 YR8/4	10 YR6/8	mo,md,sb	hard	---	c,md	hc	8.1	----	Typic Torrifluvents	
		Ck1	10-40	SCL	sg	---	7.5YR6/8	mo,md,sb	---	firm	---	hc	8.0	----		
		Ck2	40-80	CL	sg	---	7.5YR6/8	mss	---	friable	---	hc	8.2	----		
27	20 year	Ap1	0-25	SCL	sg	10 YR8/4	10 YR6/8	mo,md,sb	hard	---	---	hc	8.4	----	Typic Calciorthids	
		Ap2	25-40	SCL	sg	---	10 YR5/6	mo,md:co,sb	---	firm	fw,co	hc	8.3	----		
		Ck1	40-65	SL	sg	---	10 YR6/8	wk,fn:md,sb	---	firm	fw,co	hc	8.3	Calcic		
		Ck2	65-85	SL	---	---	7.5YR6/8	mss	---	---	---	hc	8.2	----		
28	20 year	Ap	0-20	CL	sg	10 YR7/4	10 YR6/6	wk,md,sb	slightly hard	---	c,md	hc	8.3	----	Typic Torrifluvents	
		Ck1	20-35	CL	sg	---	7.5YR6/8	mo,md,sb	---	firm	fw,fn	hc	8.4	----		
		Ck2	35-80	SL	sg	---	7.5YR6/8	wk,md,sb	---	friable	---	hc	8.3	----		

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TABLE (11) Cont'd

Profile: Period of | Horizon: Depth | Texture: Coarse | Matrix Colours | Structure | Consistency | Diagnostic

28	20 year	Ap	0-20	CL	sg	[illegible]	[illegible]	[illegible]	[illegible]							
		Ck1	20-35	CL	sg	---	7.5YR6/8	mo,md,sb	---	firm	fw,fn	hc	8.4	----		
		Ck2	35-80	SL	sg	---	7.5YR6/8	vk,md,sb	---	friable	---	hc	8.3	----		

TABLE (11) Cont'd

Profile No.	Period of Cultivation	Horizon Symbol	Depth in cm	Texture	Coarse Fragements	Matrix Colours Dry	Matrix Colours Wet	Structure	Consistency Dry	Consistency Moist	Roots	Lime	pH	Diagnostic horizons	Soil classification	Remarks
29	20 year	Ap	0-15	SCL	---	10 YR6/6	10 YR6/8	mo,md,sb	hard	---	c,fn:m	hc	8.3	---	Typic Torrifluvents	
		Ck1	15-30	SCL	sg	---	7.5YR6/8	vk,fn,sb	---	friable	c,fn	hc	8.2	---		
		Ck2	30-80	SL	sg	---	7.5YR6/8	vk,fn,sb	---	friable	fw,fn	hc	8.2	---		
30	20 year	Ap	0-20	SCL	sg	10 YR7/4	10 YR6/6	vk,md,sb	slighly hard	---	fw,fn	hc	8.2	---	Typic Torrifluvents	
		Ck1	20-35	SCL	sg	---	7.5YR6/8	mo,md,sb	---	firm	---	hc	8.3	---		
		Ck2	35-80	SCL	gy	---	7.5YR6/8	vk,fn,sb	---	friable	---	hc	8.5	---		
31	20 year	Ap	0-25	SCL	sg	10 YR7/4	10 YR6/8	mo,md,sb	hard	---	---	hc	8.3	---	Typic Torrifluvents	* the second horizon contains gypsum.
		Ck1	25-50	SCL	sg	---	7.5YR6/8	vk,md,sb	---	firm	---	hc	8.2	---		
		Ck2	50-80	SCL	sg	---	7.5YR6/8	mss	---	friable	---	hc	8.4	---		
32	20 year	Ap	0-20	CL	---	10 YR7/4	10 YR5/6	vk,fn,cb	---	friable	fw,fn	hc	8.2	Calcic	Typic Calciorthids	* gypsum crystals start from 40 cm.
		Ck	30-50	L	---	---	10 YR6/6	vk,fn,ab	---	friable	fw,fn	hc	8.1	Calcic		
		Cky	50-85	L	gy	---	10 YR6/6	vk,fn,ab	---	friable	---	hc	8.1	---		
33	20 year	Ap	0-20	SL	---	10 YR7/4	10 YR6/6	mo,md,sb	---	friable	fw,fn:	hc	8.0	---	Typic Calciorthids	* gypsum crystals start from 20 cm.
		Cky1	20-50	SCL	---	---	7.5YR6/8	vk,fn,ab	hard	---	vfw,fn	hc	8.0	---		
		Cky2	50-100	L	gy	---	7.5YR6/8	mss	hard	---	---	hc	7.9	Calcic		
34	20 year	Ap1	0-15	SL	---	10 YR7/4	10 YR6/6	mo,md,cb	---	friable	fw,fn	hc	8.3	Calcic	Typic Calciorthids	
		Ap2	15-35	SCL	---	---	10 YR6/6	vk,fn,sb	---	friable	fw,fn	hc	8.2	---		
		Ck	35-100	L	---	---	7.5YR6/8	mss	---	friable	---	hc	8.2	---		
35	20 year	Ap1	0-15	Sl	---	10 YR7/4	10 YR6/6	mo,md,cb	---	friable	c,md	hc	8.2	---	Typic Calciorthids	
		Ap2	15-30	Sl	---	---	10 YR6/6	vk,fn,sb	---	friable	fw,fn	hc	8.1	Calcic		
		Ck	30-120	Sl	---	---	7.5YR6/8	mss	---	friable	---	hc	8.1	---		
36	20 year	Ap1	0-15	SCL	---	10 YR7/4	10 YR6/6	vk,fn,cb	---	friable	c,fn	hc	8.3	---	Petrogypsic Gypsiorthids	
		Ap2	15-40	SCL	---	---	7.5YR8/6	vk,fn,sb	---	friable	c,fn	hc	8.2	---		
		Ck	40-75	SCL	---	---	7.5YR6/6	mss	---	firm	---	hc	8.1	---		
		Ckym	+75	---	---	---	---	---	---	---	---	---	---	Petrogypsic		

TABLE (II) Cont'd

Profile No.	Period of Cultivation	Horizon Symbol	Depth in cm	Texture	Coarse Fragements	Matrix Colours Dry	Matrix Colours Wet	Structure	Consistency Dry	Consistency Moist	Roots	Lime	pH	Diagnostic horizons	Soil classification	Remarks
37	20 years	Ap	0-20	CL	---	10 YR7/6	10 YR6/8	wk,md,sb	----	friable	----	hc	8.2	Calcic	Typic Calciorthids	
		Ck1	20-60	SL	---	---	10 YR8/6	mss	hard	----	----	hc	8.2	----		
		Ck2	60-120	SL	---	---	7.5YR5/6	mss	v.hard	----	----	hc	8.1	----		
38	virgin	AC	0-5	L	---	10 YR5/8	10 YR4/6	st,md,sb	----	friable	----	hc	8.3	----	Petrogypsic Gypsiorthids	
		Ck1	5-40	L	---	---	10 YR6/6	mss	very hard	----	----	hc	8.2	----		
		Ck2	+40	---	---	---	7.5YR6/8	mss	very hard	----	----	hc	8.2	Petrogypsic		
39	>25 years	Ap	0-20	SL	---	10 YR5/4	10 YR5/6	wk,fn,sb	----	friable	----	hc	7.9	----	Typic Paleorthids	* brocken hard pan.
		Ck1	20-55	SL	vg	---	10 YR6/6	wk,fn,sb	hard	----	----	hc	7.9	----		
		Ck2	55-100	CL	---	---	7.5YR5/8	---	hard	----	----	hc	8.0	Petrocalcic		
40	virgin	Az	0-20	SL	vg	10 YR6/7	10 YR5/8	mss	----	friable	----	hc	7.6	Salic	Aquollic Salorthids	
		Ck1	20-70	SL	vg	---	7.5YR6/8	mss	----	friable	----	hc	7.6	Salic		
41	virgin	AC	0-40	SL	vg	10 YR6/7	10 YR5/8	st,md,sb	hard	---	---	hc	7.5	---	Petrogypsic Gypsiorthids	
		Ckym	+40	SL	---	---	10 YR5/8	---	----	---	---	hc	---	Petrogypsic		
42	virgin	AC	0-25	SL	gy	10 YR6/7	10 YR5/8	wk,fn,sb	---	friable	fw,fn	hc	8.1	----	Typic Calciorthids	
		Ck1	25-90	SL	gy	---	7.5YR5/8	wk,fn,sb	---	friable	---	hc	8.1	Calcic		
		Ck2	+90	CL	---	---	7.5YR5/8	mss	---	friable	---	hc	8.1	----		
43	4 years	Ap	0-15	SL	---	7.5YR5/8	7.5YR5/6	wk,fn,sb	---	firm	vfw,fn	hc	7.9	----	Typic Calciorthids	
		CK1	15-35	SL	sg	---	7.5YR5/6	mss	hard	----	---	hc	7.8	Calcic		
		Ck2	35-120	CL	sg	---	7.5YR5/6	mss	v.hard	----	---	hc	7.8	----		
44	4 years	Ap	0-25	SCL	---	7.5YR6/6	7.5YR6/6	wk,fn.sb	---	friable	fw,fn	hc	7.9	Calcic	Typic Calciorthids	* commen gypsium crystals betw the depth of 50 -100 cm.
		Ck	25-50	L	---	---	7.5YR5/8	wk,md,sb	---	friable	---	hc	7.9	----		
		Ckym	50-100	L	---	---	7.5YR5/8	mo,md,ab	---	friable	---	hc	7.8	----		
45	virgin	AC	0-35	CL	---	10 YR5/8	10 YR5/6	mo,fn:md,ab	---	friable	---	hc	8.0	----	Petrogypsic Gypsiorthids	
			+35	---	---	---	---	---	---	---	---	---	---	Petrogypsic		
46	virgin	Ap	0-20	CL	sg	7.5YR5/8	7.5YR5/6	wk,md,sb	---	firm	---	hc	7.8	----	Typic Calciorthids	
		Ck1	20-60	SCl	gy	---	7.5YR5/6	mss	hard	----	---	hc	7.8	Calcic		
		Ck2	60-120	SCL	vg	---	7.5YR5/6	mss	v.hard	----	---	hc	7.9	----		

TABLE (11) Cont'd

Profile No.	Period of Cultivation	Horizon Symbol	Depth in cm	Texture	Coarse Fragements	Matrix Colours Dry	Matrix Colours Wet	Structure	Consistency Dry	Consistency Moist	Roots	Lime	pH	Diagnostic horizons	Soil classification	Remarks
47	virgin	AC	0-20	CL	---	10 YR7/4	10 YR6/8	vk,md,sb	---	friable	---	hc	8.2	Calcic	Typic Calciorthids	
		Ck1	20-60	SCL	---		10 YR8/6	mss	hard	---	---	hc	8.2	---		
		Ck2	60-120	SCL	---		7.5YR5/6	mss	v.hard	---	---	hc	8.1	---		
48	virgin	AC	0-15	CL	sg	10 YR8/6	10 YR7/6	mss	hard	---	---	hc	7.9	---	Typic Paleorthids	
		R	+15	---	---	---	---	---	---	---	---	hc	---	Petrocalcic		
49	virgin	AC	0-10	L	sg	10 YR8/4	10 YR5/6	mss	hard	---	---	hc	7.9	---	Typic Paleorthids	
		Ck1	10-45	CL	gy	---	10 YR6/6	mss	v.hard	---	---	hc	7.9	---		
		R	+45	---	---	---	---	---	---	---	---	---	---	Petrocalcic		
50	virgin	AC	0-15	L	---	10 YR8/4	10 YR6/6	vk,fn,sb	---	firm	---	hc	8.1	---	Typic Calciorthids	
		Ck1	15-35	L	sg	---	10 YR5/6	mss	hard	---	---	hc	8.0	Calcic		
		Ck2	35-100	CL		---	10 YR5/6	mss	v.hard	---	---	hc	8.0	---		
51	virgin	AC	0-20	L	---	10 YR7/6	10 YR5/8	vk,md,ab	---	firm	---	hc	8.0	---	,Aquollic Salorthids	
		Ck1	20-50	SiCL	sg	---	10 YR5/8	vk,fn,ab	hard	---	---	hc	8.1	Salic		
		Ck2	50-120	SiCL	---		10 YR5/8	mss	v.hard	---	---	hc	8.1	---		
52	virgin	AC	0-25	SiL	---	10 YR8/6	10 YR6/6	mo,md,sb	---	friable	---	hc	8.0	---	Typic Calciorthids	
		Ck1	25-60	CL	---	---	10 YR7/8	mss	slightly hard	---	---	hc	8.0	Calcic		
		Ck2	60-100	CL	---		10 YR5/6	mss	hard	---	---	hc	7.9	---		
53	virgin	AC	0-20	SiL	---	10 YR7/4	10 YR6/6	vk,fn,sb	---	friable	---	hc	8.0	---	Typic Calciorthids	
		Ck1	20-40	SiCL	---	---	10 YR6/8	vk,fn,sb	---	firm	---	hc	8.0	Calcic		
		Ck2	40-100	CL	---		10 YR6/4	mss	slightly hard	---	---	hc	7.9	---		
54	virgin	AC	0-20	L	---	10 YR7/4	10 YR7/3	mo,md,sb	slightly hard	---	---	hc	8.1	---	Typic Torrifluvents	
		Ck1	20-60	L	---		10 YR7/4	mss	hard	---	---	hc	8.1	---		
		Ck2	60-90	L	---	---	10 YR6/4	mss	v.hard	---	---	hc	8.2	---		
		Ck2	90-150	CL	---	---	10 YR5/6	mss	hard	---	---	hc	8.1	---		

TABLE (11) Cont'd

Profile No.	Period of Cultivation	Horizon Symbol	Depth in cm	Texture	Coarse Fragements	Matrix Colours Dry	Matrix Colours Wet	Structure	Consistency Dry	Consistency Moist	Roots	Lime	pH	Diagnostic horizons	Soil classification	Remarks
55	2 years	Ap	0-20	SiL	---	10 YR7/4	10 YR6/6	vk,fn,sb	---	friable	---	hc	8.0	---	Typic Torrifluvents	
		Ck1	20-40	SiCL	---		10 YR6/8	vk,fn,sb	---	firm	---	hc	8.0	---		
		Ck2	40-120	CL	---		10 YR6/4	mss	slightly hard	---	---	hc	7.9	---		
56	virgin	AC	0-20	SCL	---	10 YR7/6	10 YR5/8	vk,fn,ab	slightly hard	---	---	hc	8.2	Calcic	Typic Calciorthids	
		Ck1	20-60	SCL	---		7.5YR5/8	vk,fn,ab	hard	---	---	hc	8.2	---		
		Ck2	60-120	SCL	---		7.5YR5/8	mss	hard	---	---	hc	8.1	---		
57	2 years	Ap	0-25	SCL	---	10 YR5/8	10 YR5/8	vk,fn,ab	slightly hard	---	---	hc	7.9	Salic	Aquollic Salorthids	
		Ck	25-120	SCL	---	---	10 YR5/8	vk,fn,ab	hard	---	---	hc	7.9	Salic		
58	2 years	Ap	0-20	SCL	---	10 YR7/6	10 YR6/6	vk,fn,sb	slightly hard	---	---	hc	8.2	---	Typic Torrifluvents	
		Ck1	20-60	L	---	---	10 YR5/6	mss	hard	---	---	hc	8.2	---		
		Ck2	60-120	L	---		10 YR5/6	mss	v.hard	---	---	hc	8.1	---		
59	2 years	Ap	0-20	SCL	---	7.5YR6/8	7.5YR5/6	vk,fn,ab	---	friable	---	hc	8.2	---	Typic Torrifluvents	
		Ck1	20-50	SCL	gy	---	7.5YR5/6	vk,fn,ab	---	friable	---	hc	8.2	---		
		Ck2	50-100	SL	---	---	7.5YR5/6	mss	---	friable	---	hc	8.0	---		
60	2 years	Ap	0-30	SL	gy	7.5YR5/8	7.5YR5/8	vk,fn,sb	---	firm	---	hc	8.1	---	Petrogypsic Gypsiorthids	
		Ck	30-60	SL	gy	---	7.5YR5/8	mss	hard	---	---	hc	8.0	---		
		Ckym	60-90	SCL	---	---	7.5YR5/8	mss	v.hard	---	---	hc	7.8	Petrogypsic		
61	2 years	Ap	0-30	SL	---	7.5YR5/8	7.5YR5/8	vk,fn,ab	---	friable	---	hc	8.2	Calcic	Typic Calciorthids	
		Ck1	30-60	SL	sg	---	7.5YR5/8	mss	---	friable	---	hc	8.1	---		
		Ck2	60-120	SL	---	---	7.5YR5/8	mss	hard	---	---	hc	8.1	---		
62	2 years	Ap	0-20	SL	sg	7.5YR5/8	7.5YR5/8	vk,md,ab	---	friable	---	hc	8.3	---	Typic Torrifluvents	
		Ck1	20-40	CL	gy	---	7.5YR5/8	vk,md,ab	---	friable	---	hc	8.2	---		
		Ck2	40-80	SCL	gy	---	7.5YR5/8	mss	hard	---	---	hc	8.2	---		

TABLE (11) Cont'd

TABLE (11) Cont'd

Profile No.	Period of Cultivation	Horizon Symbol	Depth in cm	Texture	Coarse Fragements	Matrix Colours Dry	Matrix Colours Wet	Structure	Consistency Dry	Consistency Moist	Roots	Lime	pH	Diagnostic horizons	Soil classification	Remarks
63	2 years	Ap	0-20	SCL	sg	10 YR5/8	10 YR5/8	vk,fn,sb	---	friable	---	hc	8.3	---	Typic Calciorthids	
		Ck1	20-40	SCL	gy	---	7.5YR5/8	vk,fn,sb	---	friable	---	hc	8.3	Calcic		
		Ck2	40-120	SCL	gy	---	7.5YR6/8	mss	---	firm	---	hc	8.2	---		
64	2 years	Ap	0-20	SCL	gy	7.5YR5/7	7.5YR5/7	vk,fn,ab	---	friable	---	hc	8.3	---	Typic Torrifluvents	
		Ck1	20-50	SL	gy	---	7.5YR5/7	mss	---	friable	---	hc	8.3	---		
		Ck2	50-90	SCL	gy	---	7.5YR5/7	mss	---	firm	---	hc	8.2	---		
65	2 years	Ap	0-20	SCL	---	10 YR5/8	10 YR5/8	vk,fn,ab	---	friable	---	hc	8.4	Calcic	Typic Calciorthids	
		Ck1	20-60	SL	---	---	10 YR5/6	mss	slighlty hard	---	---	hc	8.3	---		
		Ck2	60-90	SCL	---	---	10 YR7/6	mss	hard	---	---	hc	8.3	---		
66	2 years	Ap1	0-8	SCL	---	10 YR7/6	10 YR5/6	vk,md,sb	---	friable	fw,md	hc	8.3	---	Typic Torrifluvents	
		Ap2	8-25	SCL	---	---	10 YR6/6	mo,md,ab	---	friable	vfw,fn	hc	8.4	---		
		Ck1	25-40	L	sg	---	10 YR6/6	mo,md,ab	---	friable	vfw,fn	hc	8.3	---		
		Ck2	40-100	SCL	sg	---	10 YR7/6	mss	---	friable	---	hc	8.2	---		
67	2 years	Ap	0-30	SCL	---	7.5YR5/8	7.5YR5/8	vk,fn,ab	---	friable	---	hc	8.2	---	Typic Paleorthids	
		Ckm	+30	---	---	---	---	---	---	---	---	---	---	Petrocalcic		
68	2 years	Ap1	0-20	SL	---	10 YR5/8	10 YR5/8	vk,fn,ab	---	friable	---	hc	8.2	---	Typic Torrifluvents	
		Ck2	20-100	SCL	gy	---	10 YR5/8	mss	---	---	---	hc	8.2	---		
69	2 years	AP	0-30	S	---	7.5YR6/6	7.5YR5/6	s.g.	---	losse	m,co	hc	8.3	---	Typic Torripsamments	
		Cky1	30-60	S	---	---	7.5YR5/6	s.g.	---	losse	---	hc	8.1	---		
		Cky2	60-120	SL	---	---	7.5YR5/8	s.g.	---	losse	---	hc	8.2	---		
70	2 years	Ap	0-20	SL	---	10 YR6/6	10 YR6/6	vk,fn,sb	---	friable	---	hc	8.3	---	Typic Torrifluvents	
		Ck1	20-60	SL	---	---	10 YR7/6	vk,fn,sb	hard	---	---	hc	8.2	---		
		Ck2	60-120	CL	---	---	10 YR8/4	mss	v.hard	---	---	hc	8.2	---		

TABLE (11) Cont'd

Profile No.	Period of Cultivation	Horizon Symbol	Depth in cm	Texture	Coarse Fragements	Matrix Colours Dry	Matrix Colours Wet	Structure	Consistency Dry	Consistency Moist	Roots	Lime	pH	Diagnostic horizons	Soil classification	Remarks
71	2 years	Ap	0-16	SCL	sg	10 YR6/6	10 YR5/6	wk,fn,sb	---	friable	---	hc	8.3	---	Typic Torrifluvents	* all the horizons have gypsum crystals
		Ck1	16-80	SCL	gy	---	10 YR5/6	mss	hard	---	---	hc	8.3	---		
		Ck2	80-120	SCL	---	---	7.5YR6/8	mss	v.hard	---	---	hc	8.2	---		
72	2 years	Ap	0-20	CL	---	10 YR67/8	10 YR6/6	wk,fn,ab	---	friable	---	hc	7.9	---	Cambic Gypsiorthids	* all the horizons have gypsum crystals
		Ck1	20-40	SCL	---	---	10 YR5/6	mss	hard	---	---	hc	8.0	---		
		Ck2	40-80	CL	---	---	10 YR5/6	mss	hard	---	---	hc	7.8	---		
73	2 years	Ap	0-20	SCL	---	10 YR7/6	10 YR5/8	wk,fn,ab	---	firm	fw,md	hc	7.9	---	Cambic Gypsiorthids	* all the horizons have gypsum crystals
		Ck1	20-50	SCL	---	---	10 YR5/8	mss	slighty hard	---	---	hc	7.9	---		
		Ck2	50-100	CL	---	---	10 YR5/8	mss	hard	---	---	hc	7.8	---		
74	2 years	Ap	0-18	SL	---	10 YR5/8	10 YR5/6	mo,md,ab	---	friable	fw,md	hc	7.9	---	Typic Torrifluvents	* all the horizons have gypsum crystals
		Ck1	18-40	SL	sg	---	10 YR6/6	wk,fn,ab	---	friable	---	hc	7.9	---		
		Ck2	40-120	SCL	gy	---	10 YR6/6	mss	---	friable	---	hc	7.8	---		
		Ck2	40-100	SCL	sg	---	10 YR7/6	mss	---	friable	---	hc	8.2			

TABLE (12) COMPLETE PARTICLE SIZE DISTRIBUTION FOR SOME SOIL PROFILES

Soil Profile No.	Depth in cm.	Clay %	Silt %	SAND %						Texture
				0.1-0.05 mm	0.25-0.1 mm	0.5-0.25 mm	1-0.5 mm	2-1 mm	Total	
4	0-25	12.80	30.40	11.70	11.6	10.8	10.6	2.10	46.80	Loam
	25-55	8.00	29.20	18.30	17.6	13.4	10.2	3.3	62.80	Sandy Loam
	55-100	19.40	22.20	17.80	7.5	17.3	15.8	6.9	57.30	Sandy Loam
32	0-20	37.30	21.30	17.90	8.0	7.00	5.6	2.9	41.50	Clay Loam
	20-40	23.40	31.30	14.20	11.3	8.10	6.9	4.8	45.30	Loam
	40-120	15.40	41.20	16.10	14.1	7.00	5.8	0.4	43.40	Loam
36	0-15	35.70	15.30	12.30	6.9	9.2	8.8	11.3	49.00	Sandy Clay
	15-40	35.00	20.00	20.20	11.4	5.2	7.1	1.20	45.00	Sandy Clay Loam
	40-75	15.00	45.20	14.80	9.3	3.00	8.2	4.4	39.80	Loam
49	0-10	27.8	25.3	11.9	9.7	7.8	10.7	6.7	46.80	Sandy Clay Loam
	10-45	30.0	37.5	11.8	7.8	4.2	5.5	3.3	32.60	Clay Loam
50	0-15	25.1	37.7	15.1	8.0	5.4	6.4	2.2	37.10	Loam
	15-35	24.6	36.8	12.5	9.7	6.3	6.7	3.4	38.60	Loam
	35-100	34.6	32.1	11.9	5.6	5.7	6.3	3.8	33.30	Clay Loam
51	0-20	25.2	40.3	21.5	5.8	3.5	2.6	1.0	34.40	Loam
	20-50	32.3	52.1	10.2	2.6	1.2	1.1	0.6	15.70	Silty Clay Loam
52	0-25	15.0	67.5	10.2	2.8	1.6	1.8	1.1	17.50	Silt Loam
	25-50	35.0	45.0	10.2	2.9	3.2	2.8	1.1	20.20	Clay Loam
	50-120	37.0	41.9	9.9	3.2	2.7	3.6	1.8	21.20	Clay Loam
53	0-20	19.6	61.1	9.9	3.2	2.7	2.5	1.0	19.30	Silt Loam
	20-40	32.0	51.6	9.6	2.1	1.4	2.1	1.2	16.40	Silt Clay Loam
	40-100	30.0	35.1	11.2	6.7	5.9	7.0	4.1	34.90	Clay Loam
55	0-30	27.1	51.7	10.3	5.3	3.1	2.0	0.6	21.30	Clay Loam
	30-55	34.9	42.3	11.6	4.6	3.0	2.6	1.0	22.80	Clay Loam
72	0-20	35.16	30.13	11.65	7.5	6.23	5.73	3.56	34.71	Clay Loam
	20-40	32.73	21.82	13.09	9.9	9.06	7.42	6.27	45.44	Sandy Clay Loam
	40-100	28.56	28.85	13.81	7.8	7.32	7.53	6.38	42.88	Clay Loam

TABLE (13) PARTICLE SIZE DISTRIBUTION AND TEXTURE CLASSES OF THE STUDY AREA

Soil Profile No.	Depth in cm	Coarse Sand %	Fine Sand %	Total Sand %	Silt + Clay %	Soil Texture	Soil Texture Grade
1	0-30	11.0	46.5	57.5	42.5	SL	Mod Coarse
	30-80	7.0	49.0	56.0	44.0	SL	Mod Coarse
	80-120	6.0	42.0	48.0	52.0	SCL	Mod Fine
2	0-30	9.5	55.0	64.5	35.5	SL	Mod Coarse
	30-60	5.5	61.0	66.5	33.5	SCL	Mod Fine
	60-120	5.2	59.3	64.5	36.5	SCL	Mod Fine
3	0-25	22.5	48.0	70.5	29.5	SL	Mod Coarse
	25-45	23.5	42.5	66.0	34.0	SCL	Mod Fine
	45-60	16.0	40.0	56.0	44.0	SCL	Mod Fine
	60-80	12.2	43.3	55.5	44.5	SCL	Mod Fine
4	0-25	23.5	23.3	46.8	53.20	L	Medium
	25-55	26.9	35.9	72.8	37.20	SL	Mod Coarse
	55-100	33.2	25.2	58.4	41.60	SL	Mod Coarse
5	0-7	14.4	34.4	48.8	51.2	L	Medium
	7-25	17.7	28.2	45.9	54.1	CL	Mod Fine
	25-50	15.3	30.8	46.1	53.9	CL	Mod Fine
	50-120	12.3	34.5	46.8	53.2	CL	Mod Fine
6	0-20	9.2	25.5	34.7	65.3	CL	Mod Fine
	20-30	8.8	30.2	39.0	51.0	CL	Mod Fine
	30-80	12.5	38.7	51.2	48.8	SCL	Mod Fine
	80-120	11.7	39.2	50.9	49.1	SCL	Mod Fine
7	0-20	13.0	40.4	53.4	46.6	SCL	Mod Fine
	20-30	16.7	31.7	48.4	51.6	SCL	Mod Fine
	30-80	23.4	45.8	69.2	30.8	SL	Mod Coarse
	80-120	25.8	41.9	67.7	32.3	SL	Mod Coarse
8	0-25	6.7	47.4	54.1	45.9	SCl	Mod Fine
	25-35	5.8	50.0	55.8	44.2	SCL	Mod Fine
	35-80	17.7	37.9	55.6	44.4	SCL	Mod Fine
9	0-20	12.2	35.7	47.9	52.1	SCL	Mod Fine
	20-60	9.0	19.8	28.8	71.2	CL	Mod Fine
	60-90	11.3	22.5	33.8	66.2	CL	Mod Fine
10	0-20	10.4	36.6	47.0	53.0	SCL	Mod Fine
	20-40	9.9	46.0	55.9	44.1	SCL	Mod Fine
	40-60	19.9	34.2	54.1	45.9	SCL	Mod Fine
	60-140	23.5	38.6	62.1	39.9	SCL	Mod Fine
11	0-20	11.9	48.3	60.2	38.8	SCL	Mod Fine
	20-30	13.8	40.9	54.7	45.3	SCL	Mod Fine
	30-75	24.5	30.4	54.9	45.1	SCL	Mod Fine

TABLE (13) Cont'd

Soil Profile No.	Depth in cm	Coarse Sand %	Fine Sand %	Total Sand %	Silt + Clay %	Soil Texture	Soil Texture Grade
12	0-25	11.4	38.9	50.3	49.7	SCl	Mod Fine
	25-45	14.6	34.1	48.7	51.3	SCL	Mod Fine
	45-80	11.1	30.5	41.6	58.4	SCL	Mod Fine
13	0-25	21.0	39.7	60.7	39.3	SCL	Mod Fine
	25-40	15.5	42.9	58.4	41.6	SCL	Mod Fine
	40-80	20.4	45.9	66.3	33.7	CL	Mod Fine
14	0-30	15.3	41.7	57.0	43.0	SCL	Mod Fine
	30-50	20.5	46.2	66.7	33.3	SCL	Mod Fine
	50-85	25.5	31.6	57.1	42.9	SCL	Mod Fine
15	0-25	12.9	31.3	44.2	55.8	SCl	Mod Fine
	25-50	8.0	35.4	43.4	56.6	SCL	Mod Fine
	50-80	11.7	40.5	52.2	47.8	SCL	Mod Fine
	80-130	13.8	37.8	51.6	48.4	SCL	Mod Fine
16	0-25	12.6	45.8	58.4	41.6	SCL	Mod Fine
	25-50	12.7	41.2	53.9	46.1	SCL	Mod Fine
	50-90	13.6	47.3	60.9	39.1	SCL	Mod Fine
17	0-40	11.80	30.3	69.7	30.3	CL	Mod Fine
	40-60	15.90	47.4	63.3	36.7	SCL	Mod Fine
	60-75	20.50	46.0	66.5	43.5	SL	Mod Coarse
	75-100	25.00	32.9	55.9	44.1	SCL	Mod Fine
18	0-30	14.0	49.8	53.8	46.2	SCl	Mod Fine
	30-60	10.1	39.2	49.3	50.7	SCL	Mod Fine
	60-120	17.2	51.5	68.7	31.3	SCL	Mod Fine
19	0-30	12.3	52.4	64.7	35.3	SCL	Mod Fine
	30-55	11.8	33.6	45.4	54.6	SCL	Mod Fine
	55-100	19.3	40.5	59.8	40.2	SCL	Mod Fine
20	0-30	15.0	24.0	39.0	61.0	SCL	Mod Fine
	30-50	31.8	13.4	45.2	54.8	CL	Mod Fine
	50-90	12.8	38.3	51.1	48.9	SCL	Mod Fine
21	0-25	8.9	22.4	31.3	68.7	CL	Mod Fine
	25-45	12.9	43.9	56.8	43.2	SCL	Mod Fine
	45-90	16.4	51.0	67.4	32.6	SL	Mod Coarse
22	0-30	17.5	52.0	69.5	30.5	SL	Mod Coarse
	30-60	22.5	47.3	69.8	30.2	SL	Mod Coarse
	60-100	17.6	40.0	57.6	42.4	SCL	Mod Fine

TABLE (13) Cont'd

Soil Profile No.	Depth in cm	Coarse Sand %	Fine Sand %	Total Sand %	Silt + Clay %	Soil Texture	Soil Texture Grade
23	0-20	21.6	48.5	70.1	29.9	SL	Mod Coarse
	20-50	26.0	43.4	69.4	30.6	SL	Mod Coarse
	50-110	17.7	42.2	57.8	42.2	SCL	Mod Fine
24	0-25	20.4	38.2	58.6	41.4	SCL	Mod Fine
	25-40	14.0	31.6	45.6	54.4	SCL	Mod Fine
	40-85	14.7	30.5	45.2	54.8	SCL	Mod Fine
25	0-20	11.9	35.7	47.6	52.4	SC	Mod Fine
	20-35	12.6	32.4	45.0	55.0	SC	Mod Fine
	35-100	30.9	40.7	71.6	28.4	SL	Mod Coarse
26	0-10	12.7	25.9	38.6	61.4	CL	Mod Fine
	10-40	14.3	69.7	84.0	16.0	SCL	Mod Fine
	40-50	11.6	30.3	41.9	58.1	CL	Mod Fine
27	0-25	15.5	48.5	64.0	36.0	SCl	Mod Fine
	25-40	24.1	31.5	55.6	43.4	SCL	Mod Fine
	40-85	26.3	44.5	70.8	29.2	SL	Mod Coarse
28	0-20	11.9	48.3	60.2	39.8	SCl	Mod Fine
	20-30	13.8	40.9	54.7	45.3	SCL	Mod Fine
	30-75	24.5	30.4	54.9	45.1	SCL	Mod Fine
29	0-25	15.9	41.8	57.7	42.8	SCL	Mod Fine
	25-40	15.1	38.2	53.3	46.7	SCl	Mod Fine
	40-85	21.5	44.4	65.9	34.1	SL	Mod Coarse
30	0-20	14.2	29.8	44.0	56.0	SCL	Mod Fine
	20-35	12.5	22.5	35.0	65.0	CL	Mod Fine
	35-75	15.7	35.7	51.4	48.6	SCL	Mod Fine
31	0-25	13.1	38.7	51.8	48.2	SCl	Mod Fine
	25-50	14.4	33.1	47.5	52.5	SCl	Mod Fine
	50-75	18.2	30.2	48.4	51.6	SCl	Mod Fine
32	0-20	15.5	25.9	41.4	58.6	CL	Mod Fine
	20-40	19.8	25.5	45.3	54.7	L	Medium
	40-120	13.2	30.2	43.4	56.6	L	Medium
33	0-20	17.0	43.5	60.5	39.5	SL	Mod Coarse
	20-50	14.5	41.0	55.5	44.5	SCL	Mod Fine
	50-100	18.0	44.5	62.5	37.5	L	Medium
34	0-15	19.0	48.0	67.0	33.0	SL	Mod Coarse
	15-35	14.5	48.5	63.0	37.0	SL	Mod Coarse
	35-100	16.0	31.0	47.0	53.0	L	Medium

TABLE (13) Cont'd

Soil Profile No.	Depth in cm	Coarse Sand %	Fine Sand %	Total Sand %	Silt + Clay %	Soil Texture	Soil Texture Grade
35	0-15	21.5	51.0	72.5	27.5	SL	Mod Coarse
	15-30	18.0	48.0	66.0	34.0	SL	Mod Coarse
	30-120	12.0	48.5	60.5	39.5	SCL	Mod Coarse
36	0-15	29.8	19.2	49.0	51.0	SL	Mod Coarse
	15-40	13.4	31.6	45.0	55.0	SCL	Mod Fine
	40-75	15.7	24.1	39.8	60.2	L	Medium
37	0-20	9.0	28.5	37.5	62.5	CL	Mod Fine
	20-60	12.0	57.0	69.0	31.0	SL	Mod Coarse
	60-120	13.0	66.0	79.0	21.0	SL	Mod Coarse
38	0-5	13.5	39.0	52.5	47.5	L	Medium
	5-40	19.5	37.5	57.0	43.0	L	Medium
	40-55	17.5	36.5	54.0	46.0	L	Medium
39	0-20	12.5	46.5	59.0	41.0	SL	Mod Coarse
	20-55	30.0	48.5	78.5	21.5	SL	Mod Coarse
	55-120	7.9	21.6	29.5	70.5	CL	Mod Fine
40	0-20	13.0	53.5	66.5	33.5	SL	Mod Coarse
	20-70	12.6	49.8	62.4	37.6	SL	Mod Coarse
41	0-40	36.3	18.70	55.0	45.0	SL	Mod Coarse
42	0-25	11.0	48.5	59.5	40.5	SL	Mod Coarse
	25-90	12.5	52.5	65.0	35.0	SL	Mod Coarse
	90-120	8.2	31.9	40.1	59.9	CL	Mod Fine
43	0-15	13.0	49.0	62.0	38.0	SL	Mod Coarse
	15-35	16.5	45.5	62.0	38.0	SL	Mod Coarse
	35-120	10.0	30.5	40.5	59.5	CL	Mod Fine
44	0-25	20.0	31.5	50.5	49.5	SCL	Mod Fine
	25-90	17.5	17.5	35.0	65.0	L	Medium
	50-100	15.2	29.5	44.7	55.3	L	Medium
45	0-35	16.4	2.1	37.5	62.5	CL	Mod Fine
46	0-25	13.0	36.0	49.0	51.0	L	Medium
	25-50	16.0	35.0	51.0	49.0	L	Medium
	50-120	20.5	41.5	62.0	38.0	SCL	Mod Fine
47	0-20	11.2	13.9	25.2	74.8	CL	Mod Fine
	20-60	25.2	21.6	46.9	53.1	SCL	Mod Fine
	60-120	20.2	32.4	52.6	47.4	SCL	Mod Fine

TABLE (13) Cont'd

Soil Profile No.	Depth in cm	Coarse Sand %	Fine Sand %	Total Sand %	Silt + Clay %	Soil Texture	Soil Texture Grade
48	0-15	13.0	19.6	32.5	67.5	CL	Mod Fine
49	0-10	9.4	16.0	25.3	74.7	L	Medium
	10-45	26.8	14.9	41.8	58.2	CL	Mod Fine
50	0-15	14.0	23.1	38.2	62.8	L	Medium
	15-35	16.4	22.2	38.6	61.4	L	Medium
	35-100	15.8	17.5	33.3	66.7	CL	Mod Fine
51	0-20	7.1	27.3	34.5	65.5	L	Medium
	20-50	2.9	12.8	15.6	84.4	SiCL	Mod Fine
	50-120	3.5	13.6	17.1	82.9	SiCL	Mod Fine
52	0-25	4.5	13.0	17.5	82.5	SiL	Medium
	25-60	6.9	13.1	20.0	80.0	CL	Mod Fine
	60-120	8.1	13.0	21.1	78.9	CL	Mod Fine
53	0-20	6.2	13.1	19.3	80.7	SiL	Medium
	20-40	4.7	11.7	16.4	83.6	SiCL	Mod Fine
	40-100	17.0	17.9	34.9	65.1	CL	Mod Fine
54	0-20	5.0	24.7	29.7	70.3	L	Medium
	20-60	5.5	21.7	27.2	72.8	L	Medium
	60-90	6.6	22.3	28.5	71.5	L	Medium
	90-150	6.3	23.6	22.3	77.7	CL	Mod fine
55	0-30	5.7	15.6	21.2	78.8	CL	Mod Fine
	30-55	6.6	16.2	22.8	77.2	CL	Mod Fine
	55-120	5.8	14.9	20.7	79.3	CL	Mod Fine
56	0-20	10.5	53.0	63.5	36.5	SCL	Mod Fine
	20-60	8.0	53.5	61.5	38.5	SCL	Mod Fine
	60-120	8.3	54.6	62.9	37.1	SCL	Mod Fine
57	0-25	8.0	55.0	63.0	37.0	SCL	Mod Fine
		8.0	49.0	57.0	43.0	SCL	Mod Fine
58	0-20	3.5	47.5	51.0	49.0	SCL	Mod Fine
	20-60	3.0	46.0	49.0	51.0	L	Medium
	60-120	2.4	46.3	48.7	51.3	L	Mod Fine
59	0-20	16.0	47.5	63.5	36.5	SCL	Mod Fine
	20-50	9.0	40.0	49.0	51.0	SCL	Mod Fine
	50-120	15.0	49.5	64.5	35.5	SL	Mod Coarse
60	0-30	25.4	38.9	64.3	35.7	SL	Mod Coarse
	30-60	24.9	34.7	59.6	40.4	SL	Mod Coarse
	60-120	22.9	34.5	57.4	42.6	SCL	Mod Fine
61	0-30	22.0	42.5	64.5	35.5	SL	Mod Coarse
	30-60	20.5	33.5	56.0	46.0	SCL	Mod Fine
	60-120	37.0	32.5	69.5	30.5	SL	Mod Coarse
62	0-20	37.5	34.5	72.0	28.0	SL	Mod Coarse
	20-40	24.5	20.5	45.0	55.0	CL	Mod Fine
	40-120	16.0	34.0	50.0	50.0	SCL	Mod Fine
63	0-20	16.5	41.0	47.5	52.5	SCL	Mod Fine
	20-40	12.5	31.5	44.0	56.0	CL	Mod Fine
	40-120	14.0	36.0	50.0	50.0	CL	Mod Fine
64	0-20	29.0	31.0	60.0	40.0	SL-SCL	Mod Fine
	20-50	45.5	39.5	85.0	15.0	LS	Mod Coarse
	50-90	22.0	31.0	53.0	47.0	SCL	Mod Fine
65	0-20	8.0	48.5	56.5	43.5	SCL	Mod Fine
	20-60	6.5	59.0	65.5	34.5	SL	Mod Coarse
	60-120	16.5	39.0	55.5	44.5	SCL	Mod Fine
66	0-8	12.5	47.0	59.5	40.5	SCL	Mod Fine
	8-25	12.5	49.0	61.5	38.5	SCL	Mod Fine
	25-40	9.3	24.1	33.6	66.6	L	Mod Fine
	40-100	16.8	35.3	52.1	47.9	SCL	Medium
67	0-30	33.9	23.2	57.1	42.9	SL	Mod Coarse
68	0-5	33.5	44.5	78.0	22.0	SL	Mod Coarse
	5-20	26.5	45.0	71.5	28.5	SL	Mod Coarse
	20-100	14.5	43.5	58.0	42.0	SCL	Mod Fine
69	0-20	74.5	22.5	97.0	3.0	S	Mod Coarse
	20-70	63.5	25.5	89.0	11.0	S	Mod Coarse
	70-120	61.0	23.0	84.0	16.0	LS	Mod Coarse
70	0-20	11.0	50.0	61.0	39.0	SL	Mod Coarse
	20-60	22.5	47.0	69.5	30.5	SL	Mod Coarse
	60-120	21.0	24.5	45.5	54.5	CL-L	Mod Fine
71	0-16	13.5	44.5	58.0	42.0	SCL	Mod Fine
	16-80	13.0	47.5	60.5	39.5	SL-SCL	Mod Fine
	80-120	12.6	45.2	57.8	42.2	SCL	Mod Fine
72	0-20	15.5	19.2	34.7	65.3	CL	Mod Fine
	20-40	22.4	23.0	45.4	54.6	SCL	Mod Fine
	40-80	20.9	21.7	42.6	57.4	CL	Mod Fine
73	0-20	29.5	30.0	59.5	40.5	SL-SCL	Mod Fine
	20-50	29.5	22.0	50.5	49.5	L-SCL	Mod Fine
	50-100	20.5	18.5	39.0	61.0	CL-L	Mod Fine
74	0-18	32.0	37.5	69.5	30.5	SL	Mod Coarse
	18-40	23.0	43.5	66.5	33.5	SL	Mod Coarse
	40-120	12.0	38.0	50.0	50.0	SCL	Mod Fine

TABLE (14) SOIL MOISTURE CONTENT AND HYDRAULIC CONDUCTIVITY

Profile No.	Depth in cm	Unit	Retained Moisture (% vol.)							Quickly Drainable Pores	Slowly Drainable Pores	Water Holding Pores	Total Porosity	B.D.	H.C.	H.C.
		bars	0.001	0.1	0.2	0.33	0.66	1.00	15.00					g/cc	cm/ha	Rank
		pF	(0)	(2)	(2.3)	(2.5)	(2.8)	(3)	(4.2)	(30 - 9 M)	(9 - .2 M)	%	%			

40-120 12.0 38.0 50.0 50.0 SCL Mod Fine

TABLE (14) SOIL MOISTURE CONTENT AND HYDRAULIC CONDUCTIVITY

Profile No.	Depth in cm	Unit bars pF	Retained Moisture (% vol.) 0.001 (0)	0.1 (2)	0.2 (2.3)	0.33 (2.5)	0.66 (2.8)	1.00 (3)	15.00 (4.2)	Quickly Drainable Pores (30 - 9 M)	Slowly Drainable Pores (9 - .2 M)	Water Holding Pores %	Total Porosity %	B.D. g/cc	H.C. cm/ha	H.C. Rank
2	0-30		84.76	52.74	51.69	50.65	47.50	44.25	33.58	32.02	2.09	17.07	58.27	1.39	59.66	V.R.
	30-60		63.38	38.25	37.50	36.76	34.36	31.87	22.74	25.06	1.49	14.02	40.13	1.57	44.56	V.R.
3	0-25		72.14	37.16	36.69	36.23	32.83	30.57	22.94	34.98	0.93	13.29	30.49	1.64	66.09	V.R.
	25-45		73.47	35.09	33.77	32.46	29.4	26.47	19.18	38.38	2.63	13.28	30.95	1.68	73.46	V.R.
	45-60		63.92	34.94	33.92	32.90	29.44	25.92	19.28	28.98	2.04	13.62	34.08	1.79	53.06	V.R.
6	0-20		56.30	38.49	35.55	33.36	31.99	31.53	16.93	17.81	5.13	16.43	55.09	1.19	66.70	V.R.
	20-30		45.50	41.69	38.27	36.61	34.80	31.43	20.94	3.99	5.08	15.67	47.17	1.40	6.00	M.
	30-80		46.25	35.14	32.11	31.26	30.61	30.47	17.86	11.09	2.88	13.40	51.70	1.28	0.60	M.S.
	80-120		45.25	37.28	33.24	29.99	29.41	29.10	16.73	7.97	7.29	13.26	49.43	1.34	10.40	M.R.
11	0-20		42.85	38.99	36.82	28.04	27.49	26.23	15.65	3.86	10.95	12.39	46.79	1.41	5.40	M.
	20-30		39.54	35.79	32.06	28.09	27.73	26.35	14.38	3.75	7.70	13.71	40.75	1.57	0.40	S.
	30-75		41.72	34.71	29.27	27.03	22.70	20.44	10.31	6.71	7.68	16.72	43.02	1.51	1.00	M.S.
13	0-25		45.30	37.07	34.47	28.04	27.22	26.91	14.15	8.23	9.03	13.89	46.41	1.42	0.30	S.
	25-40		44.77	31.48	29.17	27.20	26.07	25.66	14.25	13.29	4.28	12.95	54.72	1.20	35.30	V.R.
	40-80		45.20	39.83	36.90	32.18	31.43	31.12	18.65	5.37	7.65	13.53	47.17	1.40	1.00	M.S.
16	0-25		47.85	41.52	36.48	31.16	26.32	25.89	14.03	6.33	10.36	17.13	46.04	1.43	2.40	M.
	25-50		47.26	38.51	33.60	31.94	30.53	30.09	16.96	8.75	6.57	14.98	48.68	1.36	0.20	S.
	50-90		48.11	38.00	34.59	29.65	26.60	26.02	18.48	10.11	8.35	11.17	50.57	1.31	1.20	M.S.
20	0-20		52.37	38.17	32.44	29.63	28.74	27.08	16.98	14.20	8.54	12.65	47.92	1.38	12.00	M.R.
	20-50		43.85	40.19	36.68	27.53	26.14	24.89	12.83	3.66	12.66	14.70	40.38	1.58	1.20	M.S.
	50-90		42.95	41.90	32.32	31.96	31.07	28.02	15.95	1.05	9.94	16.01	41.13	1.56	0.3	S.
23	0-20		44.98	37.31	32.47	30.45	25.18	20-22	12.35	7.97	6.86	18.10	49.43	1.34	16.00	R.
	20-50		44.35	41.01	37.19	32.78	32.06	26.55	16.99	3.34	8.23	15.79	43.40	1.50	8.00	M.
	50-110		49.82	34.03	26.55	25.44	24.65	20-53	9.39	15.79	8.59	16.05	57.74	1.12	2.00	M.
24	0-25		42.61	35.60	33.38	30.66	29.89	29.70	15.69	7.01	4.94	14.97	42.26	1.53	0.60	M.S.
	25-40		40-03	36.90	36.50	36.15	33.12	32.66	19.64	3.13	0.75	16.51	40.00	1.59	0.20	S.
	40-85		45.54	37.59	32.44	30-21	27.73	26.86	15.23	7.95	7.38	14.38	49.43	1.34	1.20	M.S.
26	0-10		47.48	37.28	37.55	36.25	35.04	33.53	21.18	8.20	3.03	15.07	48.68	1.36	0.60	M.S.
	10-40		43.41	36.44	28.21	27.88	20.43	29.78	11.50	6.97	14.56	10.38	45.66	1.44	0.40	S.
28	0-20		53.40	38.08	35.95	30.52	30.23	27.68	15.32	15.32	7.56	15.20	54.72	1.20	25.00	R.
	20-35		44.48	38.73	27.37	26.43	25.54	24.28	11.88	5.75	12.30	14.55	46.79	1.41	0.20	S.
	35-75		47.20	42.87	37.93	35.62	31.65	28.76	17.21	4.33	7.25	18.41	43.77	1.49	1.60	M.S.
42	0-25		59.07	35.69	34.71	33.73	31.47	29.41	22.25	23.38	1.96	11.48	61.87	1.39	40.91	V.R.
	25-90		66.88	40.54	39.52	38.51	35.61	32.59	22.28	26.34	2.03	16.23	40.75	1.57	47.33	V.R.
65	0-20		81.77	49.71	48.66	47.62	43.06	38.33	28.03	32.06	2.09	19.59	33.34	1.65	59.75	V.R.
	20-60		69.40	45.26	43.77	42.28	38.27	33.74	19.45	24.14	2.08	22.83	57.14	1.40	42.56	V.R.

V.R=VERY RAPID R.=RAPID M.R.=MODERATELY RAPID M.=MODERATE M.S.= MODERATELY SLOW S.=SLOW

TABLE (15) SOIL SALINITY , CaCO3 and GYPSUM CONTENTS

Soil Profile No.	Depth in cm	EC mmhos/cm 25C	CaCo3 %	Gypsum %
1	0-30	1.64	30.9	0.71
	30-80	1.05	40.3	0.71
	80-120	1.65	42.5	0.84
2	0-30	4.59	22.3	1.07
	30-60	3.40	23.2	0.90
	60-120	2.80	25.7	0.71
3	0-25	1.05	25.7	1.64
	25-45	1.20	20.6	1.68
	45-60	1.60	22.3	1.79
	60-80	2.06	24.0	1.86
	80-120	2.54	26.8	1.86
4	0-25	2.80	10.3	0.62
	25-55	4.02	18.9	2.63
	55-100	3.60	25.7	8.01
5	0-7	48.60	21.4	1.26
	7-25	42.00	19.7	1.45
	25-50	45.80	32.6	1.66
	50-120	27.50	32.6	2.34
6	0-20	3.70	41.5	0.04
	20-30	2.10	41.5	0.01
	30-80	2.20	40.2	0.03
7	0-20	3.00	41.0	0.03
	20-30	2.15	43.1	0.01
	30-80	4.30	45.3	0.11
8	0-25	2.40	30.5	0.01
	25-35	2.20	30.5	0.01
	35-80	2.00	26.2	0.05
9	0-20	2.30	33.8	0.03
	20-60	1.60	44.4	0.07
	60-90	1.80	45.3	0.07
10	0-20	15.00	40.2	1.29
	20-40	19.50	54.1	0.15
	40-60	14.20	49.1	0.30
11	0-20	4.50	48.6	0.17
	20-30	3.00	44.8	0.05
	30-75	2.70	38.1	1.01
12	0-25	4.00	38.5	0.38
	25-45	4.50	38.1	0.30
	45-80	4.65	52.5	0.12
13	0-25	1.90	38.1	0.02
	25-40	1.80	48.6	0.01
	40-80	2.10	37.2	0.03
14	0-30	2.00	38.1	0.01
	30-50	2.20	40.1	0.01
	50-85	2.80	43.5	0.05
15	0-25	0.70	31.3	0.02
	25-50	0.55	33.8	0.01
	50-80	0.60	45.7	0.22
	80-130	0.86	38.1	1.43
16	0-25	1.30	37.2	0.04
	25-50	1.30	47.4	0.24
	50-90	1.70	41.0	0.06
17	0-40	1.50	38.1	0.04
	40-60	1.20	38.1	0.17
	60-75	2.10	33.8	0.45
	75-100	2.54	25.4	2.73
18	0-30	2.20	25.4	0.02
	30-60	1.60	46.5	0.02
	60-120	1.50	40.3	0.09
19	0-30	1.05	27.1	0.01
	30-55	0.95	35.5	0.01
	55-100	0.98	35.5	0.42
20	0-20	4.20	27.9	0.14
	20-50	2.50	38.9	0.09
	50-90	3.40	46.1	0.03
21	0-25	8.00	32.6	0.03
	25-45	2.40	42.9	0.07
	45-90	5.30	40.6	0.06

TABLE (15) Cont'd

Soil Profile No.	Depth in cm	EC mmhos/cm 25C	CaCo3 %	Gypsum %
22	0-30	0.82	33.4	0.05
	30-60	0.95	34.7	0.05
	60-100	0.46	41.0	0.28
23	0-20	1.65	28.27	0.02
	20-40	1.50	38.28	0.03
	40-110	0.85	43.40	0.17
24	0-15	55.00	5.5	1.09
	15-20	15.00	42.3	0.12
	50-120	7.50	46.5	0.11
25	0-25	3.50	39.3	0.15
	25-35	4.00	45.7	0.07
	35-100	4.00	36.0	0.05
26	0-10	5.50	36.0	0.62
	10-40	4.00	49.1	0.46
	40-50	5.00	32.6	0.15
27	0-25	17.00	33.8	0.65
	25-40	8.00	34.3	0.36
	40-85	6.00	41.5	0.29
28	0-20	2.20	35.5	0.01
	20-35	1.30	34.7	0.01
	35-75	2.00	41.5	0.03
29	0-25	3.50	30.0	0.02
	25-40	1.10	33.8	0.02
	40-85	1.40	35.5	0.09
30	0-20	1.40	36.8	0.01
	20-35	2.40	45.7	0.01
	35-70	2.20	46.5	0.03
31	0-25	1.30	36.4	0.08
	25-50	2.10	39.3	0.19
	50-75	2.20	42.5	0.22
32	0-20	1.66	31.7	0.44
	20-40	2.20	32.6	0.25
	40-120	3.50	25.7	0.23
33	0-20	2.38	29.2	0.98
	20-50	1.30	30.0	1.24
	50-100	3.10	40.3	1.87
34	0-15	3.2	42.9	0.87
	15-35	4.4	30.0	0.89
	35-100	4.4	29.2	1.43
35	0-15	1.05	36.03	2.22
	15-30	1.02	49.7	2.86
	30-120	1.66	25.7	7.65
36	0-15	3.2	33.5	1.55
	15-40	2.7	40.3	2.56
	40-75	3.0	28.3	4.45
37	0-20	1.8	36.0	0.65
	20-60	1.94	28.3	0.87
	60-120	2.44	34.3	0.95
38	0-5	24.00	37.3	0.98
	5-40	30.00	57.9	0.98
	40-55	30.00	33.5	1.07
39	0-20	2.15	63.6	0.62
	20-55	1.16	61.3	0.67
	55-120	2.15	47.2	0.62
40	0-20	32.0	40.3	0.54
	20-70	32.0	42.9	0.34
41	0-40	30.0	37.8	0.89
42	0-25	1.94	36.0	0.73
	25-90	1.38	42.9	0.62
	90-120	1.53	38.2	0.94
43	0-15	1.2	30.0	0.74
	15-35	0.74	48.9	1.61
	35-820	1.5	34.3	1.60
44	0-25	3.0	36.00	0.8
	25-50	2.5	30.00	0.62
	50-100	1.94	29.2	0.89
45	0-35	15.6	13.7	0.71
		12.65	33.5	0.98

TABLE (15) Cont'd

Soil Profile No.	Depth in cm	EC mmhos/cm 25C	CaCo3 %	Gypsum %
46	0-25	1.38	28.3	0.82
	25-50	0.74	34.32	0.79
	50-120	0.88	26.6	0.85
47	0-20	20.70	47.9	0.62
	20-60	23.75	42.6	0.44
	60-120	28.92	43.5	0.55
48	0-15	13.76	50.9	1.56
		24.97	47.9	5.42
49	0-10	20.71	31.3	0.44
	10-45	31.67	35.2	6.05
50	0-15	21.92	40.0	0.34
	15-35	20.71	53.9	0.42
	35-100	28.01	47.0	0.67
51	0-20	13.40	30.4	0.44
	20-50	26.80	30.4	0.50
	50-120	29.52	32.6	0.71
52	0-25	1.40	39.6	0.35
	25-60	4.77	52.5	0.62
	60-120	6.46	36.9	0.72
53	0-20	1.19	33.9	0.21
	20-40	3.07	43.5	0.24
	40-100	1.49	38.3	0.35
54	0-20	15.73	23.2	0.31
	20-60	16.96	48.5	0.35
	60-90	8.41	49.3	0.41
	90-150	11.08	48.2	0.57
55	0-30	1.94	27.8	0.36
	30-55	1.16	30.4	0.37
	55-120	1.75	31.6	0.41
56	0-20	16.80	32.6	1.96
	20-60	17.00	27.5	6.23
	60-120	14.73	29.7	6.52
57	0-25	27.41	27.5	0.71
	25-100	27.44	30.0	0.71
58	0-20	1.2	25.7	1.07
	20-60	0.6	22.3	1.07
	60-120	1.11	26.7	2.69
59	0-20	1.44	30.0	1.07
	20-50	1.16	34.3	0.98
	50-120	3.2	30.0	0.98
60	0-30	3.0	30.0	0.36
	30-60	2.8	30.9	0.98
	60-90	3.1	28.3	0.98

Soil Profile No.	Depth in cm	EC mmhos/cm 25C	CaCo3 %	Gypsum %
61	0-30	0.87	37.8	0.62
	30-60	0.85	31.8	0.51
	60-120	0.70	29.2	0.44
62	0-20	0.53	25.7	0.53
	20-40	0.82	21.4	0.82
	40-120	1.60	27.5	1.60
63	0-20	1.42	31.7	0.62
	20-40	1.45	40.3	0.64
	40-120	0.81	34.3	0.71
64	0-20	0.95	25.7	0.62
	20-50	0.60	25.7	0.66
	50-90	0.65	39.5	0.71
65	0-20	1.88	55.8	0.89
	20-60	1.88	32.6	1.12
	60-120	2.22	38.6	1.25
66	0-8	0.95	38.6	0.73
	8-25	0.95	40.3	0.59
	25-40	0.60	36.0	1.05
	40-100	0.65	24.0	1.69
67	0-30	2.8	36.9	0.89
68	0-5	0.74	27.5	0.98
	5-20	0.74	24.0	0.62
	20-100	0.65	31.7	0.53
69	0-20	0.6	21.4	0.39
	20-70	1.6	17.2	0.68
	70-120	3.0	25.8	0.49
70	0-20	1.05	34.3	0.44
	20-60	3.35	56.6	0.71
	60-120	4.02	53.2	1.16
71	0-16	15.6	25.7	0.44
	16-80	4.5	30.0	0.49
	80-120	5.76	32.58	1.07
72	0-20	23.0	45.5	0.57
	20-40	18.5	47.2	0.84
	40-80	17.0	51.5	1.23
73	0-20	1.05	32.6	1.25
	20-50	0.74	38.6	2.56
	50-100	0.68	47.2	6.32
74	0-18	1.85	37.8	1.07
	18-40	0.80	51.5	0.68
	40-120	0.95	58.3	0.80

TABLE (16) FERTILITY STATUS OF THE SURFACE AND SUBSURFACE SOIL SAMPLES

Soil Profile No.	Depth in cm.	Organic Matter %	Available Phosphorus ppm.	Exchangeable Potassium Meq %	Micronutrients Fe ppm.	Zn ppm.	Cu ppm.
1	0-30	2.07	58.0	0.77	7.59	4.10	1.81
	30-80	0.44	14.0	0.87	1.10	1.40	1.16
2	0-30	0.50	28.0	0.90	2.55	0.71	1.90
	30-60	1.81	18.0	0.90	0.89	0.69	1.71
3	0-25	1.13	8.0	0.59	17.79	2.25	2.78
	25-45	0.63	7.8	0.56	8.10	1.47	8.10
4	0-25	2.25	12.0	0.23	3.82	2.19	2.16
	25-55	0.18	8.0	0.10	1.38	2.39	2.82
6	0-20	2.88	10.0	0.60	0.98	0.81	0.74
	20-30	2.17	15.8	0.32			
7	0-20	1.61	12.6	0.56	0.65	0.66	1.16
	20-30	1.64	9.6	0.34			
8	0-25	2.24	4.9	0.46	1.02	0.54	0.91
9	0-20	2.96	0.6	0.68	0.75	0.83	0.92
	20-60	0.34	2.0	0.36			
10	0-20	2.24	9.6	1.16	0.61	0.45	0.68
	20-40	0.80	5.0	0.36			
11	0-20	1.86	8.4	0.70	0.92	0.82	1.51
	20-30	0.84	13.4	0.52			
12	0-25	2.05	0.8	0.88	1.51	0.63	0.82
13	0-25	1.86	9.6	0.80	1.97	0.61	1.65
14	0-30	2.35	28.0	0.88	1.42	0.68	0.58
15	0-25	1.29	9.0	0.92	0.60	0.82	0.74
16	0-25	1.44	0.7	0.68	0.65	0.60	0.75
17	0-40	1.13	4.0	1.40	1.01	0.79	0.78
18	0-30	1.45	6.2	0.52	0.86	0.89	1.06
19	0-30	1.26	2.6	0.70	1.50	0.64	0.79
20	0-20	1.82	2.8	0.70	0.48	2.05	0.51
	20-50	0.87	1.9	0.44			

TABLE (16) Cont'd

Soil Profile No.	Depth in cm.	Organic Matter %	Available Phosphorus ppm	Exchangeable Potassium Meq %	Micronutrients Fe	Zn	Cu
21	0-25	1.37	2.8	0.84	0.82	0.51	0.85
22	0-30	2.09	4.8	0.68	1.01	0.83	0.65
23	0-20	1.19	4.4	0.64	1.11	0.44	0.83
	20-50	0.54	2.8	0.34			
24	0-15	1.75	7.2	1.72	0.79	0.68	0.58
	15-50	0.90	13.4	1.80			
25	0-25	0.80	5.6	0.66	1.23	0.81	1.31
	25-35	0.60	3.7	0.74			
27	0-25	3.30	1.0	1.40	0.91	0.54	0.71
28	0-20	1.78	12.8	0.60	1.89	0.76	1.35
	20-35	1.14	9.6	0.70			
29	0-15	0.79	1.0	0.87	0.84	1.36	1.55
	15-30	0.70	1.0	0.70			
30	0-20	1.37	16.8	0.88	1.36	1.67	1.51
	20-35	0.90	8.6	0.70			
31	0-25	1.36	4.4	0.68	1.84	0.76	0.80
38	0-5	1.00	12.00	0.90	0.76	0.95	1.83
	5-40	0.69	8.00	0.56	0.39	1.33	1.93
39	0-20	1.25	20.00	0.62	9.07	1.78	1.43
	20-55	0.37	14.00	0.26	0.73	3.08	1.49
42	0-25	1.56	8.00	0.59	1.35	0.77	1.06
	25-90	0.44	8.00	0.54	0.38	1.97	0.14
46	0-25	0.12	14.00	0.43	1.35	0.82	0.59
	25-50	0.86	11.60	0.59	0.87	0.51	0.24
52	0-25	0.8	8.00	1.45	2.00	0.30	0.20
53	0-20	1.34	7.10	1.25	14.00	8.40	0.40
57	0-20	1.00	11.50	1.38	1.01	1.64	3.11
	20-100	1.06	12.00	1.10	0.54	0.62	0.11
59	0-20	0.31	11.60	1.10	0.66	0.71	2.03
	20-50	0.12	17.60	1.10	0.44	0.47	0.15
62	0-20	1.25	8.00	0.43	1.22	0.45	0.08
	20-40	0.88	8.00	0.43	0.99	0.74	0.33
63	0-20	1.25	11.60	0.59	1.66	1.70	1.61
	20-40	0.75	6.00	0.56	0.58	0.89	0.43
65	0-20	0.50	12.00	1.02	1.39	3.20	3.89
	20-60	0.19	13.00	0.90	3.04	1.12	1.07
66	0-8	1.19	7.80	0.54	1.14	1.57	1.20
	8-25	0.94	8.00	0.59	1.61	0.89	11.03
74	0-18	0.81	14.00	0.59	0.74	0.77	0.36
	18-40	0.81	14.00	0.77	0.44	0.69	0.15

TABLE (32) THE MAIN FOUNDATION OF THE STUDY AREA.

Name of	Number of	Far from	Infrastructure	Public Services

TABLE (32) THE MAIN FOUNDATION OF THE STUDY AREA.

Name of Village	Number of inhabitants	Far from the main roads (location)	Infrastructure						Public Services												
			Roads	Electricity	Potable water	Waste water	Telephone	Settlement and housing	Basic Education	Secondary School	Vcational taining cntre	Health care centre	Social welfare unit	Town mosque and church	Central post office	Police Station	Fire Station	Youth Center	Shopping Center	Other Services	Agricultural * Cooperatives
Bagdad (1980)	500 persons	18 kms to the Western side of the road	+	+	+	+	--	120 graduates 5 services 100 farmers	--	--	--	--	+	Mosque +	--	Not working	--	+ Not effective	+	--	+
El-Basra (1980)	450	40 kms Alex-cairo desert road 18 kms from the road	+	+	+	+	--	120 graduates 100 farmers + services	+ (low)	+ (low)	--	Medical central (low) +	+	Mosque +	--	--	--	--	--	--	+
El-Markazeya (Oct.1988	200	40 kms from Alex - Cairo at 75 kms	+	+	+	+	--	600 houses	+	+	--	Med. + Hospital	--	+	--	--	--	+	+	+	+
El * Olaa (Nov.88)	605	7 km from Mar Mena Monast.	+	+	+	+	--	605	+	--	--	--	--	+	+	+	--	--	+	--	+
El-Zohour (Oct.1988	320	45 kms to west of the 75 kms	+	+	+	+	--	320 + services	+	--	--	+ Low	--	+	--	--	--	+	--	--	+
El * Tanmeya (Oct.88)	182	1 km from Mar Mina Monest.	+	+	+	+		466	--	--	--	--	--	--	--	--	--	--	--	--	+
Mohamed Farid Dec.1988	160	2 km from Mar Mina Monast.-	+	+	+	+	--	174	--	--	--	--	--	+	+	--	--	+	+	--	+
13	175	15 km from 75 kms	+	+	+	+	--	200	+	--	+	--	--	+	--	--	--	+	+	--	+
14 Dec. 1987	200	30 kms Km 75	+	+	+	+	--	200 + Services	+	--	--	+	+	--	--	--	--	+	+	Bank	+
15 Dec. 1989	197	36 km Km 75	+	+	+	+	--	200	+	--	--	+	+	--		+	--	+	+	Bank	+

TABLE (32) (CONT.)

Name of Village	Number of inhabitants	Far from the main roads (location)	Infrastructure						Public Services												
			Roads	Electricity	Potable water	Waste water	Telephone	Settlement and housing	Basic Education	Secondary School	Vocational training centre	Health care centre	Social welfare unit	Town mosque and church	Central post office	Police Station	Fire Station	Youth Center	Shopping Center	Other Services	Agricultural Cooperatives *
16 Dec. 1987	200	43 kms West Km 75	+	+	+	+	--	200 + Services	+	--	--	+	--	--	--	--	--	+	+	Bank	+
17 Oct. 1988	200	40 kms on Nasr road 75 km	+	+	+	+	--	200 + Services	+	--	--	--	+					+	+	--	+
18 Nov 1988	200	10 km from Mar Mina Monast.	+	+	+	+	--	200	+	--	--	--	--	--	--	--	--	+	--	--	
19 Oct. 1988	195	40 kms km 75	+	+	+	+	--	180 graduates 15 services	+	--	--	+	+	--	--	--	--	+	--	FAO Organization	+
20 Oct. 1988	185	40 kms 75 km	+	+	+	+	--	185 + Services	--	--	--	+ Low	--	--	--	--	--	+	+ Low	--	+
21	168	50 kms km 75	+	+	+	+	--	168 + Services	--	--	--	+ Low	--			+	--	--	+	--	+

* each village has an agriculture cooperative unit limited to distributing chemicals only.