

Durham E-Theses

The land use patterns and rural settlement in the Benghazi plain

Salem A. Hajjaji

How to cite:

Hajjaji, Salem A. (1969) The land use patterns and rural settlement in the Benghazi plain. Doctoral thesis, Durham University.

Use policy

The full-text may be used and/or reproduced, and given to third parties in any format or medium, without prior permission or charge, for personal research or study, educational, or not-for-profit purposes provided that:

- a full bibliographic reference is made to the original source
- a <https://etheses.durham.ac.uk/id/eprint/9644/> is made to the metadata record in Durham E-Theses
- the full-text is not changed in any way

The full-text must not be sold in any format or medium without the formal permission of the copyright holders.

Please consult the [full Durham E-Theses policy](#) for further details.

ABSTRACTTHE LAND USE PATTERNS AND RURAL SETTLEMENT
IN THE BENGHAZI PLAIN

The triangular-shaped Benghazi Plain lies in the north-western part of the Cyrenaican peninsula. It is a wave-cut platform, with slight undulations in the northern part or Es-Sahel and almost level terrain in the south or Barga El Hamra. The escarpment which marks the plain's eastern boundary is a fault-line scarp, dissected by numerous short, deep wadis, very few of which reach the sea; the majority disappear into the underlying Miocene limestones. Climatically, the Benghazi Plain lies within the semi-arid zone. Underground water resources are meagre and in the main, except in the Benghazi-Benina area, consist of shallow layers of brackish or salty ground water. From the pedological point of view, the soils of the Benghazi Plain are mostly clayey terra rossa but generally calcareous and poor in humus. The distribution of vegetation is primarily determined by the distribution of rainfall. Generally, the northern part of the plain lies within the Mediterranean woodland region, while the southern part lies within the Irano-Turanian vegetation type.

The long history of this region shows that, at least since the invasion by the Beni Sulaim tribes in the 11th century, the predominant land use type is shifting cultivation

of cereals and animal husbandry; some irrigated farming is traditional in the coastal area where underground water is available. Here the rural settlements are clustered and the farmers practise a subsistence type of farming. The rural population is dispersed in pattern and few in number; the tenure of the land is tribal or communal, but in theory is vested in the State.

The agricultural development is handicapped by the scarcity of irrigation water. Thus, any future economic development must depend primarily on the availability of good water. However, the construction of El Gwarsha Sewage Purification Plant and Wadi El Gattara Water Dam will undoubtedly provide good irrigation water for at least 2,500 ha. of virgin land. The El Gwarsha Land Settlement Scheme has already been planned and initiated under the supervision of N.A.S.A. However, the El Gattara Land Settlement Project has been proposed in the conclusion of this thesis. This project is designed according to a co-operative or joint type of farming, which the author believes best suits the Bedu way of life. The most striking result of these two land settlement projects is that, if they succeed as is planned, they will provide Benghazi with its requirements for agricultural products, except meat and some grains. At present more than 80 per cent of these needs are imported from Tripolitania and abroad. In addition to these benefits, the El Gattara project will aid in the sedenterisation of the nomads and semi-nomads in the area.

THE LAND USE PATTERNS AND RURAL
SETTLEMENT IN THE BENGHAZI PLAIN

BY

SALEM A. HAJJAJI

VOLUME I

THESIS SUBMITTED FOR THE DEGREE OF PH.D. OF THE
UNIVERSITY OF DURHAM

JUNE, 1969

The copyright of this thesis rests with the author.
No quotation from it should be published without
his prior written consent and information derived
from it should be acknowledged.

TABLE OF CONTENTS

	<u>Page</u>
Preface	iii
Introduction	vi
Part I: Physical Background	1
Chapter 1 - Geomorphology	1
Chapter 2 - The Climate of the Benghazi Plain and the adjacent areas	21
Chapter 3 - Surface Drainage and Underground Water	40
Chapter 4 - Soils and Vegetation	59
Part II: Land Use	100
Chapter 5 - The Land Use Patterns	100
5.1 - Cultivated Land	103
5.2 - Uncultivable Land	136
Chapter 6 - Crop Production and Yields	140
Chapter 7 - Forest and Grazing Land	193
7.1 - Forest Land	193
7.2 - Grazing Land	203
Chapter 8 - Animal Husbandry	213
Part III: The Agricultural Economy	242
Chapter 9 - Land Tenure and Farming Practices	242
9.1 - Land Tenure and Water Rights	242
9.2 - Present Agricultural Land Use Regions	266
9.3 - Methods and Types of Farming	274

Chapter 10 - Farm Finance, Labour and Equipment	294
10.1 - Farm Income and Expenditure	294
10.2 - Farm Labour and Equipment	307
Part IV: The Rural Settlement	330
Chapter 11 - The Settlement Patterns	330
11.1 - The tribes of the Benghazi Plain	330
11.2 - Tribal Problems in relation to the land use	335
11.3 - Rural Population Patterns	338
11.4 - Rural Population Movement	346
11.5 - Types of settlement	351
11.6 - Rural Services	362
Part V: Conclusion	
Chapter 12 - Land Settlement Project	379
References	398

PREFACE

The selection of the Benghazi Plain area for this study resulted from a long-term interest and considerable familiarity with its geographical, economic and social aspects since I was an undergraduate in the University of Libya in Benghazi 13 years ago. Subsequently I made many field trips with the Geography Department as a lecturer, but a fuller understanding of the area and its problems was acquired during my extensive field work throughout the Benghazi Plain and the adjacent area (Fig.3) which lasted about twelve months, between September, 1966 and August, 1967. The distance covered in this period was about 5,300 km.

Before beginning the field work I made an extensive study of the available literature on Cyrenaica (since not much is available on the Benghazi Plain), in Libya, Italy (mainly F.A.O. Departments) and England. This enabled me to write the first three chapters on the physical geography during my first year in the University of Durham.

The topic of my thesis has been chosen for three main reasons. Firstly, the Benghazi Plain is the least studied area in northern Cyrenaica, despite its location near Benghazi City, the second largest city in Libya. The small amount of litera-

ture available concerns only some aspects of the area north of Benghazi. Secondly, almost all the economic development projects, particularly land settlement schemes, have been carried out (even during the times of the Italian and British Administration) in the Jabal El Akhdar area. Thirdly, it is hoped that this study, with its information, suggestions and proposals, will be applied to land settlement and other economic and social development projects, when the time comes to develop the Benghazi Plain area.

There are many people in Libya who by their help and encouragement have enabled me to complete this study. Although it is impossible here to mention all of them by name, I should like to express my gratitude and appreciation to the Extension Department in the Ministry of Agriculture in Benghazi, Extension Officers and Mudirs of each Mudirya, and the National Agricultural Settlement Authority (N.A.S.A.) in Benghazi.

I am deeply indebted to Professor J. I. Clarke, who supervised this work, for his guidance and invaluable criticism. My thanks are extended also to Professor H. Bowen-Jones and Dr. G. H. Blake who, during the absence of my supervisor in the U.S.A., discussed the plan of my thesis and field work and offered invaluable suggestions and encouragement. I wish also to thank Dr. K. Atkinson for his great help in checking the soil samples analysis. I am most grateful also to Professor W. B. Fisher for accepting me as a research student in his department. My thanks are due to other members of the staff

and fellow postgraduates of the Department of Geography,
Durham University, for their assistance and encouragement.

INTRODUCTION

The triangular Benghazi Plain is situated in the north-western part of the Cyrenaica peninsula (Fig.1). It consists of two distinctive parts: the northern part extends from north of Benghazi to Tolmeita in the north-east, and is known to Cyrenaicans as ES-SAHIL (the coast), while the southern part lies between Benghazi in the north and the southern limit of the red soil (Terra Rossa) in the south, and is known as BARGA EL HAMRA (Red Cyrenaica).

The plain occurs between $19^{\circ} 45' E$ and $21^{\circ} 00' E$ and $31^{\circ} 22' N$ and $32^{\circ} 44' N$, and is bordered by the southern Mediterranean coast to the north, the Gulf of Sirte (Sidra) to the west and the western fringe of Jabal El Akhdar (Green mountain) represented by a wave-cut faulted escarpment which is a post-Miocene shoreline. The escarpment, which is dissected by deep gorges cut by numerous wadis, extends from Antelat ($31^{\circ} N$) in the south to Ras Tolmeita ($32^{\circ} 44' N$) on the coast in the north-east, and its summit ranges from 150 m. above sea level (a.s.l.) in the south to 300 m. (a.s.l.) in the north-east.

The boundaries of the plain are clearly visible except to the south where the Barga El Hamra gives way gradually and

imperceptibly to Barga El Beida (White Cyrenaica), where whitish and yellowish soils prevail. Consequently an arbitrary line from Antelat in the east to Sidi Abdu Ati on the coast in the west, was suggested by the Italian geographers as the southern boundary of the Benghazi Plain, and it has been recognised since that time.

Benghazi Plain is the largest plain in northern Cyrenaica, though it is not the most important one. It has an area of approximately 6,000 sq.km., with a length of about 220 km; the width varies from about 500 m. in the north-east, to 50 km. at its widest part near Slug and finally about 41 km. at its southernmost part.

The plain consists of fairly flat ground with an imperceptible gradient, except in some places where it is dotted by sporadic features of Karst topography (lakes, dolinas, cracks, etc.), minor steps and scattered fairly low ranges of consolidated dunes which occur mostly near the coast. The surface of the Benghazi Plain rises gradually from the Mediterranean coast inland towards the foot of the escarpment where it reaches an altitude between 120 m.-150 m. (a.s.l.), consequently the contour lines show a remarkably even spacing, the only exception being those of Benghazi and the Benina step (Fig.1.2).

Most, if not all, of the plain appears to have a very simple structure. It consists largely of limestone sediments which range in character from being soft and amorphous to medium hard and crystalline with some interbedded clays and

marl of the Tertiary and Pliestocene times. Tectonic complications are unknown in this region, although there are some faults and monoclines, sometimes of considerable downthrow and extent. Hence the geological strata of the plain lie almost completely horizontal in accordance with the geological sequences (Fig.1.1).

Administratively, the Benghazi Plain lies in the Muhafaza Governorate of Benghazi, within the limits of Benghazi Mutasarrifya (District). The only part which lies outside the limits of the Muhafaza of Benghazi is the Mudirya (Parish) of Tolmeita, which lies in the Muhafaza of El Beida (Jabal El Akhdar) and within the limits of the Mutasarrifya of El Marj (Fig.2).

The Benghazi Plain contains 13 Mudiryas. From south to north they are: El Magrun, Gamines, Slug, Jardina, En-Nawaghia, El Gwarsha, El Fweiha, Benina, El Kweifya, Sidi Khalifa, Deriana, Tokra and finally Tolmeita. The first 5 Mudiryas are grouped together and put under one administrative unit called Niyabit-Mutasarrifya (Sub-District). The present number of Mudiryas came into existence after a long process. For instance, Tolmeita used to include Batta Mudirya in the eastern part of El Marj Plain before 1960. Tokra used to include El Hemda before 1962. En-Nawaghia was separated from Jardina only in January, 1967. Furthermore a Ministerial decree was issued on 2nd August, 1967 concerning the annexation of El Kweifya and El Gwarsha villages to Benghazi Municipality district. It

would be also desirable for Benina with its Airport to be annexed to Benghazi Municipality. Tolmeita, with its enchanting touristic site, should also be put under Benghazi because it needs development and more attention; El Marj Mutasarrifya cannot develop it since, in itself, it needs care and development. It is worth mentioning that the boundaries of the Benghazi Plain Mudiryas are drawn for the first time on a map. They were marked first in the field on a map of 1 : 50,000 scale, with the assistance of the Mudirs, Sheikhs, Mustashars (the Kheikh of Sheiks), Extension Officers, and senior employees of each Mudirya. Then the 1 : 50,000 scale map was reduced to the thesis basic map scale of 1 : 250,000.

Methods of Field Study

In a developing country like Libya, where agricultural data are limited and unreliable, field observation and questionnaires become of the utmost importance in carrying out this study. Nevertheless, the field work was hindered by some problems, of which the social attitude of the Bedu people was the main one. The Bedu are not used to statistical inquiries, and are always prone to confuse surveys with taxation measures, despite the fact that taxation was abolished in 1963. Many Bedu as well as some sedentary farmers may become suspicious of visitors who come to obtain information from them. They sometimes show resentment and reluctance to disclose some of the facts, fearing that such information

might be used against their interest. This I experienced during my first period (from September to November, 1966) of field investigation in the Benghazi Plain.

However, the approach which I followed later on was to reside in each Mudirya for 2-3 weeks with the result that conversation with the local people, particularly during my rest time, produced, to some extent, a different attitude in the people towards me and my work. This enabled me to complete my mapping of various aspects and questionnaires successfully. My personal friendship with the Mudirs, Extension Officers, and other Administrative Officers, played the main role in obtaining relatively accurate and confidential information. My complete integration with the people, in talking the Cyrenaican dialect, eating and sleeping with them, have helped considerably to obtain their acceptance and trust.

A special questionnaire, covering all aspects of the land use and settlement patterns, was prepared (see Appendix 1) before I left for the field work.

After thorough preparation, the survey of the 225 farmers was initiated in October, 1966. Samples of 10-30 farmholders from each Mudirya were made at random, so that the entire plain could be effectively represented. The required information was obtained from the 225 farmers, surveyed by direct interviews in their farms (Fig.3) by myself, and with the assistance of Extension Officers and Mudiryas Senior Officers. Although this work is based primarily on raw data obtained in the field,

most of which is recorded for the first time, it was supplemented with official data and existing literature, mostly from Italian sources. Other information was obtained by personal interview with senior officials and FAO experts on Land Use, Settlement, Soil and Water Utilisation, who were working in Libya in general and Cyrenaica in particular.

The thesis consists of two volumes; the first volume is the text, and the second is an atlas.

The text consists of 5 main parts. Part One deals with the study and analysis of the physical geography. It contains four chapters, i.e. Geomorphology, Climate, Water Resources, and Soils and Vegetation and their relationship to the agricultural and economic development. The study of the physical geography of the Benghazi Plain and the adjacent areas, is an essential background for the study of the land use and settlement.

Part Two represents one of the main parts of the thesis, 'The Land Use,' and consists of four chapters: The Land Use Patterns, Crop Production and Yields, Forestry and Grazing Lands and Animal Husbandry.

Part Three deals with the agricultural economy, and consists of two chapters: Land Tenure and Farming Practices, and Farm Finance, Labour and Equipment.

The last two parts objectively analyse the present agricultural situation and economic system operating in the Benghazi Plain and attempt to give a fair account of the existing

agricultural production. Methods for its improvement and development, as well as the exploitation of new areas with agricultural potential suitable for land settlement projects are suggested. Part Four deals with the rural settlement patterns of the area under consideration and elaborates the numerical changes and factors determining rural population distribution and movement. In addition, the types and distribution of the rural settlements and rural services are analysed. The last part (Part Five) of the thesis contains the conclusions. It provides the results of the study of the Land Use and Rural Settlement, and their development, which is proposed in a Land Settlement project which will get its water for irrigation from wadi El Gattara Dam.

Owing to the triangular shape of the Benghazi Plain it was very difficult to present clearly all aspects of the land use and settlement in detailed maps, particularly in the northern part of the plain, according to the thesis size (8" x 10"). Therefore, an atlas which contains all figures, photographs, tables and appendices, is produced in a separate volume. The figures are mostly coloured in order to give a clear picture displaying all aspects of the thesis study.

The final object of this thesis is to exploit the agricultural potential and find methods and means of increasing the production and productivity of the agricultural crops in order to supply Benghazi City with food, of which at present more than 60 per cent is imported. Secondly, it is hoped to settle

the Bedu (in the proposed Land Settlement areas) and to improve their standard of living, particularly in those lower income groups and depressed areas, which have not yet enjoyed the full benefits of the petroleum boom.

Finally, in a country like Libya, which is in a stage of revolutionary economic development, the study of any subject of geography, especially the Land Use and Settlement, could be regarded as Applied Geography. Consequently, it is hoped that this thesis work will be adopted by planning authorities such as the Ministry of Development and Planning, the Ministry of Agriculture, the N.A.S.A., or the Ministry of Information and Culture. This latter Ministry has also published my M.A. Thesis (The Geography of Libya) as a volume entitled 'The New Libya' in January, 1967.

PART I

PHYSICAL BACKGROUND

CHAPTER 1

GEOMORPHOLOGY

The Benghazi Plain is not entirely homogeneous as the name would suggest. Indeed, its topography may be better understood by considering the following three zones: (1) The coastal strip, (2) The coastal plain, or the Benghazi plain and (3) The first escarpment of Jabal El Akhdar.

1.1 - The Coastal Strip

The Benghazi Plain extends from Ras Tolmeita in the north-east to Sidi Abdul Ati in the south, a distance of about 240 km., varying in width from about 200 m. to about 50 km. The northern half of the coast, between Ras Tolmeita and Ras Yunes (18 km. south of Benghazi) runs in a N.N.E.-S.S.W. orientation, covering about 115 km. The southern half runs north-south for about 125 km.

According to Johnson's classification of shorelines⁽¹⁾ the coast of the Benghazi Plain can be described as a "shoreline of emergence," which is distinguished by the virtual absence

of offshore bars, relatively straight shoreline and the existence of lagoons and marshes (sebakh) adjacent to it, such as Ain Zaiyana, El Kuz, Bersis, and Karkura.

The almost complete absence of bays, headlands offshore bars and the gently sloping surface of the submerged part of the coast, as well as the separate lagoons and sebakh behind it, suggest that the coast line has, in fact, reached a mature stage in its development.⁽²⁾

Former high positions of sea levels are recorded along many parts of the Cyrenaican coast, by emerged shorelines and marine sediments. Hey⁽³⁾ traced five marine shorelines in this area with a fair degree of certainty:

5-6 m. Benghazi, Kweifya, Tokra, Tolmeita

15+ m. Benghazi

20 & 33 m. Tolmeita

90 m. Benina

150-200 m. Tokra - Antelat.

Fragments of ancient shorelines at levels between 5-6 m. have been recognised along the coastal strip north of Benghazi. Hey strongly believed that the Tokra step (Plate 1.3), with its constant level of 5 m. (a.s.l.) maintained over a distance of about 18 km., must owe its present elevation entirely to a shift of the sea level. At El Kweifya no shoreline was definitely located, but it was assumed, that the Pleistocene shell - limestone, which lies at an altitude of about 6 m. (a.s.l.) and resting between the bedrock and the consolidated

dunes, probably indicates the maximum height of this particular transgression.⁽⁴⁾

The existence of the 15 m. shoreline in the Benghazi area, is provided by geological evidence through boreholes drilled in different sites, for water supply purposes. The conditions under which the Pleistocene deposits were laid down appear to have been a continual alternation of marine and fresh (Wadi El Gattara) waters. It thus seems probable that these sediments were also laid down during the transgression which culminated in a shoreline of a little over 15 m.⁽⁵⁾

In the banks of Wadi Zayana (1 km. east of Tolmeita) a wave-cut platform, with beach deposits can be traced from the modern shoreline, terminating at the foot of low cliffs at an altitude of 6.5 m. Further upstream more beach deposits exist completely masked by alluvium, but resting on bedrock at an altitude of 33 m. At Wadi Esh-Shaaba south-west of Tolmeita fragments of two well developed terraces can be distinguished. The lower terrace indicates a shoreline of about 20 m.⁽⁶⁾

Benina step is also a marine cliff, and represents an ancient shoreline of about 90 m.

Finally, it is probable that the escarpment between Tokra and Antelat represents a cliff of a marine shoreline, whose altitudes now lie between 150-200 m. If so, it can only be concluded that the escarpment was formed at a time when the sea itself stood between 150 and 200 m. above its present level, and that it has subsequently undergone no important disturbance.

The coast between Ras Tolmeita and Benghazi is almost a straight shoreline, with a slight convexity towards the sea. From Ras Tolmeita westwards, the rocky coast changes into a long stretch of sandy-beach. Two small peninsulas separated from each other by an inlet at Tolmeita form the only morphological complexity in this area. A similar feature exists in the western extremity of this regular coast at Benghazi. Here the inlet is the site for Benghazi's harbour.

The coast line between Benghazi and Ras Karkura extends for about 57 km. and terminates with a small peninsula of consolidated dunes associated with a small embayment. A similar feature occurs at Ras El Kabsh about 14 km. south of Ras Karkura. From Ras El Kabsh to Ez-Zweitina a distance of about 34 km. the coastline veers slightly to south-east. In all the cases mentioned so far, the nature of the various reefs and peninsulas is betrayed by the alignment with chains of consolidated fossil dunes on shore.

Consequently, this coastal strip is devoid of natural harbours. Benghazi the main seaport of Cyrenaica owes its existence to a man-made harbour. Small inlets like those at Tolmeita and Ez-Zweitina are only used for sheltering small fishing boats (Ez-Zweitina became a petroleum port in 1968). The absence of natural harbours along this part of the Cyrenaica coast is in marked contrast to the coast of Marmarica where deeply cut wadi channels reach the coast to provide excellent sites for harbours at Tobruk and Bardia.

The coastal strip is almost entirely bounded by sand dunes (Fig.1.1) behind which depressions occur on the landward side. These depressions are frequently filled with marshes (sebakh). The consistency with which sand dunes follow the coast is interrupted only by occasional ranges of consolidated dunes or stretches of sebakh. A little distance to the north-east of Deriane a series of low coastal sand dunes (3-10 m. high and up to 1 km. wide) emerges and forms a long cordon running westward and parallel to the coast as far as a point just to the north of Sabri (north of Benghazi). Here the dunes reach a height of about 14 m. The sand dunes north of Benghazi as well as along the whole coast of Libya, are the main source of tapping the underground-water for agricultural purposes and human consumption, for all the scattered villages along the coast. In addition to their importance for vegetable farming, these dunes north of Benghazi have been used for quarrying sand for building (Plate 1.1).

The shoreline between Tokra and Bersis, and also in the vicinity of Benghazi City, is devoid of sand dunes, because the limestone formation of the plain emerges immediately above the shoreline in the form of a coastal shelf, which is sometimes only a few metres high.⁽⁷⁾

South of Benghazi the sand dunes reappear. Here they are even higher than the consolidated dunes behind them (on the mainland), and the two lines of dunes are separated by an area of lowland, which in places is occupied by sebakh. The

sand dunes range in altitude from 14 m. in the north to about 24 m. in the south, and are higher and more abundant than those which occur north of Benghazi.

According to Desio,⁽⁸⁾ the coastal sand dunes must have been produced by deflation and by mechanical action of the waves on a certain part of the submerged fringe of the lower terrace of the Benghazi Plain. The modern coastal sand dunes are composed of small rounded grains characteristically whitish in colour. In some places, especially in the lower layers, they are mixed, to a certain extent with deposits from terra rossa or marsh, giving a reddish colour.

The consolidated fossil dunes, found on many parts of the coastal strip, are of Pleistocene origin. Very often they occur in discontinuous patches with no particular morphology except in so far as they tend to modify the topography of the underlying bedrock surfaces. Many of these dunes have formed distinct topographical features immediately adjacent to the existing shoreline. Sometimes they occur as continuous ridges, as for instance, between Tokra and Deriana. More frequently they occur as single elongated hillocks or grouped together in chains. An example of the isolated hillocks occurs to the south-east of Deriana (Plate 1.2). Further to the south-west these isolated hillocks merge into a continuous chain varying in width from about 500 m. in the north to more than 8 km. in the south. Their height decreases from south to north from about 30 m. (a.s.l.) at Ez-Zweitina to about 20 m. in the area

south of Benghazi. Between Benghazi and Tokra they are seldom more than 10 m. high. The economic importance of these fossil dunes is that they have been quarried for building stones since Classical times.

Before leaving the coastal features a little more ought to be said about the sebakh or marshland occupying depressions on the landward side of the dune belts. Some of these sebakh dry out in the summer months but others remain the collecting grounds for stagnant water. They are usually of moderate depth (1-2 m.), sometimes reaching 1 m. below sea level. At high tide sea water may cross the coastal dunes to maintain the sebakh, others receiving their water supply from capillary action. As one would expect, the bed of a sebakh usually consists of clays and salts.

The sebakh stretch from Bujarrar 8 km. west of Tokra and run parallel to the coast along the rest of the coastal strip. The Sebkha El Muz, west of Bersis (Fig.1) is the largest in the area, stretching for about 14 km. along the coast and varying in width from 250-1500 m. Between Deriana and Sidi Khalifa no sebakh exist and even at Sidi Khalifa and further south-west the marshland dries out during the summer months.

The lagoon of Ain Zaiyana lying north of El Kweifya, is linked with the sea, though the salinity of the lagoon is considerably reduced through the presence of a number of springs.

Benghazi is almost surrounded by the sebakh of Es-Selmani,*

* Sebkha Es-Selmani near Benghazi has been drained recently and covered with a layer of sand in readiness for administrative buildings.

El Punta (El Keesh) and Tabellino. Salt is produced from El Punta through the evaporation of sea water which invades the area at high tide.

South of Benghazi, the sebakhs are numerous but almost all dry out during the summer months. These sebakhs provide valuable grazing grounds for camels when the grasses of the higher areas are no longer able to support animals. The sebakhs pasture support grasses which can withstand the high salt content, e.g. Alophytes, Nitraria and Limomoniastrum.⁽⁹⁾

1.2 - The Coastal Plain

The coastal plain is a wave-cut platform, which falls into two parts: (1) The Es-Sahel in the north and (2) Barga El Hamra in the south.

1.2.1. - Es-Sahel

This area extends from Tolmeita in the north-east to the Benghazi-Er-Rajma line in the south, a distance of about 115 km. From Tolmeita south-westward the plain widens gradually from about $\frac{1}{2}$ km. until it reaches its maximum width of 32 km. near Benghazi.

The surface of Es-Sahel rises gradually from almost the sea level to about 60-80 m. (a.s.l.) at the foot of the escarpment in the north-east, 100 m. in the middle and about 180 m. in the south. The gradient of the plain varies in proportion to its width (Fig.1.2). It is at its maximum at Ras Tolmeita but diminishes rapidly westwards to Sidi Abdalla (3 km. west of Tolmeita) where it is about 88 per thousand, and then it

decreases gradually till Tokra where it is 33 per thousand. From Tokra south-westward it decreases very rapidly; east of El Mabni (15 km. west of Tokra) it is 20 per thousand, at Sidi Khalifa 15 per thousand and finally at Benghazi 10 per thousand. Because of the steep gradient of the escarpment plus the small width of the plain in the area between Tokra and Tolmeita, the wadis cut their channels very deeply through the limestone formations of the escarpment and the alluvial mantle of the narrow plain, and can easily reach the sea and empty their load. In the rest of the plain, where the gradient is fairly gentle, the wadis, although deeply dissecting the escarpment, fail to reach the sea. They either die at the foothills of the escarpment, sink in the sebakh area or disappear under the littoral sand dunes. Throughout all this vast area of the Es-Sahel, there is only one wadi which is able to cross the plain and discharge into the sea, namely Wadi Es-Salaib near Bujarrar (8 km. west of Tokra). Even this wadi reaches the sea only after a period of heavy rainfall.

The plain between Tokra and Tolmeita is almost entirely masked by alluvium, originally carried by the numerous wadis and deposited on to the plain. The greater part is masked by a heavy reddish brown calcareous soil and in some other parts it is covered with a few lithosols together with rock outcrops.⁽¹⁰⁾ Gregory⁽¹¹⁾ describes the coastal plain near Tolmeita as consisting of dunes along the shore, of large delta-fans before the mouths of the wadis and of wide sheets of alluvium in the inter-

vening depressions. The area between Tokra and El Mabni is fairly flat, and the bedrock (Eocene) outcrops in some places. In other parts it is overlain by Pleistocene deposits. Its regularity is disrupted only by the Tokra step (Plate 1.3) which runs parallel to the coast from 8 km. to the north-east of Tokra to about 10 km. to the south-west of the village. The step has a height of 5 m. above sea level (2 m. above ground).

To the north-east of El Mabni lie large deposits of terra rossa, which have been carried by Wadi Zaza from the neighbourhood of El Abiyar. To the north of Bujarrar a similar area of deposition is formed by Wadi Belbarabedes. These alluvial fans often support very good agricultural land, as for instance the area to the south-west of Tokra at the mouth of Wadi Es-Salaib.

The landscape of the southern half of Es-Sahel contrasts with the drift covered plain further north, the underlying limestone outcrops giving rise to bare solid limestone pavements. In places, as for instance between Benghazi and El Kweifya, there is evidence of Karst erosion. Here the wadis die out before reaching the eastern fringe of the plain. Local patches of terra rossa soil have accumulated in the limestone depressions, permitting the growth of scrub or even crops and fruit trees. In addition the plain has only thin patches of the Pleistocene marine deposits. Continental Pleistocene deposits occur in certain places, notably the consolidated fossil dunes, which

between Bersis and Deriana form a gentle undulating surface running parallel with the coastal strip.

The regularity of this plain is also disrupted by the Benina step, which lies immediately west of Benina village (Plate 1.4). The step runs from north to south, and extends for a distance of about 10 km. Towards its extremities it loses height and merges into the surrounding area. The foot of the step maintains an altitude of about 90 m. (a.s.l.) while its crest lies at 100-120 m.⁽¹²⁾

The most striking feature of this area is undoubtedly the Karst topography. It is almost entirely confined to an area stretching between Sidi Khalifa in the north and the Benghazi-Benina highway in the south. Only a few sinkholes are present south of this area. The Karst topography in the Benghazi Plain is well developed, and the underwater channels and caverns have an important bearing on the water supply of the plain particularly around Benghazi. The percolation of a meteoric water, by means of fissures, leads here, as in all Karst zones in the world, to the enlargement of joints in the rock, forming crevasses of varying width. Near the Royal Military Academy (7 km. east of Benghazi) there exists a group of about 12 down-fall dolinas, of which the famous El Jokh El Kabir (Lete) is the most conspicuous. Inside the El Jokh is a cavern formed by a partial collapse of the roof by soluble action. The dolinas or sinkholes are generally almost circular or oval in shape, ranging in diameter from between 50 and 200 m. with a

depth of about 10-12 m.⁽¹³⁾ There are, in fact, two types of dolinas. The first includes those that develop slowly downwards, by solution beneath the soil mantle, and without any physical disruption of the underlying rocks. Eventually some of them develop into Karst lakes, as that of Budzira and Um Gdah near El Kweifya. The other type is that which is formed by the collapse of an underground cavern. This type is well represented by El Jokh, Bukarma and Bu Mansur in the north-east. The caves are probably reservoirs of rain-water and are filled during the winter. Most of these underground reservoirs, especially those in close proximity to the sea are brackish or salty. Benghazi City depends entirely for its water supply on the underground water that is collected (or tapped) by the Karst topography, especially in the Benina area.

1.2.2 - Barga El Hamra

Barga El Hamra forms an almost rectangular plain, ranging in width from between 32 km. in the north to 52 km. at its widest part near Slug, and about 41 km. in the south. It runs from north to south for a distance of about 125 km. The surface of the plain tilts very slightly towards the sea. It rises from about 2-4 m. (a.s.l.) near the coastal strip to about 140 m. at the foothills of the escarpment in the north, and about 60 m. in the south. The plain in this area has a gradient ranging from between 7 per thousand in the north to 3 per thousand near Jardina and 2 per thousand for the rest of the plain (Fig.1.2).

Wadi El Gattara in the north has a large alluvial fan covering the area between En-Nawaghia and Benghazi, in some places with a thick layer of fertile terra rossa which in its turn (around Benghazi) is interbedded with clays and gravels. This area with its fertile soil and easy access to underground water, is considered to be the most productive agricultural area in the whole of the Benghazi Plain. Unfortunately in some years the wadi's floods are very dangerous and many farm enterprises have been completely destroyed.

The only known topographic irregularity of the Barga El Hamra is, in the form of occasional rock-cut steps, a metre or so in height. Desio⁽¹⁴⁾ was able to trace about four of these minor steps in the area between Esh-Sheliedhima and Slug. Another seven of these features occur between Slug and Et-Teilmun (Plate 1.5).

Certain fossil dunes, south of El Magrun and extending southward for about 30 km. also show unusual features. These dunes are crossed by the coastal highway, from north to south, and the aeolian nature is clearly revealed by the appearance of their bedding as exposed in numerous road-cuttings. Their orientation is almost straight from east to west (their length and width are yet unknown). In addition to the above-mentioned topographical features, the southern part of Barga El Hamra is characterised by the large spread of the steppe crust (averaging 10-30 cm. in thickness). This feature is very clear to the traveller crossing the coastal highway between Gamines

and Ejdaabya. Here the surface of the ground is covered with a calcareous crust. It is thicker near the coast where the rainfall is greater, but towards the interior it diminishes in thickness as the rainfall decreases, until finally it disappears. It consists of concretionary calcareous siliceous rock often light brown to red, due to impregnations of iron oxides.⁽¹⁵⁾ The formation of this crust has a very important bearing on the water supplies in this area, by making the surface of the rocks almost impervious. Consequently run-off is greatly increased and more fresh-water runs down to either the porous limestone bedrock or seeps under the coastal dunes.

The north-eastern part of Barga El Hamra, where Wadi El Gattara, Wadi Engar and Wadi El Bab have covered the area with alluvium, is almost the only area where agriculture on a small scale is practised. Other small patches and wind-borne depressions covered with a thin layer of terra rossa are used for subsistence agricultural activities at Jardina, Slug and Gamines. The only wadi in Barga El Hamra able to reach the sea is Wadi El Gattara; the rest of the wadis terminate at the foot of the escarpment, where they usually form temporary playas or sebakhs after torrential rainfall, as for example Wadi El Bab near Esh-Sheleidhima, and many other small wadis between Es-Sheleidhima and Antelat (Fig.1).

1.3 - The First Escarpment of Jabal el Akhdar

The first escarpment or the western edge of the first terrace of Jabal El Akhdar, extends from Antelat in the south to Ras Et-Tin east of Derna, a distance of about 400 km. The

surface of the terrace behind the escarpment ranges in width from 5 to 30 km., and is an undulating plain surface. The plain forms a number of basins, of which El Marj plain is the largest and the most important in almost all Cyrenaica. The terrace is covered by a thin mantle of terra rossa (except El Marj and El Abiyar plains where the mantle is very thick) through which the underlying rocks outcrop in places. These rocks are mostly limestone, and a good number of swallow-holes, caves, dolinas and grottos have been formed in them by solution.

The crest of the escarpment is generally well defined, and shows great variations of altitude when one follows its course. South of Antelat, it first becomes perceptible in a series of low ranges (in this area subaerial erosion has been particularly intense). To the north, however, the escarpment soon becomes well defined and runs without serious interruption, as far as Ras Tolmeita. Its altitude at Antelat is about 100 m., at Esh-Shele~~id~~dhima it is about 120 m. and at Er-Rajma it reaches about 280 m. To the north of Er-Rajma the escarpment maintains its approximate north-south orientation until Rkah Dara where it curves gradually towards the north-east until one reaches the locality of Tokra at an altitude of about 270 m.-290 m. The escarpment reaches its highest altitude at Argub El Hariq (300 m.) south of Jedida. Then it decreases gradually to about 250-270 m. at Tolmeita, 50 m. at Bir El Agla and finally reaches sea-level at the mouth of Wadi Jarjarummah. Eastward it rises again gradually until it reaches its maximum

height (540 m.) near Ras El Hilal. From here it decreases gradually to about 250 m. at Derna, where it forms a steep cliff over the sea, and finally it almost reaches the sea-level again near Ras Et-Tin.⁽¹⁶⁾ The foot of the escarpment in the Benghazi Plain is quite a noticeable feature. However in some places it is masked by a thin soil mantle, formed by alluvial fans.

The continuity of the escarpment is almost undisturbed, except by the deep gorges of innumerable wadis. Due to the fault or the abrupt folding of almost the entire escarpment in this area, the gradient of the steep slopes, though seldom approaching the vertical are generally between 15° - 30° .

The rocks which compose the escarpment, for the most part are of Eocene and upper Cretaceous age, with Oligocene and Miocene beds confined to the highest parts of the escarpment (Fig.1.1).

1.4 - The Origin of the Coastal Plain and the Escarpment

Despite the abundant, geological and geographical studies on northern Cyrenaica (particularly Jabal El Akhdar), the main factor which has formed the terraces and the escarpments of Jabal El Akhdar, is still under debate and argument. The most common hypothesis concerning this matter is summarised in the following question:⁽¹⁷⁾ Is differential sub-erosion, marine erosion, or faulting the main factor in the formation of the terraces and the escarpments?

The recent (1956) and most important study of McBurney

and Hey on the "Prehistory and Pleistocene Geology in Cyrenaica," is to be considered the first-hand reference that has revealed, and to a certain extent clarified, the ambiguity of this problem.

According to Hey⁽¹⁸⁾ the Tokra and Benina steps are the most conspicuous evidence for marine erosion in the Benghazi Plain. Therefore, it would be more convenient first of all to discuss the origin of these two features.

The Tokra and Benina steps can only be explained either (a) as products of differential subaerial erosion, in which case the area between each step and the sea must be a structural surface, or (b) as products of marine erosion, in which case they must be wave-cut platforms. Differential erosion for the Tokra step is ruled out, by the fact that the bedding of the underlying bedrock has a steep seaward dip. The evidence that the step is a marine cliff is provided by the constancy of its levels, and by the presence of marine limestone exposed on the modern shore. There is no clear evidence of the marine Pleistocene deposits being associated with the Benina step. Nevertheless, the constant level at the bottom of the step indicates that it is also a marine cliff, a theory which was first introduced by Desio in 1939.⁽¹⁹⁾

The Tokra and Benina steps, therefore, provide the first real indication that the sea not only invaded this region, but also that its level remained stationary for considerable periods of time at various positions other than that which it occupies

at the present. If this theory is completely acceptable, it is reasonable to say that, in general, the whole plain of Benghazi is a wave-cut platform, produced by marine erosion.

Writers who attempt to explain the origin of the escarpment agree that it cannot be ascribed to differential erosion since it is cut in rocks of varying ages, dips and physical properties. Thus one has to look at the two alternative hypotheses. Either the feature is a fault scarp, or it is largely a product of marine erosion.

Spratt (1865)⁽²⁰⁾ is believed to be the first person who reported the existence of the fault along the first or the lower escarpment. He also concluded that the plateau of northern Cyrenaica was elevated or depressed between two lines of faults. For Cyrenaica as a whole this view is supported by Gregory (1911),⁽²¹⁾ who claimed to have located five faults associated with mountain ridges.

After the Italian occupation, when the first detailed topographic surveys of the northern Cyrenaica were undertaken, Marinelli (1920)⁽²²⁾ suggested that the two escarpments of Jabal El Akhdar, might be wave-cut cliffs, formed during pauses, in the uplift of the mountain. This theory was accepted by Ahlman (1928)⁽²³⁾ and Stefanini (1930),⁽²⁴⁾ and Marchetti (1934)⁽²⁵⁾ was able to confirm the existence of two of Gregory's faults. One was found to follow the lower escarpment from Er-Rajma in the south to El Bakur in the north-east, which eventually gave rise to a monocline traceable as far as

Tolmeita. The other followed the upper escarpment from El Marj to Sidi Mahyus in the south. As a result of Marchetti's confirmation, Desio (1939)⁽²⁶⁾ argued strongly that the escarpments could more probably be ascribed to faulting or abrupt folding. But even Desio admitted the possibility of marine erosion at relatively low levels.

Hey (1955)⁽²⁷⁾ confirmed that the lower escarpment is of marine erosion, carried out while the sea level stood at a series of successively lower altitudes from 200 m. downwards. The process is thought to have begun in the early Pleistocene times, and was not accompanied by considerable movement.

In so far as it coincides with ancient faults or a monocline, it can be, according to Davis's (1913)⁽²⁸⁾ classification ascribed as fault-line scarp, but the fault of the lower escarpment only succeeded in inhibiting the progress of marine erosion further inland.

All the writers mentioned were not able to trace a fault along the first escarpment further than Er-Rajma in the south. Conant and Gaudarzi⁽²⁹⁾ in their map of the "Geology of the Kingdom of Libya" 1964, trace the fault as far south as Slug (about 40 km. south of Er-Rajma). From Slug to Antelat the area is dotted by uncertain dashes of faulting (Fig.1.1).

Hey⁽³⁰⁾ finally reached the conclusion that both the plain and the escarpment are wave-cut features formed almost during a single period of high sea-level. Additionally, most of the plain must be older than the Tokra and Benina steps, which

as already described, represent the effects of subsequent marine erosion.

All in all, it is probably true that almost the entire Benghazi Plain and the first escarpment as seen in the landscape today were formed by erosion, and that the escarpment is associated with ancient faulting, which can be ascribed to a fault-line scarp, which acted in some way as a line resistant to marine erosion.

CHAPTER 2

THE CLIMATE OF BENGHAZI PLAIN AND THE ADJACENT AREAS

An accurate study of the climate of the Benghazi Plain is extremely difficult, not only because of the shortage of systematic data, but also because of the almost complete lack of information on climatic elements other than rainfall and temperature (except for Benghazi). Even data of these two climatic elements, in most cases, are either unreliable or are available for short periods only. Therefore, the climate of the Benghazi Plain, to a certain extent, has to be considered in the context of the general climate of Cyrenaica and adjacent areas.

In order to better understand the significance of the climate of the Benghazi Plain, it is necessary to analyse the relevant climatic elements and their effects on land use and human activities. Other less important climatic elements are either described briefly or omitted.

2.1 - Temperature

Benghazi Plain has a mean annual temperature of about 20°C. The 20°C. isotherm runs between Esh-Sheleikhima and Ejdaabya and

it divides the plain south of Slug into two parts. The plain at Benghazi lying between the isotherms $17^{\circ}\text{C}.$ and $19.5^{\circ}\text{C}.$ and the Es-Sahel lying between 19° and $20^{\circ}\text{C}.$ (see Fig.2.1). However, for better understanding of the thermal condition it is better to analyse the isotherms for January and July individually.

In January, the $9^{\circ}\text{C}.$ isotherm marks the zone of lowest temperature and coincides with the Jabal area. On the plain isotherms are 13° - $14^{\circ}\text{C}.$ in the north-east, and 10° - $13^{\circ}\text{C}.$ in the south. The isotherm $12^{\circ}\text{C}.$ south-east of Benghazi almost coincides with the eastern limit of the sub-arid littoral zone (see Figs. 2.2 and 2.15).

Winter temperatures decrease from the coast inland and from north to south. At Benghazi, the mean monthly minimum in January is $8.8^{\circ}\text{C}.$, at Tokra $10.1^{\circ}\text{C}.$, at Tolmeita $10.2^{\circ}\text{C}.$, at Slug (inland) $5.9^{\circ}\text{C}.$, and finally at Ejdaabya $6.6^{\circ}\text{C}.$ (see Table 2.1). Winter temperatures below freezing point are absent in the Benghazi Plain; the lowest mean monthly general temperatures ever recorded were $1.2^{\circ}\text{C}.$ (January, 1927) at Benghazi, $0.1^{\circ}\text{C}.$ (March, 1934) at Slug and $1.6^{\circ}\text{C}.$ (February, 1934) at Tokra.⁽¹⁾

In July maritime influence causes the isotherms to follow the general orientation of the coast; the isotherm $25^{\circ}\text{C}.$ almost follows the inland limit of the coastal strip. The isotherms between Er-Rajma and Esh-Sheleidhima diverge toward the east, and form an unusual trough between the 25° and $26^{\circ}\text{C}.$ isotherms (see Fig.2.3). Possible interpretations for this peculiarity

are the influence of altitude, which increases northward, and the influence of the desert, which increases southward.

In spite of the varied temperatures of the Benghazi Plain, the seasonal trends are almost the same everywhere, January is always the coldest month, after which the temperature begins to increase gradually in February and March. Subsequently, it rises regularly and sharply until it reaches its maximum in August after which it declines gradually and gently until October whence the decrease becomes sharp and rapid (see Fig. 2.4 and Table 2.2).

An additional fact worth mentioning, is that the summer temperatures in Benghazi (as well as for all the rest of the Plain) never reach the extremes experienced in Tripoli and the Jefara Plain.

However, the combination of high humidity and high temperatures in summer has a serious effect upon human and agricultural activities. The stopping of work, especially in fields, the closure of shops, the emptiness of the streets and roads, the crowds flocking to the beaches, the fainting of students during examinations and the feeling of frustration leading to bad temper among the people, are all common during this period. In addition, there is the profuse perspiration, reduction in appetite for food, and the increased desire for drinking more fresh or cold water, which occasionally causes the death of some people. The situation is aggravated if the hot Ghibli winds blow on the area. Regarding the plant life,

one can generally state, that the agriculture and vegetation in the Benghazi Plain are in no danger from frost, but must be able to withstand the high summer temperatures which range between 19° and 31°C .

2.2 - Atmospheric Pressure

Benghazi Plain (in fact all of northern Libya) is affected by the seasonal distribution of "low" and "high" pressures over the Mediterranean basin, the Sahara desert, the Atlantic Ocean and, to a certain extent, over Asia Minor.

In winter, the northern part of Libya falls under the influence of (a) the Azores high pressure area (1016-1019 mb), the Asiatic high and the tropical high over the Sahara desert, with its centre south of the Atlas mountains, and (b) the relatively small low pressure area (1013 mb.) over the Mediterranean Sea in the north on the other (see Fig.2.5A). Consequently, the prevailing winds over the area concerned come from the south particularly from the south-east. In addition, the cyclonic depressions which frequently invade the Mediterranean Sea from west to east cause atmospheric disturbances and instability. This results in precipitation over the coastal plain and the adjacent windward mountain slopes.

In summer, most of northern Libya is dominated by the Azores high pressure belt (1012-1016 mb.), which invades the Mediterranean Sea during this season. At this time a low pressure cell (1009-1012 mb.) extends over North Africa (see Fig.2.5B). Thus Benghazi Plain, as well as all northern

Cyrenaica falls under the influence of the northerlies (Etesian) from the Aegean Sea, which moderate the temperature of the coastal area.

2.3 - Cyclonic Depressions and Air Masses

The subsidiary cyclonic depressions, which invade northern Libya from west to east (see Fig.2.6), have a considerable effect on the climate of the area, particularly during winter and in the spring. In winter they flow continuously over the area, with a maximum frequency during February. The visit of a cyclonic depression to the Benghazi Plain is usually accompanied by high velocity winds blowing from the east and south-east. These winds sweep the area with tropical continental air masses (cThs). Since these air masses are from the desert they are generally dry, mild or cold and sometimes heavily laden with sand. If these air masses blow across the area during the early morning, they are associated with relatively cool conditions. The temperature increases gradually as the day proceeds. The tropical continental air masses are usually associated with high clouds (cumulo-stratus). When a warm front reaches Benghazi area, cumulo-nimbus clouds are rapidly formed quite frequently causing showers. The warm front is always followed by the warm-sector, which is characterised by its sunny spells and high clouds with occasional drizzle, and the wind direction changes from east-south-east to south-south-west. After the warm-sector passes a cold front steps in, which is usually accompanied by sudden change in wind direction

from southerly winds to north-north-westerly winds of very high velocity, about 60 km.p.h.⁽²⁾ These winds are also characterised by their abundance of moisture and coldness, due to the influence of the polar continental air masses (cPku) and the Arctic air masses, which come to the area from northern Europe or Russia, via eastern Europe (Balkans), or the polar maritime air masses (mPwu), which invade the area from the northern Atlantic, via Italy (see Fig.2.7). The cold front is characterised by thunderstorms, especially when it is associated with the maritime polar air masses. The weather conditions improve as soon as the cyclone moves away eastward or when it develops an occluded condition. Consequently, the winds change to north-westerly and a marked decrease in their velocity is noticeable.

Spring cyclonic depressions have a great effect on the climate of the Benghazi Plain. The atmospheric disturbances of the spring depressions are milder and smaller than those of winter. The spring winds are, to a certain extent, responsible for bringing the hot air masses from the desert, particularly when they blow in the front of the depressions which invade the coastal area from west to east. Spring depressions are often associated with the tropical continental air masses (cThs), which are sultry and hot, and with occasional strong winds (Ghibli). These winds continue their flow over southern Europe, where they are known, for instance in France as "Scirocco".⁽³⁾ The tropical maritime air masses (mTwu), which originate over

the Atlantic (see Fig.2.7) reach the area in the rear of the spring depressions, and usually coincide with the period that follows the invasion of the Ghibli winds. These air masses are cooler than the air prevailing over the Mediterranean Sea, because of the comparative coolness of the Atlantic Ocean as compared to that of the Mediterranean Sea. Consequently, these air masses reduce the temperature of the coastal area of all Libya, and though they usually do not bring rains, they are often accompanied by low clouds and occasional sand-storms.

In summer, the cyclonic depressions become very rare, and if they do flow over the area under consideration they usually occur at the beginning or at the end of the summer season. The north-easterly (Etesian) winds, which blow from the Aegean Sea bring continental modified (cP+A) air masses to the coastal areas after having crossed the Mediterranean Sea. Although these air masses do not produce rainfall (as expected after flowing over the sea), they often produce fair weather, which moderates the high temperature of the coastal areas.

2.4 - Winds

Systematic data for wind direction and velocity during the year for Libya is completely lacking, except for Benghazi and Tripoli. Therefore, the wind direction and speed of Benghazi will be taken as an example of conditions on the Benghazi Plain.

Table 2.3 shows the percentage of average monthly distribution of wind direction at Benghazi for a period of 57 years (1879-1936). In winter, the most frequent winds are those

which come from the north-west (21.6 per cent) and south-east (21 per cent). Few winds blow from the east (7 per cent). In summer, the winds in Benghazi are generally northerlies (84.2 per cent) and the most frequent winds over the whole year come from the north (41.3 per cent) (see Table 2.4 and Fig.2.8). In autumn and spring the winds blow from various directions owing to the unstable weather conditions associated with the transition between winter and summer. Table 2.4 shows also that about 95 per cent of the days of the year are windy. The most windy months are generally those of summer and the least windy months are those of autumn.⁽⁴⁾

The mean annual wind velocity on the coastal area of the Benghazi Plain is about 35 km.p.h. whereas on the plain it is about 28 km.p.h.⁽⁵⁾ Wind velocity is higher during winter when the speed of over 40 km.p.h. occurs for 20 per cent of the time. In the spring (March-April) wind velocity of over 40 km.p.h. occurs for 10 per cent, while in May it is only 3 per cent of the time. During summer high wind velocity is infrequent, but in autumn winds become stronger again.

Gales in winter are not infrequent, and when they blow on the Benghazi Plain they have a serious effect on agriculture.

The land and sea breezes are very well developed along the coast, especially when the wind is light. It is very perceptible during the hot summer nights when the people rush to the coast seeking the sea breezes.

Wind is one of the most important factors affecting crop

production in the Benghazi Plain. The moisture-laden winds from the sea undoubtedly contribute to the growth of vegetation along the coastal plain. However, in some parts adjacent to the sea, e.g. between Tokra and Tolmeita, the winds blowing from the sea are harmful to plants and limit the types of cultivated crops and trees that can be grown in this area, owing to the salt particles carried from the sea and dropped by the winds over the vegetation. Citrus and almond trees cannot grow in this area. Grapes and olives suffer if the wind blows during the blossoming time. But the most devastating wind that affects the vegetation and agriculture is that hot and extremely dry Ghibli (Ghibli = southerly) wind, which blows from the desert. The temperature of these winds often rises to more than 40°C . The Ghibli winds have a disastrous influence on the coastal plain, where they dry the soil and frequently parch the vegetation. If they blow during the period of plant growth the yield may be completely lost. A hot Ghibli during the milk-stage of a cereal often makes the difference between good or bad yield or none at all. A Ghibli during the blossoming period of the trees may also drastically reduce the crop. On the other hand, during autumn, the Ghibli winds accelerate the ripening of the dates; if it fails to blow in autumn, the date crop may not mature and probably both the quantity and the quality of the crop are considerably reduced. The Ghibli winds, which blow on an average for about three weeks a year (between February and June), also carry

dust and fine sand resulting in a lot of eye trouble (Trachoma). The bad Ghibli of December, 1959, which swept Benghazi, pushed layers of fine brown dust in through every window and shutter.

2.5 - Precipitation

Rainfall in the Benghazi Plain, as well as through all Libya, is erratic, scanty and varies from year to year in quantity, frequency and distribution. About half of the winter rainfall is due to cyclonic depressions originating over the south Adriatic and south Aegean Seas. Almost all the rest of the rainfall is associated with cyclonic depressions which invade the Mediterranean basin from west to east.⁽⁶⁾ Broadly speaking, the rainfall in the Benghazi Plain is most abundant near the coast and it diminishes inland from the coast as well as from north to south (see Figs. 2.9A and 2.9B). However, the highland of Jabal El Akhdar is an exception to the general rule. Here the increase in rainfall is explained by altitude (see Fig. 2.9C). For example, Benghazi has a mean annual rainfall of about 265.8 mm. with an average frequency of 56.9 days. Benina (in the Plain) has 226.4 mm. with 39.9 days. Er-Rajma, on the first escarpment, has 309.7 mm. with 50.5 days, El Abiyar 307.1 mm. with 61.8 days, El Marj 484.9 mm. with 74.1 days and finally Shahat on the second terrace has 595.5 mm. with 81.1 days (Table 2.5). The positive relationship between the rainfall and altitude is well demonstrated by the profiles in Fig. 2.10.

The mean annual rainfall decreases at Slug south-east of

Benghazi to about 185.5 mm. with an average frequency of about 54 days. Further south, at Ejdaya, it reaches about 129 mm. with a frequency of 20 days (see Fig.2.9B). Even on the coastal area the rainfall decreases from north to south. For instance, at Ez-Zweitina in the south the mean annual rainfall is 111.2 mm. with a frequency of 30.6 days, at Benghazi 265.8 mm. with 56.9 days, at Tokra 311 mm. with 64.8 days and finally at Tolmeita in the north-east 351 mm. with 63.4 days (see Fig. 2.9A and Table 2.5). This phenomenon is also applied on the first escarpment, where the mean annual rainfall at Esh-Sheleldhima in the south is about 106.3 mm. with average frequency of 25 days, at Er-Rajma 309.7 mm. with 50.5 days and at El Bakur in the north-east 340.2 mm. with 52 days (see Fig.2.9C and Table 2.5). The mean annual rainfall distribution of Benghazi Plain ranges between 100 and 360 mm. with an average frequency of 45.7 days. The isohyets in most parts show an even spacing in respect to altitude and remoteness from the sea, except in some areas where they are affected by the local relief, such as the area around Benghazi, between Deriana and Sidi Khalifa, around Benina and between Er-Rajma and Esh-Sheleldhima (see Fig.2.11). The rainfall decreases inland as well as from north to south. Finally, the divergence of isohyets between Er-Rajma and Esh-Sheleldhima can only be explained by the rapid increase of altitude to the north and the rapid increase of desert influence to the south.

In most years the highest rainfall is usually experienced

in January, but it fluctuates between December and February. For instance, at Benghazi the highest rainfall usually occurs in January. In 1966 the peak (196.0 mm.) was in December, and in 1961 the peak (99.5 mm.) was in February (see Table 2.6 and Fig.2.12). From year to year there may be a marked contrast in the amount of rainfall. For instance, at Benghazi the mean annual rainfall is 265.8 mm., but 616.7 mm. fell in 1894, while in 1958 only 67.7 mm (see Table 2.6). At Tokra, where the mean annual figure is 311 mm., as much as 494.6 m. of rain fell in 1938, while in 1933 only 165.1 mm. fell. On the Jabal at Shahat, with a mean annual figure of 595.5 mm. of rain, in 1924 it was 1348.8 mm., while in 1915 only 120 mm. fell (see Table 2.7). There may be also a marked contrast in rainfall for the same month. For example, in March 1926 the rainfall at Benghazi exceeded 89.5 mm., whereas this month was absolutely dry in 1894 (see Table 2.8) despite the fact that the latter year marked the highest rainfall (616.7 mm.) ever recorded in Benghazi.* Since March is the heart of the growing season, any excess or meagreness of rainfall affects the agricultural production, particularly with regard to wheat and barley, which are almost entirely cultivated by the shifting farming system on the Benghazi Plain.

The unreliability of rainfall is expected even in December or January, which are considered to be the core of the rainy season. For example, the rainfall of December, 1894 at Benghazi

* The first regular recording started during the Turkish Administration, 1881.

was 249.8 mm. while the same month in 1927 was only 8.5 mm. In January 1893, 257.5 mm. were recorded whereas in the same month of 1955 only 10.1 mm. (see Table 2.8).

The rainy season usually starts in October and continues until March. The amount of rainfall increases rapidly between October and November and December. After February it decreases gradually as indicated by the small differences in rainfall during the spring months (see Fig.2.9A). The rapid increase of rainfall in winter is due to the mass invasion of the moisture laden westerly winds and the cyclonic depressions. The gradual decrease of spring rainfall is due to the appearance of the spring depressions from the Sahara desert, which are characterised by their paucity of moisture on the one hand, and the gradual increase of temperature associated with the advancing hot and dry summer months on the other.

Because of the variability of rainfall, the Benghazi Plain or, for that matter, any other part of Libya in some years, suffers from drought. This especially applies to areas of shifting agriculture such as Barga El Hamra. Winter drought probably occurs once every 5-6 years. Moreover, it is not unexpected that two or more successive droughts may occur approximately **once every ten years.**⁽⁷⁾ Of course, when such circumstances occur, famine and starvation results as in 1946-7. Drought has always presented a serious handicap to economic and social development, particularly before the discovery of petroleum. On the other hand, two or more years of excessive

rainfall may occur, and when this happens, the yield of agricultural products can be expected to rise to two to three times the average yield. Wet conditions also produce abundant grazing lands. If the rain falls in the early autumn and then it stops for a long period (this happens quite often), the crop may be completely damaged. However, the erratic nature of the rainfall quite frequently allows the growing of cereals in areas where the average rainfall would be insufficient to support even a very light crop.

2.6 - Relative Humidity

The coastal area is always characterised by high humidity, especially in summer (July and August), due to the influence of the north-easterly (Etesian) winds and also to the high rate of evaporation from the surface of the sea and the seabkh. The humidity in the coastal areas is very susceptible to the influence of the Ghibli winds. When these winds blow from the desert onto the coast, the relative humidity falls to less than 10 per cent, then it rises very rapidly to more than 80 per cent as soon as the northerly winds from the sea replace the Ghibli winds.⁽⁸⁾ The humidity of the interior of the plain is higher in the winter season.

The coastal area has a higher mean annual percentage of relative humidity than that of the plain or the Jabal (Table 2.9). Tokra shows a higher mean annual relative humidity (65 per cent) than that of Tolmeita (63 per cent) and Benghazi (59 per cent), because Tokra is exposed to the sea winds from the

north-east and south-west, while Tolmeita is almost deprived of these winds, due to the relief barrier. It is usually imagined that Benghazi has higher relative humidity than Tokra, since it is almost surrounded by the sea and the marshland, but the open plain in the south shows the influences of the desert, which reduces the humidity considerably. Benghazi has its maximum in July (67 per cent) and nearly equal minimum in April and September (55 per cent). The first minimum occurs at the close of the rainy season, and is succeeded by an increase with the setting in of the prevailing sea winds of summer. There is some increase in relative humidity with the rise of temperature from June, July and August, followed by a further decrease with the cessation of the sea winds in autumn (see Fig.2.13).

At Slug, on the plain, the mean maximum is in January (76 per cent), the minimum is in August (40 per cent) and at Ejdabya the maximum occurs in January (67 per cent) and the minimum in July (33 per cent). On the Jabal, the mean maximum is in December or January - at El Abiyar it is 72 per cent, at El Marj 74 per cent and at Shahat 75 per cent - and the minimum is in June - at El Abiyar 40 per cent, El Marj 44 per cent and Shahat 48 per cent (see Table 2.9 and Fig.2.13). The effects of humidity on plant life and human activities has already been mentioned under the heading of temperature.

2.7 - Dew

The precipitation of dew is favoured by clear air, which increases the radiation, by high humidity of the atmosphere and

by the absence of wind. These conditions are frequently fulfilled in many closed basins or depressions particularly in the inland areas of the coastal dunes. Dew forms in the early hours of the morning, as a consequence of relatively low temperature during the night, mostly in spring when the highest diurnal ranges are experienced. An abundant precipitation of dew might make the sand quite moist, helping the growth of vegetation especially during the absence of rainfall. It is believed that dew is very important in animal husbandry; the only disadvantage occurs when animals, particularly sheep and goats, eat the moist grass during the non-drinking period (spring), because it usually affects their stomachs and eventually causes death. Consequently the animals are usually kept off the moist grass until it dries.

2.8 - Clouds

Complete overcast days are rare in the Benghazi Plain. As a rule clouds appear in the morning and they seldom last until the afternoon. Winter clouds are often very dense. The mean annual percentage of overcast days in Benghazi is about 2.5 per cent. The mean monthly average in winter is 4 per cent, but in summer only 0.96 per cent (see Tables 2.10 and 2.11). Data concerning evapotranspiration are rare and incomplete, in order to make a comparative study with clouds, but generally, it is estimated at about 35 per cent of total rainfall.⁽⁹⁾

2.9 - Climatic Regions

According to Torayah-Sharaf's⁽¹⁰⁾ modified formula⁽¹¹⁾ of

the classification of the climatic regions (as determined by De Martonne), Benghazi Plain consists of two distinct types: the semi-arid and steppe region and sub-humid region.

2.9.1. - The semi-arid steppe region: This region comprises about 75 per cent of the plain, including roughly the area between Deriana in the north-east and Antelat-Ez-Zweitina in the south. The aridity index 10, which runs between Deriana and about 10 km. south-west of Er-Rajma forms the limit between this region and the sub-humid region in the north-east (see Fig.2.14). The mean annual temperature of the semi-arid region is 19° - $21^{\circ}\text{C}.$, with a winter mean of $8.2^{\circ}\text{C}.$ and summer mean of $31.8^{\circ}\text{C}.$, and rainfall is less than 270 mm. per annum. This climatic region includes almost all the area of shifting agriculture and grazing lands.

2.9.2. - The sub-humid region: This climatic region includes the plain area between Deriana and Tolmeita, as well as all Jabal El Akhdar north of the latitude $32^{\circ}15'$ (except the Shahat-El Gubba area, which experiences a Mediterranean form of climate, due to its altitude). The mean annual temperature of this region in the Benghazi Plain is 18° - $20^{\circ}\text{C}.$ with a winter mean temperature of $10.8^{\circ}\text{C}.$ and a summer mean figure of $28.5^{\circ}\text{C}.$ The mean annual rainfall is between 270 and 360 mm. The aridity index curve of 10 coincides with the line which separates the Mediterranean shrubland (Macchia) in the north from the steppe, with perennial shrubland in the south. However, this climatic division is rather general and does not provide clear climatic

sub-regions which could be of considerable importance for agriculture and human activities.

Fantoli⁽¹²⁾ in 1952 in his study of the "Rainfall of Libya" divided Libya into climatic zones and sub-zones in respect to the morphological regions. According to his classification of Cyrenaica, Benghazi Plain falls into the following categories:-

- (i) The maritime zone embraces the area adjacent to the sea (not exceeding 5 km. inland (Fig.2.15)), extending from Ez-Zweitina in the south to Ras Tolmeita in the north-east. This area is greatly affected by the presence of the sea influencing the temperature, precipitation and humidity (as already explained under the headings of temperature, rainfall and humidity).
- (ii) The littoral steppe zone comprises the area between Tokra and the southern limit of the Benghazi Plain (excluding the maritime zone) and it is divided into two sub-zones:- (a) the arid-littoral sub-zone extends between Wadi El Gattara and the Antelat-Ez-Zweitina line, and (b) the semi-arid littoral sub-zone includes the coastal plain between Wadi El Gattara and Tokra, where the escarpment is included within the maritime zone (see Fig.2.15).
- (iii) The sub-zone of the highland or mountain climate consists of the first escarpment and its terrace between Er-Rajma and Ras Tolmeita.
- (iv) The continental steppe zone comprises the area of the first

escarpment and the adjacent area of its terrace, which extends between Er-Rajma and Antelat in the south.

However, the last two categories are not important to the area under consideration, except for some grazing and shifting cultivation of wheat and barley.

These two classifications help in the understanding of the transitional differences in climate across the Benghazi Plain.

CHAPTER 3

SURFACE DRAINAGE AND UNDERGROUND WATER

Water is the most critical factor in agriculture and human life in Libya and especially in the Benghazi Plain. Thus, the water supply has always been the centre of most human and economic problems of the Benghazi Plain in general, and the city of Benghazi in particular.

There are few perennial streams in Cyrenaica. However, in the lower parts of Wadis Derna, L'Athrun and El Glaa (near Ras El Hilal) there are perennial streams which are fed by springs. But during the dry seasons surface water percolates into the gravels and sands of the wadi beds before reaching the sea. The Benghazi Plain is devoid even of these spring fed streams. The absence of perennial streams in the area concerned is due to the erratic and scanty rainfall, to the relief and to the geological formation of the underlying rocks. These rocks almost entirely consist of Miocene limestone (see Fig.1.1), with some thin interbedded clays and marls. The limestone formations contain numerous joints, dolinas, cracks and fissures which allow the rain that falls on the surface of the plain or that carried by the wadis which rise on the

Jabal and discharge on the coastal plain, to disappear rapidly into caverns and channels, formed by solution underground, especially in the Karst region north of the Benghazi-Benina highway.

Unfortunately, rain-water is the only source of ground-water recharge required to keep the Karst lakes full and the wells and galleries supplied. Consequently, water is available only from tapping underground water resources (wells) or from artificial surface catchment.

3.1 - Surface Water

Surface water in the Benghazi Plain only appears in the wadis intermittently in winter. However, there is also the water of the cisterns, Karst lakes and marshes (sebakh) near the coast.

3.1.1 - Wadis

There are a large number of wadis in the Benghazi Plain, especially between Tokra and Ras Tolmeita. Almost all are completely dry at all times except for a few days during the winter months when violent flooding takes place. The wadis are more deeply entrenched near the first escarpment. Because of the hardness of the bed rock mostly are narrow steep sided gorges, like Wadi El Asra to the east of Tokra. Between Tokra and Tolmeita, some of the wadi gorges continue beyond the foot of the first escarpment, e.g. Wadi Um Sidra, Tbergaya, Belghelat and El Asra.

Most of the water which falls on the calcareous Jabal

area concentrates in the wadi channels. Thus, the water is multiplied in quantity, due to the very large surface of the impluvium as compared with the area of wadi beds. This explains the occurrence of occasional dangerous floods which bring damage to both land and people. A great number of trees exist in the wadi beds, which decrease in size from north to south. Furthermore, some of the water of the wadis irrigates considerable areas on the coastal plain and at the foot of the first escarpment. When this happens grain crops are sown and the seed interred by light ploughing. The typical wooden plough drawn by camel, donkey, cow or horse is used in such circumstances. Consequently, if small dams and canals were built, several important wadis, such as Wadi Zaza, Belbarabedes and Es-Salaib, could be improved and utilised for agricultural purposes. These projects could be of great benefit to the area concerned and would encourage the nomads and semi-nomads to become settled people engaged in settled agricultural activities.

According to Desio's⁽¹⁾ classification of Cyrenaican wadis, those of the Benghazi Plain fall into the following categories:

(i) Wadis which rise and disappear in the coastal plain: Wadi Bu Mariam, 3 km. south of Benina, Wadi Musa, about 5 km. south-east of Benghazi, and Wadi El Fkhakh, about 6 km. north of Benina (see Fig.1).

(ii) Wadis which begin and terminate along the first escarpment. These wadis are numerous, particularly between Er-Rajma and

Tokra. Since these wadis are not important most of them have no names; Wadi El Bakur, near Tokra and Wadi Bu Sheleiba, in the east of Bujarrar are the best known ones.

(iii) Wadis which rise on the surface of the first terrace and terminate at the foot of the first escarpment or on the higher parts of the coastal plain (from south to north): Wadis El Bab, Enghar, El Fea, Zaza, El Gasair, Belbarabedes, Um El Amaim and finally Tbirgaya south of Jedida.

(iv) Wadis which begin on the surface of the first or second terrace and reach the sea: Wadis El Gattara, Es-Salaib, El Asra, Belghelat, Esh-Shaaba, Zayana, Belkof and finally Wadi El Asr near Ras Tolmeita.

Wadi El Gattara^{*} is the most important of all wadis of the Benghazi Plain, in respect of the quantity of water, length, size of impluvium and irrigated agricultural area. Its catchment area comprises an area of about 1,660 sq.km.⁽²⁾ of semi-arid land ranging from sea-level to about 400 m. on the Jabal El Akhdar, and it has a length of about 88 km. The wadi runs from the watershed south of Jardes El Abid on the higher Jabal and dissects the second escarpment by many tributaries. Then it runs through the first terrace south-east, south and south-west of El Abiyar. Where the main water emerges from the first escarpment it forms a steep gorge which rapidly tapers out to the sea-level and enters the Mediterranean sea to the south-west of Benghazi harbour (Fig.1). The torrents of Wadi El Gattara

^{*}Wadi El Gattara is known at its lower part (near Benghazi) as Wadi El Haw-Wari.

have formed alluvial deposits spreading out over the plain including the El-Rahaba, El Gwarsha and El Fweihat areas. These deposits are 15-20 m. thick and consist of gravels and finer material (Terra Rossa). They contain a water table, which is the highest on the Benghazi Plain.⁽³⁾

In times of flood the urban areas on the lower coastal plain around Benghazi are flooded and large amounts of sediments cover the area, causing considerable damage to roads and buildings and causing a number of fatal injuries to the local inhabitants. It costs thousands of pounds to repair damage caused by each flood. Floods have also swept entire crops from farm lands and removed all of the loose soil. Many farms have been completely destroyed through excessive flood waters in many different areas. In 1954, for instance, the city of Benghazi particularly El Berka and El Keesh, experienced excessive flood damage from the water basins of Wadi Farun and Wadi El Haw-Wari (Plate 3.1). Again in February 1961, a flood occurred that was beyond the memory of most, if not all, of the people of Benghazi, resulting in the death of 4 people and making about 1,000 persons homeless. In view of the danger of floods in the wadi and because this area, with water, is capable of supporting very good crops, there is every reason to support the development of comprehensive irrigation and flood control schemes. A series of dams could be built along many of the tributaries. The construction of such dams would be beneficial, not only for water conservation on the

surface, but also for underground water supplies, as the amount of water lost through flooding and rapid runoff would be considerably reduced.

The main watershed of the Benghazi Plain, in the north-east, lies on the first terrace and separates the Mediterranean drainage in the north from the enclosed drainage of El Marj Plain in the south. The watershed begins at Sidi Ismail (south-east of Tolmeita) in the north-east and runs parallel to the coast of Sidi Brahim Bu Ras (east of Wadi Zaza) in the south-west. The watershed for the rest of the plain, partly lies on the second terrace and partly on the higher Jabal and separates the Mediterranean drainage from the inland drainage. This watershed extends between Jardes El Abid in the north-east and Sawinnu (east of Antelat) in the south.

3.1.2 - Karst Lakes

Karst lakes are generally formed by subsidence. Some are filled with saline water, particularly those near the coast like Ain Zaiyana and Budzira, which contain small fish (eels). Others are filled with brackish water and lie inland, such as El Jokh El Kabir (Lete), Bu Karma and Hawa Hamad.

The lake or lagoon or Ain Zaiyana, which lies north of El Kweifya, is connected with the sea and is fed by five springs of slightly brackish water which issues forth from the south and the south-east of the lake shores. Buoncampagni⁽⁴⁾ in 1935 measured the water discharged to the sea, and found

it to be at a rate of about 21,200 tons (228,302 litres) per hour, but, of course this includes the discharge of the springs and the water that had accumulated in the lake during the high tide. Nevertheless, this big discharge indicates that Ain Zaiyana lies on a fault.⁽⁵⁾

El Jokh El Kabir (Lete) contains relatively brackish water, with a fair proportion of salinity ranging between 1,500-1,600 p.p.m. and has a capacity of discharge of about 136,000 litres per hour, without causing any serious decrease in the water table or the salinity rate. The water flow of El Jokh is not confirmed yet, as to whether it is a stagnant cavern lake or an underground river. This is because there is no sign of surface movement, which usually indicates the direction and origin of the water. Many attempts to discover the extent of the underground caverns have failed. It was even reported that during the Second World War, two British soldiers were lost with their boat while they were trying to discover its extent.

The daily and seasonal behaviour of almost all the water levels in the Karst lakes are the same throughout the Karst area. Testing of some of these lakes for irrigation and domestic purposes was undertaken by the Italians who showed that the water levels follow regular daily changes.⁽⁶⁾ This general phenomenon would suggest that most of these lakes must be connected together by underground channels (probably faults or cracks). It has been also noticed that the changes in water

levels of Budzira and Un Ghdag (in the north of El Kweifya) occur at the same time and almost entirely at an equal rate. This suggests that, probably both lakes discharge into the same lake of Ain Zaiyana which lies to the north-east of them. A withdrawal test was taken at Um Ghdag, and after discharging $18,000 \text{ m}^3$ in 36 hours it was found that there was no change in the water level, and yet the same normal daily fluctuation in water level took place as usual. This proves that the discharged water was less than that which was recharged. This situation was repeated at El Jokh El Kabir, suggesting that most, if not all, the Karst lakes derive their water from rich underground reservoirs in this locality. The origin of the water of the Karst lakes is still debatable, but it seems fairly certain that they receive their water by the infiltration of rain-water through the limestone formation, as well as from runoff from lateral seeping from Jabal El Akhdar underground reservoirs.

3.1.3 - Sebakh

The marshes (sebakh) extend intermittently along the coast, from the southern boundary of the plain (and further south) to Tokra in the north-east. They also occur inland around Slug and in the area between Esh-Sheledhima and Antelat (Fig.1.1).

The sebakh tend to drain underground water supplies through capillary action. If an effective water conservation policy is to be put into operation the loss of such water must be

stopped, either by spraying the surface of the water with a special chemical compound or if necessary by filling in the depressions and reclaiming the marshland such as that happening in Es-Selmani marsh near Benghazi.

3.2 - Underground Water

Since water is essential for Benghazi City, extensive hydraulic studies have been carried out all over the Benghazi Plain, particularly in the area around Benghazi, in the hope of obtaining better sources for the Municipal water supply. Soundings taken by Cotterel (1949),⁽⁷⁾ in the coastal area of Benghazi, revealed the presence near the surface of large layers of underground water, and even underground streams running through the limestone formation. Studies have also shown that the Miocene limestone which underlies the Benghazi Plain probably contains continuous ground reservoirs throughout the plain, but the quantity and the quality of this water varies from place to place according to the permeability of the limestone, depth, underground caverns and the amount of the recharge from rain-water.

The underground reservoirs of the Benghazi Plain are sustained and replenished from rainfall, either by direct infiltration, lateral recharge from Jabal El Akhdar or by infiltration from wadi streams while in flood during winter. For example the runoff of wadi El Gattara (no data are available) seeps in the alluvial deposits and penetrates through faults or underground channels to El Fweihat and Benina areas.

The evaporation rate in Barga El Hamra is estimated to be more than 2 m. per year. Therefore, on average only 3 per cent of the rain (100-260 mm.) reaches the water table.⁽⁸⁾ Consequently, the underground water in this area is meagre, and a small skim of fresh water is found floating on more highly mineralised water. In the northern part of the Benghazi Plain (between El Kweifya and Tolmeita) the amount of rainfall (260-360 mm.) is higher and the evaporation rate is expected to be less than the rest of the plain, owing to the higher latitude, but it was proved by the boring-tests that the underground water is not sufficient for more intensive agricultural activities because of the high content of dissolved materials and the underlying rocks (solid Miocene). However, sufficient fresh water supply for agricultural and human usage, will be pumped to this area from the El Marj water reservoirs, in the second stage (probably in 1975) of the Dabbusia-El Marj water supply scheme.

Benghazi area has the highest water table and the richest in both quantity and good quality of water in the Benghazi Plain. This area is probably the most promising site for utilisation of underground water for agriculture, animals and domestic purposes. But, unfortunately, it is mostly reserved for the Benghazi Municipal water supply. Until other alternatives for water supply are utilised (such as distillation of sea-water) this will remain the case.

Boring tests to a depth of 100 m. at El Fweihat, El

Kweifya and El Haw-Wari, 124 m. at Benina, and 350 m. at Sultan in the south of the plain have shown that there is no artesian water at this depth. The water tapped still comes from the surface layer,⁽⁹⁾ while in the Jefara Plain in Tripolitania (with a similar geology and topography), artesian water is found at depth of less than 200 m. Thus wells and collecting galleries in the Benghazi Plain are the only means of underground water supply, particularly for public consumption.

3.2.1. - Depths of Water from Land Surface

The depth of the water from the land surface of the Benghazi Plain ranges from a metre or more near the coast to about 150 m. near the escarpment. The greatest depth observed for fresh water in the area under consideration was 172.1 m. at El Gwarsha.⁽¹⁰⁾ The 20 m. aquifer which extends between Tokra in the north-east and Shat El Bedin in the south, includes almost all the area of the coastal dune wells (see Fig.3.1).

Water levels are generally near or below sea-level at the coast, but gradually increase in altitude until they reach about 5 m. (a.s.l.) or more near the escarpment which marks the inland edge of the coastal plain (Fig.3.2).

The daily and seasonal fluctuations in water-levels in the wells is due to the quantity of water pumped out on the one hand and the rain-water recharge on the other, the latter depending on rainfall. Observations⁽¹¹⁾ of the water level

behaviour in the Benghazi area show the daily fluctuation in the water level of wells to be only 0.6 m. from which up to 2,000 tons per day can be pumped. A marked decrease in water level appears in August, then it rises to its maximum in April (see Fig.3.3).

3.2.2. - Chemical Quality

Generally, in the Benghazi Plain, concentration of dissolved minerals in water increases with depth. Investigation⁽¹²⁾ on fresh water pointed out that there is an increase in salinity in proportion to the depth of the wells, particularly at El Kweifya, Bersis and Tokra. Moreover, Marchetti in 1938⁽¹³⁾ constructed a diagram for two wells (wells Nos. 6 and 7) at El Fweihat showing the changes in the degree of salinity corresponding to changes in depth (Fig.3.4).

The salinity of underground water is probably not due only to the encroachment of sea-water (particularly inland), but because the Miocene rocks were deposited in salt water and have, undoubtedly, been filled with salt water from time to time (by transgression of the sea water) since their deposition.⁽¹⁴⁾ Therefore, all the groundwater in the Benghazi Plain at depths more than 10 m. below the water table, is moderate to highly mineralised, containing in most places from less than 1,000 to more than 6,000 p.p.m. of total dissolved solids (see Table 3.1).

Figure 3.5 depicts only a small area, lying between Benina and El Fweihat, of good quality water supply. The rest

of the plain has mostly (except some sand dune areas) poor or salty waters. Another small stretch of brackish water extends from the north-west of Gamines via Slug to the south-east of Esh-Sheleidhima. The water qualities shown in Fig. 3.5 are based on the empirical classification of water,⁽¹⁵⁾ with respect to tolerance by man, animal, plant and effects on soil structure (see Table 3.2). Water contains between 400-600 p.p.m. of chloride though it has a somewhat salty taste to the average man (good water for drinking is less than 250 p.p.m.). It is possible, however, for any person to become accustomed to such water after 1-2 months, but the effect of highly mineralised water on children, in particular, can be serious or fatal. Animals are more tolerant to highly mineralised water than is man, but, 13,000 p.p.m. total dissolved solids seems to be the maximum even for animals accustomed to such water. Camels are exceptional because they can tolerate such conditions. Water containing less than 3,500 p.p.m. chloride can possibly be used for irrigation. Soil conditions and types of crops must be considered in individual cases where the water that is highly mineralised or of a particular chemical character is to be used. For example, tomatoes, water-melons, maize, alfalfa, millet, etc. thrive when they are irrigated with brackish water, with up to 6,000 p.p.m. of dissolved solids, particularly in the coastal areas. However, the yield of any crop will be better if water of good quality is used for irrigation.

3.3 - Water Supplies

3.3.1 - Coastal Dune-Wells and Collecting Galleries

The coastal dune-wells are widely spread over the coastal area of the Benghazi Plain, as well as along the whole coast of Libya and Egypt. Since time immemorial, these wells were the main and only source of water supply for agriculture and human consumption in all urban and rural centres in the coastal areas of the Benghazi Plain, such as Ez-Zweitina, El Magrun, Gamines, El Gwarsha, Sidi Khalifa, Deriana, Tokra and Tolmeita. In fact, the presence of this type of water supply was one of the desired factors accounting for the persistence of these villages.

The coastal dune-wells and galleries derive their water from the aquifer tapped from the runoff on the Jabal and the coastal plain. These coastal dunes consist of small rounded Oolitic sand grains, cemented together in the bottom of the dunes by slightly acidic-water dissolving some of the calcium carbonate and re-depositing it in the interstices between the grains on evaporation. This produces the porous easily excavated limestone layers, in which wells along the whole coast are dug and galleries are constructed as at El Monastir, El Magrun, Slug and El Gwarsha (see Fig.3.6). Both the Oolitic sand and the limestone have an average porosity of about 30 per cent,⁽¹⁶⁾ in which water can be held as in a sponge. Where fresh underground water is available (near the coast),* it rests on a zone of diffusion. It depresses the surface of

*When the fresh water is absent, usually the sea water takes its place.

the sea-water until hydrostatic equilibrium is reached. The top of the fresh water is above, and the bottom is below sea-level, with an intermediate zone of brackish water.⁽¹⁷⁾ A small layer of fresh water is also found some distance inland, and is usually utilised by the small farms near the coast. The thickness of this fresh water layer, is less than half a metre, so any excess withdrawal of water from these wells causes the encroachment of salty water. The depth of these coastal wells varies between 2-5 m., and the yield ranges between 4,500-90,000 litres per day.⁽¹⁸⁾

The system of collecting galleries is found in several places in the coastal areas, such as El Monastir (5 km. north-east of Benghazi), El Gwarsha, El Fweiha, Slug and El Magrun.

El Monastir galleries are the most important ones. Two shallow (4 m. deep) galleries were dug in the sand dune area along the coast just to the north of El Thama village, the northerly gallery 90 m. long and the southerly 120 m. long. The total yield of the two galleries is about 340 m³ per day of water containing an average of 1,100 p.p.m. chloride.⁽¹⁹⁾ It has been noticed that, when pumping of fresh water reaches 300 m³ per day, the water becomes brackish. However, the El Monastir waterworks, which was founded by the Turks in the late nineteenth century, was abandoned after the discovery of the very rich and good water supply of Benina (1949).

3.3.2 - The Miocene Limestone-Wells

The Greeks, Romans, Arabs and Turks have constructed a

large number of wells through the Miocene formation in the Benghazi Plain, with a maximum depth of 80-90 m. However, the water layer is seldom more than 2 m. deep. Because of the Italian interest in developing water resources, many deeper wells (between 80-200 m. deep) were dug throughout the coastal plain in order to obtain better fresh-water supply mainly for Municipal water supply in Benghazi, Tokra and Ejdabya.

Benghazi City water comes from several wells at El Fweihat and Benina (prior to World War Two, it was from El Monastir and El Fweihat only). El Fweihat water supply consists of a series of shallow galleries and wells, in addition to the recent 9 deeper wells 40-100 m. deep. The yield of this waterworks in 1959 was at a rate of 4,200 m³ per day of water with 549 p.p.m. chloride content. The second source is at Benina (20 km. east of Benghazi) where about 30 wells were drilled along the 100 m. contour line (here Cotterel believes that an underground fault exists) ranging in depth from 80 to 125 m. The yield is between 91,000 and 182,000 litres per hour. The total yield of Benina area was estimated at about 17 million litres (5 million gallons) per day in 1967 (Benghazi daily consumption was about 5 million gallons).

According to the hydrological investigations in the Benghazi Plain, sufficient water for public consumption and irrigation could be obtained from wells, if water is taken from more than one source in places outside Benina-El Fweihat

area (this area is strictly reserved for drinking water for Benghazi City). Moderate additional or new withdrawal can be made by increased rate of pumping from existing wells or by constructing new wells outside Benghazi area, particularly in the area between El Kweifya and Jedida (see Fig.3.7). However, the extension of present areas of development (between Jardina and Benghazi) would be the best source for additional withdrawal.

Where a large quantity of water has been withdrawn (except Benina and El Fweihat areas) water levels are declining rather rapidly. At these places, withdrawals of water appreciably exceed recharge from rain-water infiltration and underground flow. Withdrawals on a large scale in the vicinity of the sea or where salty water underlies fresh water (see Fig.3.8) results in replacement by salt-water. This has happened in several wells at different sites on the plain, e.g. Tokra, Bersis, Deriana, El Gwarsha, Gamines and El Magrun. It is likely to take place at other sites in these places in the future. Consequently, such contamination will limit or destroy the usefulness of several wells.

The problem of irrigation in the area between Jardina and Benghazi will soon be solved after the completion of the new plant, at El Gwarsha, for purifying the Benghazi sewage-disposal as well as the construction of El Gattara water dam. Thus an abundant amount of good water supply can be produced for irrigation. In addition, an appreciable amount of fertilizers will

be extracted from the sewage-disposal content. Consequently, a great development in agricultural activities in the area between Benghazi and Jardina (Barga El Hamra) can be expected. This will depend, of course, on adequate capital, experience and encouragement by the government to develop the water potential of their projects to the full.* However, the problem of water supply for irrigation in the rest of the plain is still very imminent. Therefore, more hydrological investigation and drilling of new wells is necessary, in the hope of finding more good water supplies to solve this problem.

3.3.3. - Cisterns

Cisterns are found where underground water is absent or very scarce, particularly inland near the escarpment. Indeed as a general rule cisterns are located near the escarpment while the wells are near the coast. Cisterns are reservoirs built to conserve rain water during the winter season in order to provide drinking water for people and animals mostly in summer. A cistern has a small hole at the top (which can be closed and locked) leading to a cavity which is dug, by hand, in the limestone layers. Lime or cement is used to make the walls waterproof. There is little evaporation and the water remains sweet and cool. Most of the cisterns date back to ancient times; Greek and Roman cisterns are still found in use at Tolmeita, Tokra and several other sites on the plain.

* More details will be provided, under the heading of irrigation.

Cisterns vary in size, from small ones sufficient for a family (about 4 persons per household or family), to large ones which may provide enough water for several families. A cistern holding $2,000 \text{ m}^3$ can supply enough water for 250 head of cattle and 5,000 sheep for about 200 days.⁽²⁰⁾ The necessary impluvium for a 200 m^3 cistern generally varies between $250-1,000 \text{ m}^2$, depending on the rainfall intensity. Because of the difficulty of the maintenance of large cisterns, some people have several smaller cisterns rather than a single large one. However, the cisterns used today in the Benghazi Plain are not normally large, but vary considerably in size. Cisterns are also found in some old houses in Benghazi City and some of them are still utilised particularly in the areas where tap-water has not yet been introduced, for instance at Sug El Hashish and Es-Sabri.

According to the 1960 Agricultural Census, Benghazi Plain had about 1,255 cisterns, whereas the 1967 Survey counted only 800 cisterns of which about 60 per cent were found in Barga El Hamra (Table 3.3 and Fig.3.6).

To sum up, cisterns are of great value for human and animal water consumption and for economic development generally. Therefore, new well constructed cisterns, particularly in Barga El Hamra, would undoubtedly be of great value in developing the area.

CHAPTER 4

SOILS AND VEGETATION

4.1 - Soils^{*}

The only previous soil studies carried out in the Benghazi Plain concerned (a) the humidity of terra rossa in the Es-Sahel area, north of Benghazi, which was undertaken by Micheli in 1936,⁽¹⁾ and (b) a soil survey by N.A.S.A. in the small areas of Butraba and El Gwarsha, which was mainly for land settlement projects.

The soils of the Benghazi Plain are shown on the reconnaissance soil map (Fig.4.1), prepared mainly from field observations during the spring and summer of 1967. For most of the area the soil distribution was observed carefully and marked on a 1 : 50,000 map in the field. The map of land use⁽²⁾ on the 1 : 50,000 scale, supplemented by the use of a geological map (Fig.1.1) proved very helpful in determining this general distribution. For several parts

^{*}The term soil is used here in a broad sense including also unconsolidated geological strata and sometimes even rocky ground as far as this supports vegetation.

of the plain, however, reconnaissance of the soils was necessarily cursory, due solely to technical obstacles. Air-photographs on the 1 : 5,000 scale of the Benghazi Plain are available with N.A.S.A. only and they are not allowed to be taken away.

Seventeen soil pits were examined throughout the plain, particularly in the cultivated areas. The location of each profile is given in Figure 4.1. 36 soil samples for carrying out physical and chemical analyses were taken to the N.A.S.A. laboratory in El Fweihat near Benghazi. Duplicate samples of each horizon were brought to the soil laboratory of the Geography Department, Durham University for the analysis of organic matter, colour, nitrogen, carbon and available phosphate and potash. The field profile descriptions as well as the results of the laboratory analyses are given in Appendices 4.1, 4.2 and 4.3.

4.1.1 - Soil Character

The soils of Benghazi Plain are entirely within the pedocal soil group, and are clayey with heavy texture and generally calcareous, poor in humus and mostly reddish.⁽³⁾

Since one of the two main themes of this study is agriculture, the study of the soils here is treated according to their agricultural value. Consequently, the following main units of soil were recognised and mapped:-

- 4.1.1.1. Terra rossa and transported terra rossa
- 4.1.1.2. Alluvial soils
- 4.1.1.3. Reddish-yellow steppe soils

4.1.1.4. Regosols

4.1.1.5. Lithosols and rock outcrops

4.1.1.6. Solonchaks

4.1.1.7. Cemented soils and crustal soils

4.1.1.8. Soils of the wadis

4.1.1.1. - Terra rossa and transported terra rossa

Despite much debate and theorising on the origin of terra rossa, it has not been well defined yet. Nevertheless, almost all pedologists have accepted Reifenberg's⁽⁴⁾ definition of the terra rossa of Palestine.

Briefly, it may be said that terra rossa develops on hard, pure and white limestones under Mediterranean climatic conditions, with the alternation of a wet season in winter and a warm dry summer. It is found in the countries on both sides of the Mediterranean.

According to Little,⁽⁵⁾ terra rossa in Cyrenaica is best developed on hard limestone, where rainfall is over 200 mm. per annum. In the Benghazi Plain this embraces the whole of the northern part of the plain (Es-Sahel).

Terra rossa is, generally, not deep and it fills small patches, clefts and fissures in the hard limestone. It has a reddish (2.5 YR 4/6) colour and a very thin surface layer that is brownish-red (2.5 YR 4/4). The lower layers contain numerous fragments of gravels and pebbles as well as ferruginous and calcareous concretions, and rest on the unweathered rocks (Plate 4.1).

Terra rossa covers large areas of the Benghazi Plain and Jabal El Akhdar from which most of the transported terra rossa on the plain is derived. Consequently terra rossa on Benghazi Plain comprises two distinctive types: (1) residual terra rossa and (2) transported terra rossa.

Residual or local terra rossa forms mainly a shallow soil 15 to 50 cms. deep (Profiles 9, 11 and 13), and fills small scattered patches and small depressions as well. The most important area lies between the Benghazi-Benina highway and Sidi Khalifa (Fig.4.1).

Immense quantities of Jabal El Akhdar terra rossa have been transported and laid down on the plain during Pleistocene and Holocene by Wadis El Gattara, Zaza, Belbarabedis, Es-Salaib, etc. It accumulates in the nearest depressions and wadi courses, particularly those which do not reach the sea (Profiles 5 and 15), but it is also found further afield where it has been carried by wind (Profile 7). A complex of residual and water- and wind-transported terra rossa is well represented by the soils of the sink-holes or dolinas (Profile 10).

Terra rossa which has been transported mainly by water is found in vast areas around Benghazi, and was brought in by Wadi El Gattara. The other important area occurs between El Mabni - Ghot El Aarka and Tokra (Profile 15). Transported terra rossa are more varied in texture and often include a predominantly stone horizon in their profiles (Profiles 5,

7 and 15, also see Plate 4.1).

Mechanical analysis of terra rossa reveals that their textures are relatively heavy. The clay content ranges from 13.6 to 47.6 per cent. The clay content of 13.6 per cent for the surface layer of profile 11 is probably a reflection of the Karst topography and its actively moving surface. However, the clay content increases considerably with depth, for example in Profiles 10 and 11 the clay content increases from 27.6 and 13 per cent to 37.6 and 34 per cent respectively. The silt content varies from 18 to 28 per cent. Sand contents are relatively high in all profiles, ranging from 43 to 67 per cent. The high sand content (67 per cent) of Profile 11 probably results mainly from sand carried from the nearby sand dunes by the dominantly N.W. and N.E. winds.

As regards chemical properties, the analytic data of terra rossa reveal that the pH values range from 7.30 to 7.70 and the total carbonate calcium (CaCO_3) varies between 5 and 42 per cent.

The relatively heavy texture of terra rossa gives a reasonable moisture holding capacity, which ranges from 40 to 52 per cent. This feature indicates that this soil type is capable of retaining an adequate quantity of water for summer cultivation.*

*Data concerning the infiltration rate in Benghazi Plain are not available.

Residual terra rossa contains very low calcium carbonate, 5-7 per cent, (Profiles 8-13) and conductivities are 0.25 and $1.3 \text{ mmhos} \times 10^3$ at 25°C . Agricultural value, or in other words available plant foods in residual terra rossa are very low, the averages of organic matter and nitrogen being 1.1 and 0.17 per cent respectively. Potash and phosphate are 2.8 and 6.6 mg./100g. respectively. Irrigated farming on this type of soil is not profitable unless fertilizers and fresh water are applied with good management, otherwise forest trees and scanty grasses form the only crop of value. Unfortunately, this soil is more or less subject to water and wind erosion, and gully and rill erosion are really severe in several places⁽⁶⁾ (Plate 4.2).

Transported terra rossa, though it lacks some essential minerals (e.g. nitrogen) and organic matter is quite rich in other minerals, deep and relatively easy farmed, because it is usually mixed with sand blown in from the desert, and this makes it more friable. With fresh irrigation water, transported terra rossa provides very good agricultural land, but not the best land.

4.1.1.2 - Alluvial soils

Alluvial soils are composed of sediments recently deposited by running water, and normally do not show a prominent horizon differentiation (Profiles 5 and 8).

Alluvial soils in the Benghazi Plain show a wide range of textures; they are generally medium to heavy textured

and are all calcareous. However, all alluvial soils of the depressions are normally heavy, while alluvial soils along the streams of the wadis and the foothills have medium to light textures. Their colour varies from reddish-yellow and yellowish to grey.

Alluvial soils of the wadis in the semi-desert area (south of Wadi El Gattara) are mostly stony; owing to the unfavourable climatic conditions of this area, where rainfall is less than 200 mm. annually.

Wide stretches in the Benghazi Plain are covered by alluvial deposits. The most important and extensive areas, from the agricultural point of view, are the flood plains or depressions of Wadis El Bab, Enghar, El Gattara, Zaza and Es-Salaib and their northern and southern continuations. Almost all of the sediments brought down and deposited on the plain are from the Eocene, Oligocene, Miocene and Upper Cretaceous formations of Jabal El Akhdar. These soils are also of considerable depth, i.e. about 10 metres in Es-Silg near Wadi El Bab and 5 to 15 metres near Bersis and Bujarrar and about 23 metres east of Jardina.

Alluvial fans have soils generally red in colour and developed on conglomerates of limestone. They usually start from the mouth of the valley to the tail beginning with gravels and proceeding through coarse sand, fine sand, sandy loam and clay loam to clay. Generally, these soils are deeper on the lower parts of the fans. The thinner soils higher up are less fertile in places and badly eroded in

other places. However, in general, alluvial fans are well developed near Esh-Sheleidhima and in the area between Tokra and Tolmeita⁽⁷⁾ (Profile 17). Hey⁽⁸⁾ described these fans as of Pleistocene age.

The alluvial soils are generally loams or sandy clays (Profiles 4, 5, 8 and 17), containing, however, gravels, pebbles, and sometimes even boulders. Mechanical analyses reveal that the clay content increases with depth. The percentages are from 27.6 to 37.6 in Profile 5, 12 to 37.6 in Profile 8 and from 29.6 to 41.6 in Profile 17, while the silt content decreases, from 24 to 18 per cent in Profile 5 and from 21 to 17 per cent in Profile 8. The sand content ranges between 37 and 52 per cent.

The saturation percentages are relatively high, but slightly lower than terra rossa. They range between 38 and 40 per cent, and are thus moisture retaining and friable when rainfall is available, but when dry, they become very hard. The pH values are between 7.65 and 7.70.

The electrical conductivities of the saturation extract of Profiles 4, 5 and 8 represent no salinity problems, as the salinity level is negligible, being between 0.24 and 0.65 mmhos/25°C⁰. Consequently, these soils could be used for the cultivation of many crops if good water is available.

The calcium carbonate content of Profiles 5 and 8 is low, being 5 to 7 per cent, whereas in Profile 4 it is a relatively high (20 per cent). This is due mainly to the

accumulation of lime of the Jabal El Akhdar rocks as the water evaporates from the surface which is usually inundated every rainy year for a considerable period.

The alluvial soils contain much less organic matter (between 0.42 and 0.98 per cent) than terra rossa soils (between 0.58 to 2.31 per cent). Nitrogen here is too low, but is generally higher in the top soils, being 0.78-1.68 in the top soil and 0.06-0.94 per cent in lower horizons. Phosphate (P_2O_5) according to the British rating, comes under the category "very low" (from 0.6 to 5.2 mg/100g.), the top soils having a higher content than that of the subsoils. This is, however, related to the organic matter. Potash (K_2O) is generally of a higher status than the phosphate. Profile 4 can be classified according to the British rating as "very low" (4.3 mg/100g.), while Profiles 3 and 8 are low, being 9.1-18.2 and 6.4-9.7 mg/100g. respectively. Potash contents are reasonable for field crops, while the phosphate content is low.

4.1.1.3. - Reddish-yellow steppe soils

This soil type occurs mainly in a triangular zone in the southern part of the Benghazi Plain. This zone extends to the north as far as about 1 km. north-east of Jardina village, in the east it is bounded by the alluvial soil zone, in the west it intermingles with the consolidated dunes and coastal sand dunes, while to the south it shades imperceptibly into the whitish semi-desert soils (Fig.4.1).

The origin of these soils is to be ascribed to aeolian sands of continental origin brought from the desert by winds and deposited on the plain. Minor additions to this soil zone have been made by the water and wind transported alluvial and sea sand soils from neighbouring areas.

The parent material of the reddish-yellow (7.5 YR 7/6 in Profile 3) soils is generally sandy and calcareous throughout and shows little horizon differentiation, except probably for a shallow surface that shows a very faint organic matter accumulation.⁽⁹⁾ The unfavourable semi-desert climatic conditions and the high content of carbonate calcium of the parent material are responsible for the very weakly developed horizons. It is also observed that in deep soil mantle a faint horizon of calcium carbonate accumulation may be found.⁽¹⁰⁾

In general, reddish-yellow steppe soils are shallow, being 5 to 60 cm. deep and easily subject to wind erosion, especially by the Ghibli winds which carry most of their load into the sea and to a certain extent to the northern part of the plain (Profile 6).

The reddish-yellow steppe soils in accordance with their physiographic location can be divided into two distinct soil units: first, an area which is almost entirely covered by reddish-yellow soils in the south and, secondly, a complex of reddish-yellow soils and lithosols in the north. However, there is not much difference between these two units; in the first sand occupies vast areas, while in the second lithosols

are dominant, though the sand occupies all depression areas in between. Minor patches of consolidated dune soils, alluvial soils and regosols (the latter is found mainly in the western fringes) are not uncommon.

Texturally, these soils range from sand, sandy loam to sandy clay loam (Profiles 1, 2, and 3) and show distinctly darker colour with depth. They generally vary from reddish-yellow (7.5 YR 7/6) and very pale brown (10 YR 7/4) to pink (7.5 YR 7/4) colour. But it is noticeable that the general appearance of the area is reddish, due to the influence of terra rossa.

The surface soil in most parts and especially in the north is covered with stones and gravels (Plate 4.3) and they decrease with depth (Profiles 1, 2 and 3). The saturation percentages are relatively low, being between 32 and 45 per cent. This is due mainly to the relatively high sand content (51-79 per cent). Clay contents range from 2.6 to 25.6 per cent, the low clay content (2.6 per cent) of Profile 3 being due to the presence of high silt fraction 37.6 per cent. Values for pH are between 7.50 and 7.65, being generally uniform with profile depth.

The electrical conductivities vary from 0.19 to 10.0 mmhos/25°C. (Profiles 1, 2 and 3). The high salinity percentage of the top soil of Profile 1 is due to the salts carried by the predominantly westerly winds, from the large water body of Sabkhat Karkura in the west and deposited on

these areas, reducing its suitability for agriculture. Therefore, salt tolerant crops (tomatoes and barley) should be selected for cultivation on this soil, because at present this area, with the exception of few backyard gardens, has no irrigated agriculture whatsoever. The subsoil of Profile 2 also has an excessive salinity, which is a result of the presence of gypsum in the underlying rocks, while the top soil of this profile contains a very negligible amount of salt (0.40 per cent). Profile 3 represents no salinity problem. Consequently, these latter soils could be used for the cultivation of any crops, but fresh water for irrigation must be provided.

Organic matter and nitrogen are very low (0.42-2.04 per cent and 0.02-0.18 per cent respectively). However, the relatively high contents of potash (0.10-4.6 mg/100g) and phosphate (1.3-9.3 mg/100g) contribute insignificantly to the soil fertility. It is noticeable that the top soils always contain higher percentages of organic matter, nitrogen, potash and phosphate.

The agricultural value of these soils, in general, is marginal, and without irrigation no agriculture is possible except shifting cultivation and grazing in rainy years. At present the main agricultural activity is shifting cultivation of barley and to a lesser extent of wheat. Because of the climatic conditions of this area, as well as in most of the plain, the yields are always marginal and not guaranteed.

Under irrigation some vegetables and fruit trees can be grown in a few protected areas, such as Jardina, Slug and Gamines.

4.1.1.4 - Regosols

Regosols or sand dune soils are young soils formed on coarse or very coarse sands and gravels. The parent material consists almost entirely of loose rounded white to yellowish grains (Plate 4.4). Their profiles are generally undeveloped, but they may have a weakly developed "A" horizon, especially in the more humid areas of the coast (Profile 16).

Regosols are brought to the coast by wave and wind actions and, with the exception of some patches of transported terra rossa mainly in the north and desert sand (loess) in the south, they are a product of local weathering of the underlying limestone strata.⁽¹¹⁾

Almost the whole coastal area of Benghazi Plain is fringed by sand dunes or regosols (see Chapter 1). The sand dune belt is often interrupted by sebak, and with the exception of the El Mesied-Tolmeita sand area which is almost level, the relief is rolling to hilly, and great parts of these dunes are moving and are a continual threat to agricultural lands.

Laboratory analytic data reveal that regosols contain very high proportions of sand, ranging from 85 to 95 per cent (Profiles 13 and 16), while the clay content is very low, 1.6 and 4.6 per cent. Therefore, these soils have very

low water capacity and very high permeability. Consequently the saturation percentage is very low, 26-33 per cent, and still lower further south. Values for pH are from 7.50 to 7.60.

True coastal sand dunes have very low electrical conductivity values, being less than 0.50 mmhos/25°C., and calcium carbonate is very high, ranging from 52 to 75 per cent.

Due to the almost complete absence of vegetation cover the organic matter here is very low (average 1.36 per cent). Phosphate and potash are relatively high, averaging from 2.6 to 4.3 and from 2.3 to 9.2 mg/100g. respectively in Profiles 13 and 16. Thus the soil conditions of this area indicate a remarkably poor status as regards plant nutrients.

Although they are not generally utilised, the soils of the coastal sand dunes have surprisingly high agricultural value in small areas protected from the strong sea winds where good subsoil water is available and accessible in a reasonable quantity, and where large quantities of animal manure are usually added to the soil (Plate 4.5). Production is of irrigated vegetables, as well as date palms, vines and figs which do not need irrigation after their roots reach the subsoil water ($\frac{1}{2}$ to 4 metres deep). Subsequently, the roots extend over a large area of soil and penetrate to great depths.

Despite the low chemical fertility of the light soil

of the coastal sand dunes, they are of great importance, as they constitute a major source of vegetable production for the whole Benghazi Plain and Benghazi City in particular. Regosols have no grazing value worth mentioning.

4.1.1.5 - Lithosols and Rock Outcrops

Lithosols are shallow and stoney soils which cover limestone bedrock, without a definite profile development. However, a very thin organic matter horizon, merging into shattered hard rock close to the surface may develop. Lithosols consist of a high proportion of unweathered limestone fragments mixed with gravels and particles of clay, silt and sand, and they are very calcareous and easily affected by erosion, especially by water runoff. Lithosols are widespread all over the Benghazi Plain. They are found on the foothills, on the plain and near the coast. They are also found interdigitated with terra rossa, alluvial and sand dune soils.

Rock outcrops consist of almost bare limestone and often are associated with lithosols, but sometimes they may occur alone in small areas. Rock outcrops are also found in small spots all over Benghazi Plain, in fact they are one of the most conspicuous features of the physiography of the Benghazi Plain. The largest area, however, is found south and east of El Kweifya, east of Benghazi (Fig.4.1). Rock outcrops here are bare, hard and white limestone of middle Miocene age and are found widely on level land. The surface is almost entirely devoid of soil and broken only by fissures,

cracks, small depressions and sink-holes or dolinas.

However, apart from small pockets of very thin and humose grit in the fissures and cracks there is no soil formation.

The existence of bare limestone and eroded areas in the Benghazi Plain, which have undoubtedly increased in historical times, is likely due to deforestation,⁽¹²⁾ and probably the over-grazing by the Bedu for a very long time. In addition, the torrential character of the rainfall leads to rapid surface runoff.

Lithosols have very low agricultural potential. In the more humid area in the north of the plain they are mainly suited for brush wood and offer very limited grazing conditions. Rock outcrops have practically no agricultural value.

4.1.1.6 - Solonchaks

Solonchaks are soils which always contain large quantities of soluble salts in the surface layers and are normally salty throughout the profile.⁽¹³⁾ They are usually reddish-yellow (7.5 YR 6/8) or reddish-brown (2.5 YR 4/4), but dark greyish or bluish colours may be found in water-logged seabkh such as at Bersis and El Kweifya.

There are several types of solonchaks in the Benghazi Plain: (1) sea-water flooded seabkh soils, found along the coastal strip from Bersis in the north to the southern boundary of the plain, (2) rainfall flooded seabkh soils, which occur in the north and north-west of Slug, (3) a complex of fresh groundwater and sea-water seabkh soils found

in Ain Zaiyana north of El Kweifya, (4) wadi outlets sebakh soils formed by Wadi Es-Salaib, north of Bujarrar.

However, solonchaks are not really the concern of this study, except those which may be utilised for marginal grazing and indirect agricultural practices.

Laboratory analyses of the chosen solonchak types reveal that the texture is generally sandy clay loam to clay or sand (Profile 14) overlying hard white limestone bedrock. The clay, silt and sand contents of surface horizons are 30.6, 23 and 46.4 per cent respectively. They do not differ too much with depth being 26.6, 28 and 45.6 respectively at 50 cms. The pH value ranges from 7.30 to 7.60. The saturation percentages are between 39 and 45 per cent.

The salt content of sebakh soils in different horizons, varies considerably with the seasons; in winter when rainfall is abundant, the salt content is less, while in summer the salt is abundant, due to the loss of water by evaporation. The salt content of Profile 14 (the samples were taken in late spring) ranges from 0.31 to 15.3 mmhos/25°C.

The available nutrient analyses indicate that these soils have abundant phosphate (9.1 and 6.3 mm/100g.), and some potash (1.5 and 0.9 mm/100g.). The organic matter is, however, relatively high being 2.31 per cent in the surface horizon. This is due to the abundance of the sebakh vegetation.

The true sebakh areas do not have any agricultural value, they are either inundated by sea-water throughout the year or covered by salt encrustations during the dry season. Thus much of the land lies idle.

However, some saline flats, which are generally adjacent or at the fringes of true sebakh, on drying out provide salt tolerant vegetation (see vegetation section) of very low quality for grazing, mainly by camels.

Secondary sebakh soils formed by mixed saline and fresh waters (e.g. Ain Zaiyana and Buatni) or rain water carried by wadis (e.g. Bujarrar and El Mkamen) are no doubt less salinised and consequently they produce reeds and sedges, which are usually used as wind-breaks for vegetable horticulture in sand dune areas.

There are minor sebakh units formed at the escarpment by the occasional flooding of the wadis descending from Jabal El Akhdar especially in the area south of Esh-Sheleidhima. Since these are temporary swampy areas, they have very low soluble salt contents (Profile 4) and are often cultivated for barley. Therefore, they are excluded from the solonchaks and instead they are treated as alluvial soils.

4.1.1.7 - Cemented and Crustal Soils

One of the most striking geo-pedological features of the coastal plain is the appearance of the cemented calcareous sand hillocks, which are termed by Hey⁽¹⁴⁾ "consolidated sand dunes." They are, however, of little importance as soil

building materials and are suitable only for some scrub growth and scanty grazing mainly in the northern part of the plain. Consolidated sand dunes do not have any actual agricultural value.

According to Desio⁽¹⁵⁾ and Marchetti⁽¹⁶⁾ many areas of the Benghazi Plain south of Slug are covered with a calcite crust termed a "steppe crust" (see Chapter 1). These areas are also unsuitable for cultivation and are of little use for grazing. This is due not only to the character of the mantle, but is also due to their location in areas of extremely low rainfall (less than 150 mm.) and high temperatures (28°C. mean annual) of Benghazi Plain.

4.1.1.8 - Soils of the Wadis

The wadis of the Benghazi Plain, as have already been described, flow only seasonally and mostly disappear or sink in sand dunes before reaching the sea. Large quantities of boulders, gravels, sand and finally silt and clay are carried down from the Jabal El Akhdar and deposited on the plain. These soil types form such a complicated pattern that it was not feasible to depict them on the map. Therefore, they are classified under a single type termed "Soils of the Wadis."

Although there are some soils of good agricultural value in these wadis, due to the occasional floodings, any agricultural practices would have to make allowance for these periodical flood conditions, otherwise a flood disaster would be inevitable as occurs frequently along Wadi El Gattara.

4.1.2 - Erosion

The progress of erosion in the Benghazi Plain, as in many semi-arid areas, is linked with the destruction of vegetation. There is no doubt that Libya, or at least the northern part, was once densely forested.⁽¹⁷⁾ The destruction of the vegetation cover, by wars, cutting the trees for firewood and charcoal and over-grazing, as well as the tendency of the Libyan climate toward dessication since pre-historic times, which has not yet reached its climax, are the most serious causes of soil erosion.⁽¹⁸⁾

Wind erosion tends to be more effective in the southern part of the Benghazi Plain, which receives low rainfall, is almost completely devoid of a vegetation cover, and is wide open to the south and the strong desert winds (Ghibli). Run-off is weak, due to the almost broad level terrain and the erratic and small quantity of rainfall, as well as the tendency of the soils to be more friable and permeable than those of the northern plain. However, erosion in the semi-desert areas is to be considered a minor problem, compared to the **water** availability problem.

In the northern part of the Benghazi Plain, where there is greater vegetative cover, the soil mantle is more subject to runoff than to wind erosion. The Jabal El Akhdar reduces the violence of the strong desert winds, and runoff is accelerated by the steeper slope of the plain, the short distance from the sea and the relatively high mountain

escarpment. In addition, a greater quantity of water is brought down by the numerous short deep wadis.

Gully and rill erosion are not widespread in the Benghazi Plain, but evidence of their danger becomes visible in the northern part of the plain. Here the soils (terra rossa) tend to be more impermeable than in the southern part of the plain. Consequently, runoff is rapidly increased, especially near the escarpment, and rilling and gulling are produced (Plate 4.2). For reasons given above, gulling and rilling are not common in the southern part of the plain, except near the wadi outlets.

Generally speaking, soil conservation seems to be a minor problem in the area under consideration, especially in the semi-desert area. In fact, water availability is the limiting factor in agricultural productivity, and not the soil so rain-water should be conserved and care be taken that water should not be allowed to run to the sea or to evaporate and must be fully utilised for cultivation. This aim, however, can be achieved by building dams on the gorges of the wadis such as: Wadis Es-Salaib, Belbarabedis, Zaza, El Gattara (a big dam project for Wadi El Gattara is under construction), Enghar and Wadi El Bab.

Hubert⁽¹⁹⁾ believes that in some parts of Cyrenaica, runoff and erosion are closely related to the overgrazing and destruction of vegetation. In order to avoid erosion, especially in shallow and gradient soils, shallow ploughing

should be practised, because deep ploughing tends to increase the possibility of drying up more soil, and where the soils are dry they are easy prey to wind erosion. Therefore, contour ploughing should start immediately after the first rainfall, in order to increase penetration of the water and reduce runoff.

4.1.3 - The Use of Fertilizers

The soils of the Benghazi Plain, and Cyrenaica as a whole, are calcareous and relatively poor in plant nutrients. Nonetheless, it should be emphasised again, that water is the limiting factor in agricultural productivity and not the intrinsic fertility of the soil. Nevertheless, as water becomes available, the need for nutrients by crops increases as well, and therefore the question of fertilizers becomes more important. Thus any immediate hope for better agricultural development depends on water availability rather than fertilizer use. Because of this it would be in many ways better if good care and much money were paid for the search for water, rather than for chemical fertilizers. In fact, during my field investigations, I found that most, if not all, farmers in the area under consideration, were not happy with the application of chemical fertilizers,^{*} because their effect on agriculture production (perhaps because of the misuse of the fertilizers by farmers) was not only unsatisfactory but also turned the soil more saline and less productive.

^{*}The government subsidises the farmers for half the price of fertilizers.

Most farmers use animal (sheep and goats) manure, which have a good effect on both dry and irrigated farming and are also easily obtained. Unfortunately, animal manure is often very badly handled in the Benghazi Plain; small heaps are usually left exposed to the scorching sun of the summer and torrential rain of the winter.

Chemical fertilizers are not suitable for dry farming, because, although nitrogen may increase crop growth, it also increases the water demand of the crops, and this is very difficult, if not impossible, to fulfil. If chemical fertilizers are applied, it is better to add superphosphate to animal manure, in order to prevent the losses of nitrogen in the form of ammonia and to increase the phosphorus content which is often low in animal manure.⁽²⁰⁾ As nearly all soils of the Benghazi Plain are calcareous and have high pH (7.30-7.80), chemical fertilizers, when added, should have an acidic or neutral component. Thus ammonium sulphate, ammonium nitrate and superphosphate are preferable. Fertilizers like sodium nitrate and calcium cyanamide should never be applied to the soils of Cyrenaica.⁽²¹⁾

4.1.4 - Land Capability Classifications

The purpose of the land capability classifications in the Benghazi Plain is mainly aimed at classifying the land with respect to its power for agricultural development and potential land settlement. The various land capabilities of the area concerned are designated according to the land

capability classes as defined by the U.S.D.A. Agriculture Handbook No.210.⁽²²⁾

The land capability map (Fig.4.2) of the Benghazi Plain is based on the general soil map, both of which are tentative. Nevertheless, it shows a fairly comprehensive idea of the agricultural development areas and new areas for agriculture development as well.

The criteria followed to assign land capability classes are based mainly on water quality and availability, soil properties and climatic limitations as well as minor limitations such as: stoniness, depth, salinity, erosion hazard and slope. The first two factors, however, are certainly the most important limitations in terms of agricultural productivity.

Land of Class I which is suitable for irrigated agricultural development comprises a very restricted area, which incidentally, coincides with the area of good to fair water that occurs in a semi-circle around Benghazi (Fig.4.2). This area of Class I is surrounded by Class VIII to the north, Class II to the south and to the east by Class V capabilities. However, Class II in El Haw-Wari and En-Nawaghia areas has recently been upgraded from Class IV after the new exploration of the fairly good water in a very large quantity (40 to 60 metres of deep water). In addition, there is the newly constructed road, which runs between Benghazi and Slug. This newly reclaimed area, where five relatively large commercial farms have already been operating successfully, is expected

to be the most promising agricultural area in the Benghazi Plain, especially for citrus plantations.

The areas of Class III are quite widespread throughout the plain and they are mainly in small patches, but the most promising area of all, if good water is available, is located between El Mabni - Ghot el Aarka and Tokra. This area of deep transported terra rossa incidentally occurs in the area of fair water and of more possibility of additional underground water (Fig.s 3.5-3.7).

Class IV areas are found in small patches along the coastal strip and near the escarpment. The criteria affecting land capability classification within these areas are the relatively shallow soils, salinity, easy susceptibility to water and wind erosion, slope and lack of rainfall. In the southern part of the Benghazi Plain soils of Class IV may produce good yields in rainy years. In normal years the yield is usually low, and during drought years the crop fails completely.⁽²³⁾

The saline soils in the extreme south of the plain, the lithosols and the consolidated dunes are classified within Class V. These areas are suitable only for pasture, especially in the southern part of the plain, and mixed pasture and brush wood in the north. In the extreme north a complex of dry farming (mainly wheat), grazing and woodland patches occurs under Class V.

Coastal sand dunes comprise land of Class VI capability,

though there are small areas having Class IV potentiality, particularly where fairly good subsoil water is easily obtained. Nevertheless, any big agricultural exploitation of these small areas is not feasible, for the underground water is limited and subject to declining and salt water contamination (Fig.3.8), and the soil requires much management and large quantities of fertilizers as well.

The foothill areas, especially in the northern part of the plain where the slope is steep and erosion marked, are assigned to Class VII. The agricultural potentiality of these areas is very low because of the severe limitation of runoff erosion that restricts their use largely to goat and sheep grazing and some brush land as well. It is very doubtful if any improvement is possible in these areas.

Bare outcrop areas, stagnant sebakhs, lakes, ponds, dolinas, some wadi beds, sandy beaches, quarries, El Mkamen and the sites of ancient settlements are classified under Class VIII capabilities. The soils and land forms of these areas have limitations that preclude their use for cultivation, and they are restricted to recreation, mineral abstraction, water supply and tourism.

4.2 - Vegetation

The distribution and growth of natural vegetation in the Benghazi Plain is governed by several factors, the most important of which is the distribution and frequency of rainfall. In addition, the quality, depth and distribution of

the soil mantle have a considerable effect, as well as the physiography of the area, other climatic elements, and human interference.

Owing to its general geographical position, the Benghazi Plain has two major vegetation types,⁽²⁴⁾ Mediterranean vegetation (Maquis) and Irano-Turanian vegetation (Steppes), which may be tentatively subdivided as follows (see Fig.4.3):

- 4.2.1. Mediterranean wood and brush forest (Maquis)
 - 4.2.1.1. Wood Forest
 - 4.2.1.2. Brush Forest
- 4.2.2. Irano-Turanian vegetation (Steppes)
 - 4.2.2.1. Mediterranean coastal steppes
 - 4.2.2.2. Semi-desert steppes
- 4.2.3. Littoral vegetation
- 4.2.4. Coastal Sebakh, ponds and sand dune vegetation

4.2.1 - Mediterranean Wood and Brush Vegetation (Maquis)

4.2.1.1. - The Wood Forest^{*}

This type of vegetation is confined mainly to wetter (350-370 mm.) northern parts of the Benghazi Plain, where terra rossa intermingles with some boulders.

The real Mediterranean forest (Maquis or Macchia) starts about 5 km. east of Tolmeita, and covers mainly the wadi beds, most of the foothill area together with the deep gorges and the sea-side of the first escarpment. However, the forest

^{*}The utilisation, economic and medical values of the forest and the grass lands will be dealt with in the chapter on Forest and Grazing Land.

still grows thicker on the higher mountain (see Plate 4.6).

The Mediterranean wood forest plant species are found mainly in the foothill area and on the mountain slopes. However, the Phoenician Juniper, JUNIPERUS PHOENICEA (vernacular name - SHA'ARA) is by far the most abundant element of the Macchia (Italian) or Maquis forest and widely spread all over the area concerned. (In fact, it covers almost the entire Jabal El Akhdar). It is generally found interspersed with other species mainly PISTACIA LENTISCUS (ver. BATTUM), ARBUSTUS PAVARII (ver. SH'MERI), and RHUS OXYCANTHA (ver. JEDARI).

In the more humid sector, mainly in the wadi beds (e.g. Wadis Záyana, A'asar and Belgasim), some truly characteristic Mediterranean forest species (which usually grow on the higher mountains) are found interspersed with other undergrowth species. These Mediterranean forest trees are Carob beans,⁽²⁵⁾ CERATONIA SILIQUA (ver. KHARRUB), wild olive, OLEA OLEASTRA (ver. ZEITUN BARRI) and kermes oak, QUERCUS COCCIFERA (ver. BALLUT).

The undergrowth of the wood forest area is made up of a large variety of species, of which PHILLIREA VARIABILIS (ver. S'KHAB), MYRTUS COMMUNIS (ver. KELIL), SISTUS SALVIFOLIOS (ver. BERBESH), PHLOMIS FLOCCOSA (ver. ZHEIRA), RHAMNUS OLICIDES (ver. SELLUF) and CALYCOTOME SPINOSA (ver. GANDUL), are the most vigorous shrubs.

The grass cover is abundant and embraces numerous species of which the dominant ones are CALENDULA (ver. GAH'WAN and SLEAA), ASPHODELUS MICROCARPUS (ver. UNSUL), URGINIA MARITIMA (ver. UNSEIL), ADUNIS MICROCARPUS (ver. LESLIS) and Camel thorn ARISTIDA PUNGENS (ver. LIBED).

Some salsola grasses are found here near the coast, and the most dominant species is SALICORNIA FRUTICOSA (ver. GHASUL). Since the coastal cliff, in this area, is about 5 metres above sea level the presence of these grasses is due solely to the spray of the high waves and the salty winds blowing from the sea.

It is worth mentioning here, that this forest area has suffered heavily from fire which was caused by the negligent and irresponsible attitude of the shepherds. The damage has occurred mainly between Wadi Belgasim and the sea-shore.

4.2.1.2 - The Brush Forest

The brush land area of the Benghazi Plain covers an area of about 120,000 hectares, extending 90 km. from Wadi El Fej in the south to beyond Tolmeita in the north, and varying in width from 13 km. in the south to $\frac{1}{2}$ km. in the north (see Fig.4.3). This forest is considered to have the richest vegetation in the whole of the Libyan northern plains.⁽²⁶⁾

The brush forest region is almost entirely wooded, the spacing between individual trees or bushes being very variable, for these species respond to physiographic influences, such as soil moisture, soil depth, and the flatness or rolling surface.

Consequently, the density and variety of the forest increase toward the escarpment in the middle part and in the northern part of the plain and because of the wetter conditions.

This type of brush forest is generally considered as a transitional zone between the dwarf-shrub societies and the Mediterranean species, which are not always easy to separate. Hence the further south one goes the sparser the forest becomes yielding at first to coastal steppe and then to semi-desert steppe.

This shrubby area is favoured by 250-350 mm. rainfall annually which almost entirely occurs within the sub-humid region (see Fig.2.14 and Fig.4.3). The greater part of this area consists of heavy reddish-brown calcareous soils (terra rossa) particularly in the depressions and near the escarpment, the only exceptions being a few lithosols together with rock outcrops, sand dunes and the sebakh areas near the sea-shore.

The brush trees vary in height and species, and are generally speaking shorter in the south being between 30-50 cms. whereas in the north they are between 50-300 cms. The dominant tree species in the area between Tokra and Tolmeita are RHUS OXYCATHA and PISTACIA LENTISCUS. The RHUS is almost entirely confined to the foothills. Minor species which are scantily spread are TAMARIX ARTICULATA (ver. ETHEL) and Carob (these two species are mainly found on wadi beds, e.g. Wadi

Jebela, Wadi Aaser and Wadi Tberglaya), wild olive, figs, FICUS CARICA and spiny broom CALYCOTOME SPINOSE, with undergrowth of several species of which the PHOMIS FLOCCOSA is the most dominant.

The grass cover in this area is very luxuriant and the dominant species are URGINIA MARITIMA and ADUNIS MICROCARPUS.

The southern part of the brush forest is relatively sparse, particularly near the coast and in the south. The predominant tree species here are RHUS OXYCATHA, which represents about 70 per cent of the forest,⁽²⁷⁾ and PISTACIA LENTISCUS, about 20 per cent. Some of PERIPLOCA LOEVIGATA (ver. HALLAB), LYCIUM EUROPEUM (ver. OWSIJ) and Camel thorn shrubs (see Plate 4.7) are found. Carob is very rare in this area and its presence is mainly confined to wadi beds, e.g. Wadi Zaza (Plate 4.8), and small clumps of Carob trees are found on both sides of the highway in Bersis area. The Carob tree seems to have been widespread in the Benghazi Plain in the past, but at present, the southern boundary of naturally growing Carob is found north of the highway about 2 km. west Sidi Sweiker and just north of Sidi Mansour dolina 10 km. north of Benina.

The understory consists of a large variety of species such as PHLOMIS FLOCCOSA and POTERIUM SPINOSUM (ver. SHEBREG). The latter is a small thorny and many-branches shrub, which grows on thin soils in rocky terrain and is usually the sign of age-old degradation of land.⁽²⁸⁾ There are also RETAMA RETAM (ver. RTEM), RHAMNUS OLISIDES and THYMUS CAPITATUS

(ver. ZAATER).

The grass cover here is very luxuriant, particularly during the spring season. The northern part of this area is still richer in grass cover, mainly because the soil mantle is thicker, especially in the depressions and alluvial wadi beds (see Chapter 1), and the rainfall is more abundant. The most conspicuous grass species are URGINIA MARITIMA, ADUNIS MICROCARPUS, CALENDULA and CYNAR SIPHERPIANA (ver. KHARSHUF or GAAMUL wild artichoke) (see Plate 4.9).

4.2.2 - Irano-Turanian Vegetation (Steppes)

This Mediterranean steppe region embraces a vast area, extending from the southern boundary of the brush forest in the north to the southern boundary of the Benghazi Plain (semi-desert). This region occupies an area of about 400,000 hectares⁽²⁹⁾ and has a length of about 128 km. and its width varies from 13 km. in the north to about 54 km. in the deep south. It receives a mean rainfall ranging from about 100 to 300 mm. per annum.

This region of vegetation occurs almost entirely within the suggested region of steppe climate, whereas it occupies only the southern part of Fantoli's⁽³⁰⁾ Littoral Steppe region (see Figs. 2.8, 2.9 and Fig.4.3).

4.2.2.1 - Mediterranean Coastal Steppes

This region coincides with the mainly Karst topography between Wadi El Gattara in the south and the brush forest in the north, with a mean rainfall ranging between 200 and 300 mm.

The soil cover here is mainly red to reddish-brown terra rossa transported by wadi streams and wind actions and deposited on the depressions and dolinas or sink-holes; and some areas of true terra rossa as well. Most of this area is bare rock outcrop, especially between Sidi Khalifa and the Benghazi-Benina highway. This ground surface affords little possibility for plant growth except for certain LITHOPHYTES including LICHENS. Consequently the true growth is mainly confined to areas near the foothills and does not extend more than 3 km. from the escarpment, the slope side of the mountain and along the stream of Wadi El Gattara, with a few isolated specimens. The sink-holes are almost completely occupied by fruit trees such as figs, olives, vines, palm trees and almonds.

The dominant tree species is ZIZYPHUS LOTUS, which is mainly found near the escarpment, wadi streams, west of the Lete and near Wadi Musa south-east of El Fweihat. Less abundant species are PISTACIA LENTISCUS and FICUS CARICA. Some shrubs, mainly RETAMA RETAM and THYMELEA HIRSUTA are also found in scattered localities.

The grass cover here is luxuriant, particularly in the areas of deep soil cover. The dominant and conspicuous species are LULIUM RIGIDIUM and CYNAR SIPTHORPIANA. Less frequent species are⁽³¹⁾ PHALARIS MINOR, ADUNIS MICROCARPUS and MEDIGAGO DENTICOLATA. Rare species are AEGYLOPS VENTRICOSASA, STIPA SPINOSA and DACTYLIS GLOMIRATA.

4.2.2.2 - The Semi-Desert Steppes

The semi-desert or pre-desert region includes all the Benghazi Plain south of Wadi El Gattara (Barga El Hamra). The vegetation cover here is richer in the north and east and it varies in response to the rainfall shifting northward in dry years and moving further south in wet rainy years. However this area in general is grassland, and almost devoid of trees except near the escarpment, wadi floors and some scattered places. This region receives a mean rainfall of 100-240 mm. per annum, and it can be classified climatically as steppe with the exception of the south-eastern sector which can be classified as desert. But in Fantoli's classification, the region occurs within the continental steppe division (see Figs. 2.14, 2.15 and 4.3).

The surface cover of this region, in general, is thin and mainly sandy, sandy loam or sandy clay loam. Where there is a thick soil cover, as for example in the depressions, the soil is mainly silt loam or silt clay loam. Consequently, the density and variety of vegetation vary from place to place according to the ground surface. While the thin soil cover allows only for the growth of annual plants (which complete their life cycle in a single season), the deep alluvial soils of the Wadi Enghar and Wadi El Bab areas, as well as some scattered areas (depressions) all over the region, allow the storage of some water in a permanently wet, deeply seated layer, which provides the deep roots of perennial plants with a continuous supply of moisture.

The main tree species of the semi-desert area, especially in the northern sector and wadi floors are RHUS OXYCANTHA, PISTACIA LENTISCUS and ZIZYPHUS LOTUS.

These tree species, as was stated earlier, either grow individually or in small clumps. ZIZYPHUS LOTUS is almost the only species which is relatively widespread all over this region. Besides, it is believed that this species was widespread in the past, and covered the whole steppe region from Egypt to the Sirte area. It is for its fruit that the ancient Libyans, who lived in this area, were known to the Greeks as "Lotofagi = Lotus eaters."⁽³²⁾ The largest plantation of lotus is found in a rectangular area around Jardina. It extends from the escarpment east of Jardina, toward the west until it reaches east of Sidi BuFakhra near the coast, with a width of about $\frac{1}{2}$ to 1 km. The existence of this stretch is somewhat peculiar because the surrounding areas in the north and in the south are almost completely devoid of trees. This peculiar phenomenon might be explained by the fact that it is probable that this lotus area indicates its former course of Wadi Enghar to the sea. Consequently, the soft material or the relatively deep alluvial soil of this area allows (as was stated earlier) for the storage of some water, which provides this deep rooted desert tree with moisture throughout the year. Another more likely explanation is that this area was probably affected by a slight subsidence caused by underground movement (see Chapter on Geomorphology)

at the same time when the fault of the first escarpment was formed. Consequently, this subsidence might have caused several cracks in the geological layers in this area, through which these long rooted trees could penetrate to underground water. Strong evidence for this assumption is the semi-circular sink-hole, with easy accessibility of underground water, lying about $\frac{1}{2}$ km. west of Jardina village, in which the main wells for the people and animals occur.

Some small clumps of lotus are also found around Sidi Mohamed El Fazzani, in the western part of Ghot (depression) Tanzalugh, around Gamines and Slug, as well as around Tika in the north-west (see Fig.4.3).

The main shrub species of this region are THYMELEA HIRSUTA, RETAMA RETAM and PEGAMUN HARMALA (ver. HARMEL). The Harmala plants are found mainly near the escarpment and around the populated villages, e.g. Slug and Gamines.

The dwarf plant, HALOXYLON ARTICULATUM (ver. REMT) covers almost all the depressions near the escarpment, south-east of Slug and along the coast (see Fig.4.3). This very poor shrub, about 30 cm. high, marks the transition between the semi-desert steppe and the desert vegetation.

The grass cover consists of various species. These species are very luxuriant in favourable climatic conditions, during the period which usually extends from October-November to April-May.⁽³³⁾ Moreover, unless the spring rain fails, a carpet of lush flowers and herbs covers the ground and produces

a very striking colourful display (see Plate 4.10). By the end of spring with the approach of the scorching summer sun, the soil dries and the grasses die and are blown about by the hot desert winds (Ghibli).

During the summer season, only some harder bushes and thorns remain on the ground, and vast areas of bare land with lithosols appear. However, the dominant grass species in this region are LULIUM RIGIDIUM, PHALARIS MINOR, ASPHODELUS MICROCARPUS and ARISTIDA PUNGES or Camel thorn, especially around En-Nawaghia. ASPHODELUS, PITYPANTHUS TERTUESUS and CYNAR SIPTHORPIANA are found mainly in Jardina Mudirya. Less frequent species are PHALARIS BRACHYSTACHYS and BROMUS ALOPECUROIDES. Rare species are AVENA BARBATA, AEGYLOPS VENTRICOSA, KOELERIA PHLEODES and ENARTHROCARPUS.

4.2.3 - Littoral vegetation

This is found on a coastal strip, which consists mainly of a discontinuous chain of dunes (see Chapter 1), running from Shat El Bedin (at the southern boundary of Benghazi Plain) in the south to Ras Tolmeita in the north, a distance of about 220 km. long, and from 100 metres to 2 km. wide,⁽³⁴⁾ and covering a total area of about 23,100 ha. This strip receives a mean annual rainfall of 100-360 mm., with a predominantly seaboard climate.

Since this area is almost dominated by dunes the soil mantle is very thin in most of the area. In the southern strip the soil is more or less whitish sandy loam inter-

mingled with some gravels, whereas, in the middle sector, between Gamines and Tika, it is mostly bare rock (Lithosols) with small patches covered with thin greyish silty loam soil. In the rest of the strip the soil mantle varies between bare outcropped rocks, lithosols and some depressions with a relatively deep layer of dark reddish clay loam soil (terra rossa). Consequently, the vegetation cover here is not thick. However, the lack of a dense forest cover, at least in the north, is due not only to the soil and climate, but also human interference since these areas are the most highly populated. Nevertheless, there are some sparse shrubs of which the main species are TAMARIX ARTICULATA and RETAMA RETAM especially around Sidi Khalifa and El Magrun, THYMELEA HIRSUTA, which is found mainly in the area between Swani Saoud and the highway south-west of Tika as well as to the north-west of El Magrun; finally the HALOXYLON ARTICULATUM is found mainly to the north-west of Gamines.

The grass cover of the Littoral zone consists mainly of LULIUM RIGIDIUM in the northern sector (north of Benghazi) and spartograss LYGIUM SPARTIUM (ver. HALFA) in the southern sector, especially in the Bussufen and Shat El Bedin areas. ARISTIDA PUNGENS (ver. SEBATT) is very luxuriant in Sidi Khalifa. It extends for about 750 metres, south of the highway. Between Ganfuda and Tika the dominant grasses are STIPA TORTILIS and EMPERATA CYLINDRICA (ver. DEES), the latter occupying a vast area between Swani Saoud and Tika. The ASPHODELUS MICROCARPUS

is found in many parts of the Benghazi Plain.

4.2.4 - Vegetation of Coastal Sebakh, Ponds and Sand Dunes

4.2.4.1 - Sebakh vegetation

True sebakh are almost devoid of vegetation and are periodically flooded. However, such vegetation as grows in or around the sebakh is of HALOPHYTE (salsola) type. Hence, limited vegetation species such as LIMONIASTRUM GUYONIANUM (ver. ZETAH), occupy almost all the vegetative sebakh areas, especially north of Deriana, west of Sidi Khalifa, east of El Thama, south of Ganfuda (see Plate 4.11) and north-west of Gamines. SALICORNIA FRUTICOSA (ver. GHASUL), SUAEDA FRUTICOSA (ver. SEID), SALSOLA GIFOLIA and MESAMBRIANTHEMUS, are also found in small numbers. The only shrubs I have seen growing in this area are tamarisks of stunted appearance.

4.2.4.2 - Pond Vegetation

The vegetation of the ponds in the Karst topographic areas around Benghazi and El Kweifya, such as Budzira, El Mgarin and Ain Zaiyana, is of HYDROPHILE type. The most common species are canes, reeds, sedges and myrtle (see Plate 4.12) and some spartium is also found, particularly in Ain Zaiyana.

In the swampy area (El Mkamen) in the north-west of Slug, the dominant plants are myrtle (ver. SHAFSHAF) and LULIUM RIGIDIUM. Some PHALARIS BRACHYSTACHYS and BROMUS ALOPECURDIDES are also found. The rare plants are AVENA BARPATA, AEGYLOPS VENTRICOSA, KOELERIA PHLEODES and

ENARTHRO CARPUS.

4.2.4.3 - Sand Dune vegetation

The strip of immense littoral dunes, mostly in two parallel lines with low depressions (usually seabkh) in between, is reasonably humid, receiving a mean rainfall of 150-250 mm. Fog plays an important role in the plant growth in this strip, the sea moderates the temperatures and the sea winds also carry moisture.

The natural vegetation is represented by scanty patches of AMMOPHILETUM ARINARIA. Within the patches the plant cover may reach 60-80 per cent, but within the total dune area there is no more than 5-10 per cent plant cover⁽³⁵⁾ (see Plate 4.13).

Fresh supplies of sand are continuously imported by the violent predominantly N.E., N. and N.W. winds (see Fig.2.8), and the surface layers of sand are too mobile to allow healthy plant growth. The shifting sand dunes are also (as was mentioned previously) a threat to a number of agricultural localities, especially in the Sidi Khalifa, El Monastir-El Thama, Ganfuda, Karkura and Shat El Bedin areas. Nonetheless wherever there is subsoil humidity, shrubs grow such as RETAMA RETAM especially in the Sidi Khalifa and Karkura areas, HALOXYLON ARTICULATUM which is found in abundance in the Bussufen area and LYGIUM EUROPEAUM particularly in Karkura.

Along the shore-line, there is a strip of date palms, forming beautiful palm groves at Sidi Khalifa, El Kweifya, El Thama-El Monastir, Ganfuda and Karkura. Fields of figs

and vines (which are excellent for sand dune fixation) are widespread all over the area, especially in Karkura, Er-Ragta and Shat El Bedin.

The dominant species of grass cover in the sand dune area are EMPERATA CYLINDRICA, PSAMARENARIA, SALICORNIA FRUTICOSA, POLYCONUM MARITIMUM (ver. NASRAH), DACTYLIS GLOMERATA and LYGIUM SPARTIUM as well as sea onions and camel thorns.

PART II

LAND USE

CHAPTER 5

LAND USE PATTERNS

The land use of the Benghazi Plain, in fact of all Cyrenaica, has not been studied until now. The history of the land use has remained largely unrecorded, but a vague picture may be ascertained as a result of the observation of travellers. Della Cella⁽¹⁾ for example, in 1768 described land use in the Benghazi Plain as follows:-

"In the plain immediately adjoining Benghazi,
I observed a few palm trees and some tracks of land
sown with barley, but all the rest is desolate and
uncultivated"

From the above statement, it seems that the rest of the Benghazi Plain was, and to some degree still is, engaged mainly in livestock husbandry, for grazing was the main feature of land use in the rural area, because Della Cella wrote:

"The area was rich in animal wealth and it was a flourishing trade with Malta"

One century later Hamilton⁽²⁾ described a similar picture:

"The route is along the sea-shore through a wide plain covered with briars and batum bushes, showing only in very few places slight marks of cultivation..... near the old town are many patches of cultivated ground, producing vegetables and fruit."

In the preparation of the land use map (Fig.5.1), the topographic map of Libya,⁽³⁾ on the scale 1/50,000 was used as a base map. The types of land use i.e. irrigated land, unirrigated land, cropland, horticultural land, shifting cultivation land, woodland, etc. were recorded on this map in the field. However, frequently one area of land use which qualified for two or more types is depicted as one category, mainly because of problems of scale and accurate definition of boundaries. Then the map (1/50,000 scale) was photographed and reduced to the scale 1/250,000 map (the basic map of the thesis) to present the whole work on one sheet.

The land use patterns in this study are based mainly on the system of the World Land Use Survey.⁽⁴⁾ However, the objective of land use classification in the Benghazi Plain is to differentiate between types of land according to their relative agricultural productivity and potentiality as new settlements for the rural nomadic and semi-nomadic people

in the area under consideration.

The 1960 Census of Agriculture, despite its unreliability and inefficiency,^{*} is the only source of its kind. Thus its data have been used in most of this study to show the distribution of land use patterns and agricultural production. The remaining information needed for the purposes of this thesis was obtained by the field survey, questionnaires, official statistics of 1965 and rough calculations from a variety of maps (1/50,000, 1/100,000 and 1/250,000). Table 5.1 gives a general picture of the land use patterns of the Benghazi Plain according to the 1960 Census of Agriculture.

Table 5.2 gives a generalised picture of the cultivable land by types of land use according to the 1960 Census of Agriculture. About 26.5 per cent of the arable or cultivable land was under temporary crops, 5.3 per cent under temporary meadows, 1.0 per cent under vegetables and flowers and 67.2 per cent fallow land.

Owing to the inefficiency of the 1960 Census of Agriculture with regard to the land use patterns of the Benghazi Plain, therefore, a tentative land use classification (Table 5.3) based on the field survey of 1966-67, and a variety of maps, questionnaires and official statistics of 1965,[†] have been introduced to complete this study.

^{*}According to the 1960 Census of Agriculture (p.26a) "All land use patterns which were not part of holdings were not included in the Census.

[†]The 1965 Statistics of Agriculture are the only available data since 1960 and are still unreleased.

5.1 - Cultivated land

The total area of Benghazi Plain is estimated at about 600,000 hectares or 6,000 sq.km. The arable or cultivable land, utilised for various agricultural purposes in 1965, was about 248,915 ha. or 41.4 per cent of the total area (Table 5.4). Of this arable land, 2,561 ha. were irrigated land, 600 ha. of which were devoted to horticulture, mainly as small gardens inside the walls of the villages, i.e. Gamines, El Gwarsha, El Fweihat, Tokra etc. 1,064 ha. were under irrigated vegetables and 847 ha. under fruit trees. There were 67,246 ha. under cereals two fold rotations of winter wheat and barley with fallow depending upon the frequency and reliability of rainfall. About 578 ha. were under permanent tree cropland, mainly unirrigated or partly irrigated fruit trees which are found mostly in the dolinas, near the escarpment and in the coastal sand dune areas. Fallow covered 178,071 ha.

The area producing annual field crops in 1965 amounted to about 11.5 per cent of the total area of the Benghazi Plain and about 27.6 per cent of the arable land. It includes all cultivated areas; irrigated or partly irrigated areas near the coast, the dry and shifting agriculture areas (mainly wheat and barley) and small gardens of fruit trees and vegetables in the middle of the plain and near the escarpment, e.g. Es-Sira El Hamra (south-east of Deriana), Beit Ben Rajeb (east of Jardina), etc. It also includes a small number of

marginal areas which are not cultivated as frequently as the main arable land near the coast, and which are often allowed long fallow periods, as for example the lithosol areas, the areas surrounding the sebakh (mainly cultivated with barley) some of the dolinas, sand dune areas and some rock outcrop areas, notably in the north of the plain.

5.1.1. - Irrigated land

As has often been mentioned, the climatic factors and the characteristics of the terrain in the Benghazi Plain, make irrigation important. Full irrigation permits intensive use of land and a wider choice of crops than dry farming. If additional good water supplies are available increasing yields on the existing cropland are possible and new areas can possibly be brought into perennial cultivation, which means more agricultural production.

Despite the importance of irrigation in the Benghazi Plain, in fact in all of Libya, only a small proportion (1.0 per cent) of arable land is irrigated, owing to the scarcity of good underground water (for irrigation).

The traditionally irrigated area of the Benghazi Plain is almost entirely confined to the areas between the coast and the 20 metre contour line in Es-Sahel and between the coast and the 30 to 40 metre contour lines in Barga El Hamra. However, Benina, El Haw-Wari and En-Nawaghia are areas irrigated fairly recently by deep wells, drilled by modern equipment in the vicinity of the 100 metre contour line.

The irrigated land in Benghazi Plain has not been accurately surveyed yet. Leuenberger,⁽⁵⁾ the F.A.O. Water Utilisation expert, believes that the total amount of irrigated land (6,532 ha.) of the 1960 Census of Agriculture is not correct, because it was based on the questioning of the farmers and not on actual measurements using aerial photographs and field observation (as he did in his study). The census total of irrigated land was an area of roughly 65 square kms., and

"Such an area would cover a continuous strip of 1 km² from Benghazi to Tokra, something which simply doesn't exist."

He suggested that the actual area under irrigation in the coastal area is about 620 ha. Leuenberger,⁽⁶⁾ however, has contradicted himself in other reports, in which he estimated the irrigated land at about 2,000 ha. or more in the coastal area of the Benghazi Plain.

Leuenberger was, to a certain extent, right about the unreliability and inaccuracy of the 1960 Census of Agriculture, but he has forgotten that the 1960 Census covered the whole area of the Benghazi Plain (Es-Sahel and Barga El Hamra, see Table 5.5) and not only the Es-Sahel area from Benghazi to Tolmeita, as he defined the Benghazi Plain in his reports. Thus, his suggestions that the irrigated area was 620 ha. concerns only the irrigated area of Es-Sahel and

not the whole area which was covered by the 1960 Census of Agriculture.

Table 5.5 shows also that Slug Mudirya had 516 ha. of irrigated land, whereas in reality even today (1967) the area under irrigation does not exceed 5 ha., since the cultivated area is not more than 12 ha. Gamines with about 200 irrigated small farms had no irrigated land at all according to the 1960 Census. Moreover, Table 5.5 shows that in Tokra there were 594 ha. of land irrigated by means other than the dalu and engine pumps. In reality almost all the irrigated land in Tokra is still (1967) irrigated only by dalu and engine pumps and there are no other means possible, since there are only two windmills irrigating about 30 ha. and there is no coastal sand dune cultivation which is usually irrigated by human power. In Deriana, Sidi Khalifa, El Kweifya and El Magrun where most of the irrigation is carried out by human power or windmills, the Census failed to record it.

Although the irrigated area has increased considerably in recent years by the newly irrigated areas of Benina (about 458 ha.), El Haw-Wari (80 ha.) and En-Nawaghia (about 200 ha.), as well as the increased areas in the existing irrigated land, due to the newly introduced and rapidly spreading engine pumps and windmills, nevertheless, the area under irrigation in the Benghazi Plain still does not reach

the figure of the 1960 Census (6,532 ha.). Yet it is much greater than the area which was suggested by Leuenberger⁽⁷⁾ (620 ha.) in 1964 and more than according to the 1965 Statistics (2,561 ha. see Table 5.6). In the light of field observation, it might be suggested that an area of about 3,000 ha. was under irrigation in 1967.

Table 5.4 shows that about 41.5 per cent of the irrigated area was devoted to vegetables, 33.1 per cent to fruit trees, 23.4 per cent to horticulture and only 2.0 per cent to legumes. Generally speaking, the irrigated area is almost entirely around Benghazi which incidentally is an area of good water and in Class I and II of the land capability classification. It is worth mentioning also that the average consumption of irrigation water per unit of land is smaller in the coastal area, due to the sea influence, than in the hinterland, and, of course, higher in the semi-arid area in the south (rainfall less than 200 mm. per annum) than in the north (rainfall 250-350 mm. per annum).

Thus about 80 per cent of the irrigated land is found in the Es-Sahel, despite the fact that the arable land in the Barga El Hamra is more than three times that of the Es-Sahel.

5.1.1.1 - The evolution of irrigation

Irrigation in the Benghazi Plain and in almost all the northern part of Libya has been practised since Greco-Roman times. A large number of the Greco-Roman wells and cisterns

are still in use for irrigation all over the Benghazi Plain. Even today the farmers and the Bedu seldom dig a new well or cistern but instead they reconstruct the destroyed or neglected ones, which are numerous and widespread in the Benghazi Plain and in some other parts of Cyrenaica as well. The famous historical gardens of Hesperides⁽⁸⁾ in the area between Benghazi-Benina and El Kweifya, must have depended on irrigation. The remnants of canals in the Tolmeita and Deriana areas (Plate 5.1) reveal the past prosperity in both irrigation and domestic water supply (today both areas are deprived even of good drinking water). Nevertheless, irrigation must have been declining before the Arab conquest, and probably was completely neglected after the massive invasion of the Beni Hilal and Beni Suleim in the 11th century, after which Cyrenaica became entirely a Bedu country. According to the Bedu custom of disdaining sedentary agriculture, irrigation must have been completely abandoned, except of course in a very few small backyard gardens around Benghazi.

Irrigation on a relatively wider scale would have started after the settling of the Tripolitarians (sedentary farmers) who came to Cyrenaica during the middle of the eighteenth century, as mercenaries to help the Saadi tribes in their war against the Awlad Ali tribes, which finally defeated them and pushed them into Egypt. After the end of the tribal war, most of the Tripolitarians settled in the coastal area of Cyrenaica, at Derna, Tolmeita, Tokra, Benghazi, El Gwarsha, etc. These

new settlers immediately engaged in irrigated agriculture on a rental or crop sharing system, and thus practised the same irrigation methods and techniques of the dalu system which is used in their homeland, Tripolitania. This system, however, is still in existence, almost everywhere in Cyrenaica. The Turks had not introduced any improvement in the irrigation system or any other agricultural activity.

The Italian occupation, mainly by private Italian entrepreneurs, brought about some development in the irrigation system and agricultural techniques.

The British Military Administration produced an increasing demand for the development of water supplies, mainly for domestic purposes, as a result of which a huge underground supply of good drinking water was discovered at Benina (see Chapter 3). This, no doubt, led the Libyan authority, after independence, to follow this path in discovering more water for domestic use and irrigation, especially from Benina and the surrounding areas.

The discovery of large underground supplies at Benina has encouraged some capitalists to buy land and drill deep wells (about 100 m. deep) and thus reclaim new land for irrigation. This has led to the establishment of 5 large commercial farms with an irrigated area of about 500 ha. X

The Libyan Government, however, since independence, has spent a large sum of money and tried hard to find new water supplies for irrigation and domestic purposes. In addition,

many experts from different countries and international organisations came and made investigation reports.

Unfortunately, most of these reports are kept in files and probably forgotten to be followed by others and so on. The situation has remained the same, with the people and the land still desperately needing water, and yet little has been done about it although good water is probably available in the area (see Chapter 3) under consideration.

The irrigation water in the coastal plain is extracted from wells containing a shallow layer of non-saline ground water overlying saline water (see Chapter 3). The 1960 Census of Agriculture reported 7,690 wells in the Benghazi Plain. Leuenberger, for the same irrigated area, suspected the reliability of this above figure and instead he estimated about 6,000 wells. The Italians in 1928⁽⁹⁾ conducted a survey which gave the Benghazi Plain 1,414 wells, whilst the 1/50,000 scale map of 1964 shows that there were about 1,557 wells. However, according to field investigation, not many wells have been dug for irrigation in Benghazi Plain since the Italians left the country, and in fact there are more than 600 farms with their wells destroyed or deserted. Consequently, an estimation of 3,200 wells will probably be justified (see Table 3.3).

5.1.1.2 - Irrigation methods

The irrigation methods followed in the Benghazi Plain are (1) by DALU, using animal or human power, (2) by pump, and (3) by windmill.

5.1.1.2.1 - The Dalu

(a) The use of animals in dalu irrigation prevailed before the introduction of engine pumps and windmills.

By this method the irrigation water is lifted from shallow wells (5 to 15 m. deep) by a camel or donkey, while in Tripolitania, in similar areas, the draught animal is usually a cow. The water is lifted in a small skin or rubber bag, with an average capacity of about 30 litres. The bag or dalu is filled with water and lifted by means of two ropes attached to the draught animal (see Plate 5.2). The full dalu is pulled up by the animal and the water is poured into a small shallow pool (about 2m^2 in area and 0.5 m. deep), the so-called meda, which leads the water into a canal to the reservoir or jabiya. By this method, the jabiya takes between 6 to 8 hours to be filled with water. Thus, this method yields about $10-15\text{ m}^3$ per day which can irrigate 1 to 1.5 ha. The water is usually drawn before sunrise in order to avoid exhaustion and evaporation. After the jabiya is full, the water can then be discharged through long earth canals into small beds a couple of square metres in area called Jdula separated by little embankments of sand.

The dalu method is very primitive and time wasting and most of the water is lost through the earth canals by seepage, in addition to the limited area which can be irrigated by this method. Thus farmers, in most cases, are obliged to leave more of their land fallow. However, a new era of engine pumps

and windmills has started in recent years, as a result of the impact of petroleum on every aspect of life in Libya. Most of the farmers in the Benghazi Plain began to orientate themselves toward the use of engine pumps and windmills, and they also realised the advantages and necessity of a concrete canal lining. The concrete canal lining project in the Benghazi Plain was initiated by the LAJAS (Libyan-American Joint Agricultural Services) in 1960, and by 1961 about 360 farmers had benefited with a total length of about 72,000 metres lined.⁽¹⁰⁾ During my field work in 1967, I saw many farmers constructing and installing concrete canals in their farms by themselves, the Ministry of Agriculture providing half the cost of raw materials and free wooden forms for constructing canals.

There is no doubt that the increasing number of concrete canals not only improves irrigation conditions but also brings irrigation to new areas. Thus farmers can increase their cropland and decrease their fallow (which they were obliged to leave due to water limitation).

The animal-dalu irrigated areas have continually decreased, particularly in recent years. At present the animal-dalu method is maintained by the poor farmers and is mostly found in Gamines, El Gwarsha, Tokra, Tolmeita, El Kweifya and some parts of El Fweihat.

According to the 1960 Census of Agriculture, 3,330 ha. were irrigated by the dalu method of which 49 per cent were in

El Gwarsha and El Fweihat alone (Table 5.5).

(b) The use of human power in dalu irrigation exists only in the coastal sand dune farming areas where underground water is easily accessible near the surface, and no other means (animal, pump or windmill) can be used. Here the water is obtained after the removal of the sand from a consolidated sand layer of about 50 cms. deep, known locally as "Tush-Shani." Then wells are dug, usually by axes and sometimes by explosion. The wells, after being cleared, are lined with stones or hollowed barrels in order to prevent the sand from collapsing into the wells (Plate 5.3a). The depth of these wells varies from 50 cms. to 150 cms. The water level is shallow with between 10 and 40 cms. of fresh or brackish water floating over sea water. The water is lifted from the well by hand usually with a rubber dalu or bucket (Plate 5.3b) and irrigates the small plots directly from the well, watering it once forward and once backward (Plate 5.3c) until the whole area is completely irrigated. Since these wells are very shallow and contain little water, each plot contains from 2 to 4 wells, in order to provide sufficient water. Moreover, the terrain is levelled with slight inclination toward these wells to allow the irrigation water to return quickly to the wells by seepage, and to eliminate evaporation.

At present, there are no data showing the area irrigated by this method or its potential for agricultural land development, but it is understood that rainfall availability is the

limiting factor in the potential of these wells (see Chapter 3).

The 1960 Census of Agriculture gave 599 ha. of unclassified irrigated areas. This means that these areas were irrigated by manpower, since there was only one windmill at that time, which belonged to a Greek farmer in Bujarrar and irrigated only about 20 ha.

However, there are two types of irrigation by sand dune wells:-

(i) Perennial irrigation wells. These wells are utilised to irrigate crops (vegetables) all the year round especially in the spring and summer. They are found mainly in El Thama, El Monastir, Sidi Khalifa, Gasr El Ajuz, Karkura and Shat El Bedin.

(ii) Seasonal irrigation wells. These types of wells are used for partly irrigated winter crops (mainly vegetables) during the period of planting and before the first winter rains, or in the case of delayed rainfall. They are less important than the former ones for their water is very shallow and brackish and is used mainly for salt tolerant crops, i.e. tomatoes, melons and pumpkins. These wells are utilised only in the dry farming sand dune areas (Fig.5.1), namely Ganfuda, Deriana, Aseila, Et-Terria, El Murra and some other small areas along the coastal belt.

5.1.1.2.2 - Pump Irrigation

The use of engine pumps for irrigation in the Benghazi

Plain is a new means of irrigation among farmers outside the Benghazi area. They became widespread notably in the Es-Sahel with the flourishing of vegetable farming, caused by the big demand at Benghazi market.

The engine pumps in the Benghazi Plain are installed near wells with depths varying between 5 and 15 metres. Little care is taken of them (Plate 5.4), and this makes the farmers waste both time and money in repairing them, in addition to the risk of crops drying up if other irrigation methods are unavailable. Such compensatory methods are either use of the dalu-animal method or renting, borrowing or buying spare engine pumps to replace the broken one in order to save the crops. However, some farmers, especially in the large commercial farms in El Fweihat, Benina and El Gwarsha, have built suitable shelters or rooms for their engine pumps and take good care to protect such equipment from defects.

At present, about 90 per cent of the engine pumps (mostly are portable) are tapping water from wells previously worked by the dalu-animal system.

According to the 1960 Census of Agriculture, there were 24 engine pumps in the Benghazi Plain of which about 55 per cent were found in and around Benghazi. Table 5.7 shows also that there were 3 electrical motor pumps in Tokra and 2 in Tolmeita, but this is not true, because until September, 1967, there was no electricity at all in either village.

The number of engine pumps has recently increased

enormously (especially the portable type of engine pump) in the coastal area. The 1967 survey shows that there were about 392 engine pumps in the Benghazi Plain. 87 per cent were found in Es-Sahel area. In Sidi Khalifa alone there were about 27 per cent (Table 5.7). In general, however, it might be said that the widespread use of engine pumps and windmills during the last few years is due mainly to the subsidies of the Ministry of Agriculture which allows farmers to buy and install engine pumps and windmills at 50% of the total cost.* The 50 per cent which is supposed to be paid by the farmer is loaned by the National Agricultural Bank on condition that the farmer must pay back the loan within a period of three to five years without any interest.⁴ In addition there is free taxation of such equipment.

The quantity of available water in the coastal area is still not large enough to allow the installation of a large number of engine pumps and, as stated earlier, since the existing water body lies over salty water, the encroachment of saline water as a result of excessive pumping is feared. Therefore, a controlled rate of pumping water for irrigation must be imposed on each farmer who owns an engine pump. But, unfortunately, with the present social and political situation, the farmer is not ready to accept this, nor can the government exercise its authority over the farmers.

*The average cost of a small engine pump is about £L.220 and a windmill is about £L.400.

⁴A Royal decree was issued in 1966 prohibiting any interest on loans given by the N.B.A. and the I.R.E. Banks to Libyans.

However, Leuenberger⁽¹¹⁾ suggested that a pumping rate of 8000 m³ per year is sufficient for the size of farming units the farmer owns in this area (see Chapter 9) in order to keep the dynamic equilibrium existing between the fresh or brackish water and the sea water undisturbed.

5.1.1.2.3 - Windmill Irrigation Method

The use of the windmill for irrigation in the Benghazi Plain is relatively new, and was introduced by the Italians; windmills first were installed on galleries in Slug, El Fweihat and Tokra to pump water for domestic and army purposes. During the last years of their rule, they installed some windmills for livestock watering in El Magrun, Jardina and Tolmeita. Unfortunately, almost all these windmills are defunct at present, despite their importance to both human and livestock water supply. Nevertheless, the Ministry of Public Works, has lately installed a few windmills for domestic and livestock purposes in El Magrun and Tolmeita.

Windmills for irrigation purposes have also been introduced since the Italian time, but there are very few and they serve only small gardens, mainly in El Fweihat and El Gwarsha areas (Plate 5.5). At present windmills are widely adopted for irrigation because of their cheapness and easy operation, besides the subsidised price.

Windmills are mostly installed on wells of 20 to 30 m. deep. The windmills which operate in the Benghazi Plain are either medium or large, according to the size of the discharge

pipes (Table 5.8). However, with both windmills and diesel engine pumps, the deeper the well the less water can be extracted, but this does not apply in the case of electrical motors.

Most of the interviewed farmers intend to install or replace their engine pumps by windmills, particularly because of government encouragement and the easy availability of spare parts. Leuenberger⁽¹²⁾ recommended that engine pumps installed on shallow wells should be avoided in order to prevent salt water encroachment from over-drafting, and they should be replaced by windmills.

Windmills are a good and cheap means of irrigation and the increasingly widespread use of them is of great importance to agricultural development. But, unless local technicians for repairing and maintaining windmills are trained, their operation remains precarious, for there is only one Italian technician in the whole of Cyrenaica (even Tripolitania has very few technicians) and he might leave the country without even advance notice. However, precautions similar to those in the case of engine pumps must be taken into account for the safety of the crops.

The 1960 Census of Agriculture recorded only one windmill in Tolmeita, while the 1967 Survey recorded 83 windmills, of which 75 per cent were in El Gwarsha Mudirya (Table 5.7). Consequently, it may be concluded that the engine pumps were concentrated in the northern part of the Benghazi Plain while the windmills were concentrated in the south.

The availability of water for irrigation is, however, not the only handicap to agricultural development, but there are problems such as the ignorance of almost all the farmers of agricultural techniques and management, the lack of adequate capital, almost complete absence of supervision and guidance and the inherited tribal attitude toward sedentary agriculture. There is a general belief among the Libyan farmers that the more water is applied to the crop the higher will be the production. In many cases water is flooded over the ground and thus wasted instead of being used properly. This of course leads to the risk of deterioration through an increase of salts on the bases (as was stated earlier, almost all the irrigation water in the coastal plain is brackish). Nevertheless, with such saline water, frequent irrigation is needed, for 25 per cent more water than usual is required in order to avoid the accumulation of salts in the root zones.⁽¹³⁾

Water for irrigation, which has to be properly managed throughout the growing period, is a very important factor in agricultural development. The soil texture in the Benghazi Plain varies from place to place (see Chapter 4), so the infiltration rate of water varies accordingly. It is, in general, low in the clayey soils (terra rossa), moderate in the loamy soils (alluvial soils) and rapid in the sandy soils (regosols). The irrigation requirement for field crops as shown in Table 5.9⁷ could possibly be adopted for the Benghazi Plain, since it was originally established for a similar semi-

arid area in West Pakistan.⁽¹⁴⁾

Generally speaking, the sandy loam soils require light irrigation at frequent intervals, compared with the clay loam or clay soils which need heavy irrigation at longer intervals. In general, however, heavy irrigation is preferred before sowing and for the fruit trees as well. Light irrigation is needed for better germination of the crops. Sprinkler irrigation is unfavourable in the Benghazi Plain (unlike Tripolitania where it is widespread), mainly owing to the salinity of the water which by this method burns the crop. Therefore, surface irrigation should be applied and an increase of the concrete lined canals is the best way of saving water.

Leuenberger⁽¹⁵⁾ has also suggested a regime, based on a study carried out in similar area in the U.S.A. for the irrigation requirements and irrigation intervals of various crops grown in the coastal region of Libya (Table 5.10).

5.1.1.3 - Semi-irrigation

Semi-irrigation is practised in the dry crop farming areas mainly in the coastal sand dune belt. Since the rainfall is erratic and scarce, a small amount of water is applied to the crop (mainly vegetables) at the planting stage until the first rain falls, or at critical times (delayed rainfall) in order to give the crop advantages it would not have it if were produced under totally dry conditions. For example, vegetable cultivation in Ganfuda (south-west of Benghazi) is based primarily on this method, though it is very costly, since the

farmers use carts equipped with large barrels carrying water from as far as El Gwarsha (about 6 km.) or even Benghazi (9 km.).

Nevertheless, the crops, mainly tomatoes and marrows, are very successful and bring very good returns which more than justify the high cost of this method of semi-irrigation, which could offer possibilities for expansion particularly in El Thama, El Monastir, Sidi Khalifa, Bugtefa and Shat El Bedin, where water is sufficiently close to the surface. But this needs improvement of the present techniques of semi-irrigated farming. Thus more devices are needed to know the properties and limitations of specific land areas and the crops upon which they are to be cultivated. In addition to the use of carts and wagons, equipped with large rubber tyres to minimise the draft when pulled over soft sand, the introduction of a few permanent feeder lines, constructed from concrete or other flexible tubings, would minimise the capital cost of such irrigation.

5.1.1.4 - Development of new irrigated areas

The previous mentioned irrigated areas in the Benghazi Plain are entirely irrigated by known sources of underground water (Chapter 3). According to the experts' investigations and remarks, additional underground water outside the Benghazi-Benina-El Kweifya area is not available, at least at present. However, during my field work I have observed much drilling with private modern equipment in search of

irrigation water in the area between En-Nawaghia and Jardina, and this activity has yielded a large quantity of underground water suitable for irrigation. The depth of the tested well is 100 m. The water level was found at 64 m. at the drilling stage, but then it rose up to the 20 m. level. Thus the water level became 56 m. deep. By 1967, five large commercial farms were established, one in the west and four in the north of En-Nawaghia by capitalists from Benghazi City. It is expected that more farms of this kind will be established in the above-mentioned area in the near future.

This large quantity of underground water indicates that the area is relatively rich in water supply for irrigation. Thereby new areas could be brought under irrigation, notably in the north and west of En-Nawaghia, east and north-east of Jardina and south of El Haw-Wari. This area, as suggested elsewhere, is very promising for agricultural development, particularly for citrus and orchard plantations, which have already been successful in the five newly established farms mentioned above.

Another underground water body of over 1,000 litres per second is known to exist in the Benghazi-Benina-El Kweifya area (Chapter 3) and about 40 million litres of this water flows through Ain Zaiyana and is lost to the sea every day. This large quantity of underground water, apart from that utilised by Benghazi City ($22,750,000 \text{ m}^3 = 5 \text{ million gallons}$ per day) has not been exploited yet. Although the terrain of this area is mostly bare rock (karst) and lithosols, there is

an area near the escarpment between Benina and Sidi Khalifa with fertile and relatively deep terra rossa. It is now used for grazing and shifting cultivation, but could be reclaimed by irrigation projects (see Fig.5.1).

The expansion of irrigation is possible also in the areas of the Class II and III land capability classification (Fig. 4.2). in the northern part of the plain, where additional underground water is feasible (Fig.3.7). These areas were, in ancient times, very rich in olive tree plantations and cereal cultivation, but have never been irrigated, due to the great depth of the water level (100 m.) and the difficulty of digging wells by hand and drawing water by the animal or human methods used for irrigation in the coastal area where the water level is between 5-10 metres deep. Nevertheless, there are some deep (40-60 metres) old wells in Ghot El Arka east of Deriana, east of Jardina and Gasr et-Tawil, which were dug mainly for domestic and livestock purposes.

The availability of water in these localities (a detailed study is still needed) shows the high potential for irrigated farming which, of course, in turn will increase agricultural production and encourage the Bedu of the area to settle and practise sedentary agriculture.

If, however, an irrigation scheme in the higher areas of the plain caused a decrease or depletion of the water in some wells in the coastal area, how could this problem then be solved? In my own opinion the development of the hinterland, where

there are vast areas with more fertile and deeper soils and abundant and less saline underground water, is more important than the preservation of small farms in the coastal areas. The farmers of such affected small farms could be transferred to these proposed new irrigation areas, since there will be no tribal problems regarding the new settlers, because almost the whole rural population of the area concerned belong to one tribe of El Awaghir.

At present, it is doubtful that any consideration can be given to this proposal, because the government and all other agricultural development organisations (N.A.S.A. and F.A.O.) are fully engaged with the agricultural development in Jabal El Akhdar on the one hand and with other more urgent projects, such as the Benghazi sewage scheme and the Wadi El Gattara water dam, on the other.

The N.A.S.A. is developing a new effluent irrigation scheme from sewage in the El Gwarsha area, south of Benghazi for a land settlement project, and the Ministry of Public Works is constructing a dam on Wadi El Gattara, which will probably be used for an effluent irrigation scheme, but this has not yet been confirmed.

5.1.1.5 - The Sewage Purification Plant

This project was originally aimed at solving the crude sewage problem of Benghazi City because the present sewage system exists only in the older part of the city and effluent is discharged to the sea near the harbour and beaches, result-

ing in pollution of the coastal waters and spoilation of the coastal amenities. In the rest of the rapidly expanding city the crude sewage is extracted periodically from water-tight cesspools dug near the houses and buildings. The streets of Benghazi are also always flooded by the winter rains and many swamps are consequently formed, particularly in the poorer areas. Consequently, the government felt responsible for solving this problem and began constructing a sewage purification plant in El Gwarsha. The project, which was proposed in 1961, is under way and the construction is at its final stage (Plate 5.6). As a result of this project an irrigation scheme has been planned for new land settlement in El Gwarsha.

The Sewage Purification Plant is located on state land north-east of El Gwarsha village. It occupies an area of about 49 ha. (Fig.5.2). The estimated daily capacity of the plant is about $40,950,000 \text{ m}^3$ (9 million gallons).⁽¹⁶⁾ At present, the amount of water available for irrigation will be about 13.65 million cubic metres (3 million gallons) per day which needs 22.75 million cubic metres (5 million gallons Benghazi's daily production) of crude sewage water to produce it. Additional water is expected to enter the sewage system as a result of the winter rains, but there is no definite information available yet for the rate and the amount of this surplus water. Nevertheless, Leuenberger⁽¹⁷⁾ has suggested that a quantity of $350,000 \text{ m}^3$ per year will be expected. In addition

to the water supply, the plant will provide about 10,000 tons of fertilizers per year.

The cost of this project was estimated by Howard Humphreys Consulting Engineers in 1961 at £L.3,000,000.⁽¹⁸⁾ In 1967, the cost reached £L.6,000,000, and will probably rise again. This is due to the scarcity and high cost of labour, and the project has already been in the hands of more than four construction companies.

Construction started in 1964 and the agreed completion date was May, 1968, but the shortage of labour in Benghazi and the psychological effect of the June war (the project was undertaken by an Egyptian firm) on the workers have delayed the completion of the project and it will be delayed for a considerable period to come.*

The chemical quality of the purified sewage water is not yet known but, generally, it is similar to that of Benina water from which it is derived. Nevertheless, the amount of the dissolved materials (phosphate and nitrate) will be higher by the time the water has passed through the purification treatment. Although this water is of low quality, it is suitable for well controlled irrigation which maintains a relatively high level of soil moisture and thus prevents the concentration of salt in the root zone.

According to the experts' estimates, the sewage plant water could irrigate an area of about 1,000 ha. of existing irrigated land and new dry farming lands. The quantity of

*The project has been taken over from the Egyptian company by a Yugoslavian company since the beginning of 1968.

water which will be available from the sewage plant can irrigate an area of about only 420 ha.,⁽¹⁹⁾ 105 farms of one hectare under full-time irrigation and 315 farms of 3 ha. under part-time irrigation.

N.A.S.A. has chosen the area which consists of mostly privately owned land for an irrigation scheme (Fig.5.2). This area will be expanded by the increase of the sewage water supply as a result of the daily increasing water consumption of the rapidly growing Benghazi City.

The surplus which will be available as a result of the winter rains is, however, excluded from the irrigation scheme because it comes in the time when it is not needed. Moreover it cannot be stored in the existing shallow reservoirs for the high summer evaporation might cause an increase in the salinity of the water beyond the plant tolerance. The storage in the form of ground water is not feasible, since the estimated surplus water ($350,000 \text{ m}^3$) is too small and, of course, the water will infiltrate and run toward the sea. Besides, the ground water of the immediate vicinity of the irrigation scheme area is salty or brackish. Therefore, its salinity will increase as a result of salt leaching.

The surplus water could, possibly, be used for partially or semi-irrigated winter cereals (wheat and barley) in Irrahba area or, as Leuenberger has suggested, to irrigate some of the olive orchards near Benghazi, which at present depend entirely on rainfall.

Some experts⁽²⁰⁾ suggest that initial full investigations were necessary to assure the economic possibility of this scheme before execution is taken. This assumption is, to some degree, logical but in this case is unnecessary for the project was originally proposed not for the purposes of irrigation or for land settlement, but in fact, it was created to solve the problem of Benghazi's sewage disposal. Therefore the scheme must go ahead without any hesitation or delay, in the hope that the irrigation scheme will succeed as well. However, the success of the scheme will bring hopes of fresh vegetables and fruits for Benghazi, which at present are mostly imported from Tripolitania and abroad.

5.1.1.6 - Wadi El Gattara Dam Irrigation Scheme

Although the Government has not yet decided how the water supply collected by the newly proposed Wadi El Gattara Dam ought to be utilised, it is most likely that it will be for agricultural purposes. The possibility of adding this water to the Benina reservoirs in order to reduce the salinity of the existing domestic water supply for Benghazi City is not feasible, because it would represent only a small proportion ($36,000 \text{ m}^3$) of the daily consumption ($22,750,000 \text{ m}^3$) of Benghazi City.

The main purpose of the construction of the Wadi El Gattara Dam is to protect the urban population of Benghazi City and the rural population of the watershed area in the Benghazi Plain and in the Jabal El Akhdar (El Abiyar area)

from the frequent floods caused by this wadi, resulting in damage to agricultural lands, roads, buildings and loss of animals and human lives (Chapter 3).

The proposed main dam^{*} is located near Sidi Busdyrah, about 8 km. south-east of Er-Rajma, with a height of 33 m. and a capacity of about 100 million m^3 of rain water. A secondary dam 28 m. high with a capacity of about 10 million m^3 lies about 10 km. west of the main dam, exactly at the outlet of the Wadi El Gattara near Bir Bu-Laati (Plate 5.7). 7 other small check dams of 3 to 6 m. high will be constructed across the main tributaries in the upper catchment (Table 5.11 and Fig.5.3). to catch the coarse material and also to reduce the intensity of the flood water at the main dam site. In addition to the benefit of conserving the soil from the runoff, it was also proposed to channel the lower reaches of Wadi El Gattara i.e. Wadi Faruon from the El Haw-Wari Bridge to the sea, a distance of about 8 km., in order to protect Benghazi City and the surrounding agricultural land from the high floods.

According to the engineers' evaluation, the amount of water which will be available in the main dam is about 25 million cubic metres per year. About 5 million m^3 of this water will be lost by evaporation and 7 million m^3 by infiltration every year. Thus, the remaining water, which can be utilised for irrigation, will be about 13 million m^3 per year.

^{*} A governmental tender for the constructing of this dam was won by a Yugoslav firm at the beginning of 1967. The construction of the dam is going on at present.

According to Leuenberger's⁽²¹⁾ calculations of the water required for irrigation by the sewage water supply, it is possible to calculate, with slight changes, the area capable of irrigation from the dam water supply. The ratio between the area which can be irrigated with full-time and part-time irrigation remains the same (1 to 3), but the maximum water requirement per hectare per day will be 75 m^3 , instead of 95 m^3 in El Gwarsha, because the dam water comes from rainfall with low salinity and will be practically free from sodium chloride. Consequently the total area which could be irrigated by the water supply of Wadi El Gattara dam will be about 1,780 ha., (445 ha. for full-time irrigation and 1,335 ha. as part-time). There are vast areas of fertile and relatively deep terra rossa on both sides of Wadi El Gattara inside the Benghazi Plain which could be allocated to this proposed irrigation scheme, but it would be more constructive to choose the area which lies in the south of Wadi El Gattara (Fig.5.3) in the En-Nawaghia Mudirya, which has the lowest per capita income (less than £L^{a} .50 per year) and where most of the land is privately owned, and since the population are almost entirely semi-nomadic, a project like this is vital to them (new land settlement projects for this and other areas will be proposed in the conclusion of this thesis). If the irrigation scheme of the Wadi El Gattara Dam for one reason or another is not feasible, an alternative project would be possible. This would be to plant olives, (this area was

^a £L. stands for Libyan pound.= about L.0-17-6.

famous for its olive tree plantations in ancient times), almonds and figs, which could be partially irrigated, or to create improved grazing land for fodder (mainly hay) production, and at the same time afforest the surrounding areas for recreational purposes.

5.1.2 - Unirrigated Crop Land

Land of this type is cultivated with rain water only, and there is no irrigation from any other source. Crop cultivation, therefore, is precarious.

The unirrigated crop land in the Benghazi Plain comprises about 11.4 per cent of the Benghazi Plain, and occupies mainly the area between the 20 m. contour line and the escarpment.

According to the 1965 statistics, cereals occupied 98.5 per cent (67,246 ha.) of the unirrigated crop land, 52.2 per cent (35,877 ha.) being under wheat and 46.3 per cent (31,369 ha.) under barley. The unirrigated vegetable land was almost entirely confined to the coastal sand dune area such as Aseila, Deriana, El Kweifya, Ganfuda, Et-Tarria, Karkura, Er-Ragta and Shat El Bedin (Fig.5.1) where suitable underground water for irrigation is not available. It occupied an area of 410 ha. or 0.6 per cent of the unirrigated land (Table 5.4). Some unimportant plots of unirrigated vegetables (mainly for family consumption) were found in the middle of the plain and near the escarpment, in Tolmeita, Es-Sira El Hamra, north and north-west of Benina airport, east of both En-Nawaghia and Jardina and in Esh-Sharafit south-east of Gamines (Fig.5.1).

The unirrigated area of fruit trees was about 578 ha. (0.8 per cent), and they were found mainly in the dolinas of El Gwarsha, Es-Sira El Hamra and in the various areas of the coastal sand dune belt. All kinds of fruit trees are grown on the plain, while in the coastal sand dune areas the palm groves, vines and figs are almost the only fruit trees grown. Along the road near Benina village (Zeew Farm) and around Benghazi are dry framed olive trees and orchards. Some clumps or individual fig trees are also found on the escarpment, wadi outlets and the lithosols and rock outcrop areas in Es-Sahel and Barga El Hamra.

The unirrigated leguminous land lies mainly in Tolmeita, Benina, El Gwarsha, Jardina and Gamines (Table 5.12).

Table 5.12 shows also that about 44 per cent of the unirrigated legume cropland was found in Tolmeita and Jardina alone, while the irrigated leguminous area was found mainly around Benghazi where, of course, irrigation water is abundantly available.

According to the 1965 Statistics, (Table 5.4), about 71.6 per cent of the cultivable land was lying idle (fallow), and most was used for grazing. This percentage is generally about the same every year. Therefore additional land for unirrigated crops (mainly cereals) could be added every year, and to make maximum use of the area available, mechanisation in sowing, harvesting and threshing should be used.

New areas for planting olive trees and other orchards

(on a dry farming system) are certainly available since most of the plain, as it was mentioned before, was famous for olive tree plantations during ancient times. The ruins of presses are found in many places in the plain and the remaining olive tree trunks near the escarpment between Benina and Sidi Khalifa are eye witness of the flourishing olive tree plantations during Greco-Roman times.

During my field investigation I was told by the assistant Mudir of Sidi Khalifa that an area of about 32 km.² between Benina-Sidi Khalifa and the escarpment (the site of the ancient olive tree trunks) was confiscated by the Italian government and reclamation for dry farming of olive trees was planned. If the Italians had succeeded in this project, they were planning to plant more new areas along the escarpment in Es-Sahel with olive trees and other orchards, depending on the rainfall. This project never started because the Italians left the country after their defeat in World War Two.

The growing of olive trees in this area, from a climatic standpoint, is ideal since it has an annual rainfall of more than 250 mm. (the limited average for olive growth is 200 mm.) with abundant underground water in the fissures of the limestone formation which are easily penetrated by the deep and strong roots of the olive trees. In addition, there are fertile and relatively deep terra rossa soils (Plate 4.2).

If the Libyan government reconsiders this project and reclaims the land which was prepared by the Italians (accord-

ing to the Italo-Libyan Treaty of 1956, all the ex-Italian property is inherited by the State) for the olive tree plantations and plants it under careful supervision, it will certainly be a very striking agricultural development. This project, if it ever occurs, would produce a large quantity of olive oil which would probably satisfy most of the needs of the Benghazi Plain, which are at present entirely imported from Tripolitania and abroad (mainly from Spain and Greece). The success of this project would also provide wind protection for Benina Airport and village and to a certain extent Benghazi City. There would be the added benefit of the conservation of soils from erosion and gullyng, which at present take place (Plate 4.2).

Other arable areas which could be brought under unirrigated cultivation of cereals (mainly wheat and legume) are found in the northern part of the Benghazi Plain, notably in the area between Deriana-Tokra-Tolmeita and the escarpment, particularly after the brush forest has been properly cleared. At present, it is competing with the limited existing cropland for space and moisture, in an area which has an annual rainfall ranging between 280 and 350 mm. with excellent and relatively deep terra rossa.

The reclamation of new areas by the clearing of brush forest has proved a great success in recent years, thanks to the Bujarrar Co-operative Society^{*} which initiated the clearing of forest land for cereal farming in 1964. By 1967, the

^{*}This Co-operative Society is the best one of the only tow existing co-ops in the whole of the Benghazi Plain.

Co-operative Society had cleared and reclaimed an area of about 300 ha. of good land for dry cereal cultivation. As a result of this, many farmers in other parts of the forest land started clearing their tribal land by hiring governmental or private caterpillars and tractors.* At the beginning of 1968 the government declared that any farmer could get free clearing of his forest land, on a request applied to the Ministry of Agriculture. Hence, the new reclaimed areas will be increased enormously in the coming years.

There are about 14,247 ha. of good forest land which are expected to be cleared of bushes and scrub in the coming years. 900 ha. are found east and south-east of Sidi Khalifa, 3,193 ha. in Deriana, 9,240 ha. in Tokra, Bersis and Bujarrar and 914 ha. in the area between Tokra and Tolmeita.

Out of the whole area expected to be cleared, there will be only 350 ha. which could be utilised for irrigated farming, mainly in Tokra and Tolmeita Mudiryas.

It is worth mentioning that, although more than 80 per cent of the cultivable land of the Benghazi Plain is in Barga El Hamra, yet less than 30 per cent of it is under rotational crops. The best deep soils of the depressions of Barga El Hamra are still covered by dwarf and perennial herbaceous plants. The clearing of these vegetative areas is not feasible since large numbers of livestock live on these plants,

*The cost of clearing one hectare of forest land in 1967 was £L.3 by the Co-operative Society, £L.4 by the government and £L.5 by private companies.

and they are the only source of grazing fodder for the camels in the early summer when all the grasses wither and vanish.

Generally speaking, the reclaiming of new areas for unirrigated farming in the southern part of the plain depends entirely on the availability and the efficiency of the rainfall. Therefore, any plan for land reclamation will be precarious.

The possibility of bringing more or new areas under unirrigated crops like vegetables in the coastal sand dune is bound, primarily, to the availability and cost of the labour force, market proximity and prices and the capital available to the farmers. Yet it is still precarious since it depends entirely on the rainfall, particularly during the planting period. Thus, the reclamation of new land in these areas is not very important to the agricultural development of the Benghazi Plain compared to the proposed irrigated areas already mentioned.

5.2-Uncultivable land

The uncultivable or non-arable land use in the Benghazi Plain consists mainly of areas without any agricultural value. The total area of this type of land use is about 351,085 ha. or 58.6 per cent of the total area of the Benghazi Plain. 9,449 ha. (1.6 per cent) consist of settlements and associated non-agricultural land, i.e. built-up areas, roads, railways*

* Although the railways closed in 1966, the tracks have not been removed yet.

and recreational areas. 241,474 ha. or 40.3 per cent of the total area of the Benghazi Plain is considered unproductive of which 14,100 ha. (2.4 per cent) are water bodies such as marshes, swamps, ponds and salt pans (the marshes and swamps, although providing a little camel thorn (see Chapter 4) pasture, for a few camel herds which occasionally traverse them, are essentially unproductive land), 223,174 ha. (37.2 per cent) are lithosols and rock outcrops and 4,200 ha. (0.7 per cent) are coast sand dunes (Table 5.12). Other patches of sandy desert in the deep south of the plain are clearly unproductive land.

Unproductive land use categories which do not have any direct or indirect effect on agriculture will not be discussed here; these categories have been already discussed, notably in the chapter on geomorphology, or some will be dealt with in the chapter on settlement. Therefore, most emphasis will be devoted to grazing land and forest land.

5.2.1 - Built-up areas

The rural-urban competition for land use is important only in the vicinity of Benghazi City. The size of Benghazi City is rapidly increasing, owing to the expansion of the urban and industrial land uses, in keen competition with agriculture for the use of land. However, the expansion of Benghazi City toward the south, south-east and south-west, overtaking the best agricultural area around Benghazi, will certainly continue as more people arrive from the rural areas and the number of

privately owned houses, villas, factories and garages increases. The influx of population to Benghazi is due mainly to the recent and sudden petroleum boom in the country, which led to the abrupt rise in the standard of living and the introduction of numerous projects of reconstruction and planning. This has, of course, created many jobs which attracted many rural people to the city for better opportunities in life and thus they left their farms behind them.

The high price of land, caused by the rapid urban and industrial expansion, has already yielded a belt of waste land on the outskirts of the city, evacuated by agriculture in anticipation of urban land uses. This phase can be clearly seen in the southern part of Benghazi in El Fweiha and El Gwarsha areas. In the rest of the plain, although there are some reconstruction projects, as in Slug, Gamines, El Gwarsha and Benina, their effect on agriculture is very negligible.

Industrial buildings are, however, expanding toward the best agricultural land use of El Gwarsha, south of Benghazi. While this is going on in these areas, there are vast deserted areas of lithosols and rock outcrops found in the eastern and north-eastern parts of Benghazi City (which are as far from the centre of the city as those areas of El Gwarsha) and they are still not used for residential or industrial buildings. These areas are almost entirely devoid of any agriculture, except for some scattered self planted trees and cultivation in a few dolinas or sink-holes.

In conclusion, unless the Government uses its authority to stop the creeping of the industrial and residential building on agricultural land and moves them to less important land use areas, the agriculture will be the loser in this contest.

CHAPTER 6

CROP PRODUCTION AND YIELDS

6.1 - Cereals

Cereals have always been the predominant crops and the only important crops for the majority of the rural population in the Benghazi Plain. According to the 1965 Agricultural Statistics, they occupied about 98.5 per cent of the total dry farming land use in the area under consideration (Table 5.4).

The importance of cereals (mainly wheat and barley) is an outcome of the local climatic conditions on the one hand and of the subsistence economy, the only farming Bedu can practise, on the other.

Cereals have probably flourished in the Benghazi Plain from the earliest period of history. Numerous dikes and terraces near the escarpment, i.e. Wadi Enghar, the ruins of ancient villages and the widespread remains of Greco-Roman cisterns, particularly in Barga El Hamra, reveal the importance of cereal cultivation in this area. At present cereal production ranks second to livestock production as a means of subsistence and as a source of income for the Bedu of the Benghazi Plain, or Cyrenaica as a whole.

Cereal production in the Benghazi Plain and Libya as a whole is practised under the dry farming system* in winter. This system depends entirely on the rainfall conditions. Consequently the fluctuations of rainfall are the main cause of the fluctuation of cereal production. For example, in a good rainy year[/] the cereal yields may well be above average, while in a bad or dry year the yields may fail completely and the farmer may not be able even to regain his capital and usually uses the sown fields as grazing ground for his animals. The relatively successful season of 1966-67⁶ and the failure season of 1959 are good examples for the above-mentioned cases. Fig.6.1 shows clear declines in production from 1955 to 1957, from 1958 to 1959 and from 1962 to 1963. It is noticeable also that, although the increase of rainfall totals from 1958 to 1962 was relatively rapid and steady, the increase of cereal production was small and gradual. In fact, in 1959, it dropped to its lowest since 1947-48, owing to the effect of the dryness of the previous years on the one hand and the uneven distribution of the rainfall on the other. In the 1962-63 season the rainfall in Benghazi dropped sharply from 348 mm. to 184 mm. causing, of course, a rapid decrease in cereal production. From 1963 until 1965, cereal production increased, not so much because of the quantity of the fallen rain but the good distribution throughout the growing seasons

* All methods and techniques of farming of cereals and other plants will be dealt with in Chapter 9.

[/] A good rainy year means a relatively sufficient rainfall distributed throughout the growing season.

⁶ According to the first observed results of harvested crops.

(Table 2.7 and Fig.6.1). Owing to the good quantity and distribution of the rainfall of the winter season of 1966-67, cereal production was very successful and the first results of the output per hectare were very encouraging. Unfortunately, many of the poor farmers, especially those in Barga El Hamra, did not share this lucky 1967 harvest, because they were either afraid of drought and did not like to risk their money as in previous years or were not able to finance the operation. Consequently, most of them migrated temporarily to Benghazi and left their families behind them grazing some animals. Some others went to work in the construction of the new coastal dual-carriageway, and some engaged in collecting stones to sell to the constructing company.

In general, the average yield of cereals in normal rainy years is about 21.5 fold (Table 6.1). More specifically, however, in good rainy years the average wheat yield is about 20 fold and barley 30 fold, whilst in very good years the average yield is about 30 fold for wheat and 40 fold for barley and in poor years the average of both the wheat and barley is less than 15 fold.

The cereal yields vary from one Mudirya to another (Fig. 6.2). It is also worth mentioning that in poor rainy or dry years Barga El Hamra suffers more than Es-Sahel, whereas in good rainy years the yield in Barga El Hamra exceeds that of Es-Sahel. This is because the permeable loamy soils of Barga El Hamra with abundant rainfall are more suitable for cereal cultivation than the impermeable clayey terra rossa of the

north. In normal years, however, the Es-Sahel area, with its high rainfall, yields better than Barga El Hamra.

The problem of low yields is far more serious because most of the farmers grow low yielding varieties of wheat and barley in areas (lithosols) which probably are not well suited for growing cereals.

The production of cereals in the Benghazi Plain or in Libya as a whole has probably been the same since classical times, because climatic conditions and cultivation methods have remained almost the same. Nevertheless, there are some areas exempted because in the last few years, their cereal production has been multiplied significantly mainly through the use of hybridised seed, sold to the farmers at a subsidised price by the government* and the introduction of mechanisation in sowing, harvesting and threshing. Agricultural machinery is hired from the government at a low charge, compared to that of the private companies which is about 50 per cent more.

Droughts are not uncommon in the Benghazi Plain, in fact in all of Libya, and probably the most serious one which hit the whole country, notably Tripolitania, in the twentieth century, occurred in 1947-48. The last relatively dry year was that of 1959, when the production of the Benghazi Plain almost completely failed, except in Tolmeita which produced about 99 per cent of the Benghazi Plain production (Fig .6.1 and Table 6.2).

* The market prices for barley and wheat in 1967 were £L.3.50 and 5.00 respectively, while the government prices were £L.2 and 3 respectively.

When a drought occurs, the production of the succeeding year is usually not guaranteed, even if the rainfall is sufficient, because of the effect of the previous drought on the soil. Thus a good yield is not expected before the second or third year. If, however, two consecutive years of drought have occurred, the problem will be worse and the poor farmers will suffer most and consequently sell everything they possess in order to feed their families.

Although drought years have left unhappy memories, exceptionally productive yields when the production exceeded 100 folds are recorded with great joy. This, however, as some farmers said, happens only once in a man's life and the last excellent production known to the elderly people was that of "SABET EN-NUWAR," the good flowery year, which occurred in 1902.

The government has, in recent years, realised these problems, which in the past were faced by the farmers alone, and consequently it has formed Committees in every Muhafza, in order to assess any agricultural damages and report them to the Ministry of Agriculture to compensate the farmers against their losses, such as the damage caused by a northerly storm which hit almost every farmer in the coastal sand dune area in 1965. Moreover, in order to encourage cereal production, the government has guaranteed the cultivators since 1963 that it will purchase all the yield produced by the farmers at stabilised prices despite any fluctuation of the market prices.

6.1.1 - Wheat

Wheat is a winter crop in the Benghazi Plain and it is mostly cultivated under the dry farming system. There is no irrigated wheat or barley in the Benghazi Plain because the limited quantity of good water for irrigation in the coastal area can be used more profitably for vegetable cultivation rather than any other agricultural practice. Besides, there is plenty of arable land suitable for cereal cultivation near the irrigated areas. However, in similar areas in Tripolitania, cereal cultivation is mostly carried out under irrigation, owing to the abundance of underground water.

Wheat has always been a principal staple crop cultivated in Libya in general and northern Cyrenaica in particular. It is the principal foodstuff of the urban and rural population of the Benghazi Plain, whereas, in Tripolitania, barley is the main item in the diet of the rural population.

Wheat and barley are cultivated almost everywhere in the Benghazi Plain and yet they vary in production from place to place, due mainly to the climatic and soil limitations. In the northern part of the Plain where terra rossa soils predominate and the annual rainfall ranges between 250 mm. and 350 mm., the wheat production surpasses that of barley. According to the 1965 Agricultural Statistics, they comprised 82.3 and 17.6 per cent respectively of the total grain production in the Benghazi Plain, while in the transitional zone between Barga El Hamra and Es-Sahel (El Haw-Wari-En-Nawaghia area),

where the soil is mostly alluvial (transported terra rossa and desert sands) and the rainfall ranges between 200 and 250 mm. per annum, wheat production equals barley. In the southern part of the plain, where the sandy loam and sandy soils prevail and the annual rainfall is less than 200 mm., the percentages of both wheat and barley production were completely opposite to those of the northern part of the plain, being 27.8 and 72.2 per cent respectively (Fig.6.2).

According to the 1960 Agricultural Census, wheat production in the Benghazi Plain was 13,748 qtls. whereas in 1965 it was 59,432 qtls., over four times as much (Table 6.2).

The wheat varieties grown by the rural population in the Benghazi Plain and Cyrenaica as a whole are mostly of local origin and generally appear to be well suited to the local environment, where they were originally developed. In general, hard wheat or durum (*TRITICUM DURUM*) is grown in heavy clayey soils, especially in the northern part of the Benghazi Plain and on the Jabal El Akhdar. Soft or bread wheat (*TRITICUM AESTIVUM*), which is grown mainly in the sandy loam and sandy soils, is found largely in Barga El Hamra.

The most common local varieties of wheat are MOGHRABIYA, DBAKA and IDKEIR. The latter, despite its small grains and relatively low yield, is, so far, the most widespread variety grown in the Benghazi Plain, mainly because of its high drought resistance and good adaptation to low rainfall areas.

Some of the soft wheat varieties grown in the Benghazi

Plain have, however, outyielded some of the famous hard wheat varieties.⁽¹⁾ Although local wheat varieties are satisfactory in production and adaptability for the local environmental conditions, they are to some extent no longer favourable to the present advent of change and modernisation of agricultural development in the Benghazi Plain and in Libya as a whole. Thus trials of other varieties have been carried out since 1953 mainly by F.A.O. and U.S.A. agronomists in the experimental farms at Zorda in El Marj and El Fweihat near Benghazi. As a result of this breeding programme of superior (mostly imported) wheat varieties developed in Cyrenaica, several new successful varieties were produced (Table 6.3). At present most of these new varieties have been distributed to the farmers at a subsidised price.

The newly introduced Mahmoudi D981 variety is now the most commonly cultivated wheat in Cyrenaica. It occupies about 95 per cent of the cultivated durum area and consequently it has almost completely replaced the local variety of Moghrabiya. The Mahmoudi D981 variety was originally introduced from Tunisia in 1954.⁽²⁾ This variety is characterised by a good yielding capacity, stiff straw and large attractive good quality coloured seed, but it is, however, susceptible to stem rust.

The bread wheat (soft) variety of FLORENCE AURORE has also succeeded in the Benghazi Plain and throughout Libya as well. It was introduced from Algeria in 1956 and it is

characterised by its wide adaptability to local conditions, good yielding capacity, early maturity and good grain capacity. But unfortunately it shatters with poor tilling and is prone to damage by Ghibli winds.

The development of local wheat varieties by hybridisation is mainly aimed at producing superior varieties resistant to the prevailing stem rust which causes serious damage and to drought or heat as well, while increasing the yielding capacity. Early maturity of wheat is mostly achieved in the relatively low yielding local varieties of Moghrabiya and Idkeir. The purpose for cultivation of these local varieties is to avoid the drought spells and early summer heat and consequently it may give a high yield. One of the earliest maturing *Triticum Durum* variety which grows in Cyrenaica, is the Moroccan B.D.3225.⁽³⁾ It matures approximately three weeks earlier than either Moghrabiya or Mahmoudi. This variety is, however, characterised by its low tilling capacity and weak straw which makes it susceptible to the strong Ghibli winds.

In addition to the droughts and primitive cultural practices of wheat and barley, production in the Benghazi Plain, pests and diseases are also causing a considerable problem. Damage to wheat crops and reduction in yields caused by rodents and ants have always been a serious problem in the Benghazi Plain and Cyrenaica as a whole. Ants attack the fields at seeding time, especially in the southern part

of the plain (sandy loam and sandy soils) and ruin some of the sown seed. The farmers, however, allow for this by increasing the seed rate. In the more advanced agricultural areas such as El Fweihat and Benina where farmers use machinery and hybridised seeds, they use seed dusters with fungicides against bunt, because this insecticide keeps away the ants and rodents. Damage by birds at harvest time is another serious problem in most areas under consideration. Damage by frost is not common in the Benghazi Plain because of its favourable maritime climate, unlike Jabal El Akhdar where it occurs every few years and causes serious damage to the crops. Damage by Ghibli winds, particularly at the time when the ears have just emerged or during a long absence of rainfall, is always of great concern to the farmers.

Heavy losses of wheat caused chiefly by *SITOPHILUS GRANARIUS*⁽⁴⁾ is also a great problem. However, the government has recently taken steps to combat this problem and started renting to the farmers compartments in its silos in Benghazi and other stores built for this purpose in some of the Mudiryas. Thus this pest's damage has been minimised considerably.

The yellow migratory desert locusts are also most common and cause great losses if they attack the fields.

The most common disease affecting wheat is stem rust (*PUCCINA GRAMINES TRITICI*) especially in the seasons of late rains. Leaf rust (*PRICONDITA*) is also a very familiar wheat

disease, but it is less destructive than stem rust and usually spreads during the spring, when the temperature begins to rise. Bunt (*TILLETIA CARRIES*) is also common in the Benghazi Plain but in recent years the damage from this disease has decreased considerably due to the seeds being treated before sowing.

6.1.2 - Barley

Barley has always been the principal crop in the areas where soils are less fertile and the rainfall is scanty (steppe area). Barley is the major field crop in Barga El Hamra, with regard to both the quantity produced and area sown (Appendix Table 6.1), whereas in the Es-Sahel it is cultivated mainly in the poorer areas of the lithosols, regosols and seabakh marginal lands. In addition, barley was, until recently, the main foodstuff in the diet of the rural population.

Prior to 1959, the difference between barley and wheat production was very wide, and from 1959 to 1964 the production ratios did not vary too much, but since 1965 wheat production has surpassed that of barley (Fig.6.3). Barley production also varies from one place to the other according to the different climate and soils which have been discussed already in the wheat production (see Appendix Table 6.1, Figs.6.1, 6.2 and 6.3). According to the 1965 Agricultural Statistics, the average yield per hectare in the Benghazi Plain was about 2.8 qtls. (Appendix Table 6.1). Although

Barga el Hamra is ideal as semi-arid land for growing barley, in fact barley did better in the Es-Sahel area where the average production per hectare reached 5 qtls. in Tolmeita, while in Gamines it was only 1 qtl. This is due mainly to the effect of rainfall since the annual average is more than 300 mm. in Tolmeita and less than 200 mm. in Gamines.

However, barley grows in the northern part of the plain in poorer (lithosols) areas than in the southern part where it grows in relatively deep sandy laom soils. It is generally believed that in the near future barley cultivation may be replaced by wheat cultivation except for those areas which are not suitable for wheat. This is due to the fact that, firstly, most of the rural population in the Benghazi Plain now depend almost entirely on wheat for their foodstuff, in addition to the new taste for macaroni, spaghetti and rice which was brought about as a result of rising standards of living in the rural communities, since the impact of petroleum on the economy of the country as a whole. Secondly, in the past ten years the price of barley has risen very little compared to that of wheat. In addition, many farmers, especially after the introduction of machinery, preferred to cultivate wheat even in areas which were primarily used for barley.

According to the 1960 Agricultural Census, the Benghazi Plain produced about 40,782 qtls. of barley or 73.9 per cent of the total grain production (Table 6.2). In 1965 it was only 36,028 qtls. or 13.2 per cent less than in 1960. The

1965 Agricultural Statistics reveal also that barley production was about 25.8 per cent less than wheat production.

The most common variety of barley in the Benghazi Plain is the local 6 row "BALADI"⁽⁶⁾ which gives good yields under most conditions throughout the area under consideration. Nevertheless, this variety has low yields compared to some other imported varieties. The barley variety ATHENAIS which was introduced from Cyprus in 1953 has shown itself so far to be very suitable and successful in the Benghazi Plain and Jabal El Akhdar and it has outyielded the local varieties in most years (Table 6.4). This variety has generally proved to be more resistant to drought than the local barley. The Athenais variety is characterised by its flour's resemblance to wheat in whiteness. Although this Athenais variety matures earlier than the local varieties in the Benghazi Plain, its production is lower than the local varieties, whilst on Jabal El Akhdar it matures later than the local barley, but it does much better. Consequently, the Athenais variety could probably be recommended for barley cultivation in the northern part of the Benghazi Plain where the climatic and soil conditions resemble those of Jabal El Akhdra, whilst in the southern part of Barga El Hamra, it would be much better to grow the Tripolitanian variety BENI ULID and the PAPHITICO EARLY from Cyprus.⁽⁷⁾ Other varieties suitable for barley cultivation in the Benghazi Plain are CALIFORNIA MARIOT (U.S.A.), ESPERENCE (Morocco), BEECHER (U.S.A.) and a selection of other local varieties (Table 6.4).

Barley for forage production, although not common in the past, will be in the future if it has to be substituted by wheat as a necessary ingredient in the rural people's diet. Therefore the Athnais and Atlas varieties are the best types which could be recommended for the Benghazi Plain.⁽⁸⁾

Barley production for brewing is not practised in Cyrenaica, although beer is the favourite alcoholic beverage among many people. The absence of breweries in the Benghazi Plain or Cyrenaica as a whole is because alcohol is strictly prohibited by the law to the Moslem community in Cyrenaica, unlike Tripolitania where it is manufactured and sold publicly to everyone. It could be suggested, however, that since there is a winery plant for processing grapes of the Jabal El Akhdar, which is operated by a Greek there is no reason why a brewery should not be established in Benghazi instead of depending on imported beer. This will firstly encourage the production of barley in the Benghazi Plain and Cyrenaica as a whole and, secondly, it will eliminate the importation of beer from abroad. Another alternative measure to encourage the growing of barley in Cyrenaica as a whole is to raise the standard price which was set up by the Government and to find good foreign markets for exportation.

If a long straw barley suitable for the local conditions is found, low cost barley for forage in both grains and straw could replace the present high cost (£L.4 per qtl) of the forage crop seed such as oats and vetches, and it would solve

the decline of barley culture on the one hand and guarantee a summer feed for animals on the other.

Barley in the Benghazi Plain rarely suffers from insects or diseases, but the most common disease is smut (*USTILAGO HORDEI*).

Weeds in the cereal fields of the Benghazi Plain, notably in the tribal land where the bulk of the cereals are grown, are a serious menace. The most common weeds are wild oats (ver. *BAHMA* = *AVENA ALBA*), wild mustard (ver. *HARA* = *BRASSICA CAMBESTIS*), wild gladiolus (ver. *SEIF EL GHRAB* = *GLADIOLUS BYZANTINUS*), *Alongiglumis* and *Sinapsis Awensis*.⁽⁹⁾ During the 1967 field survey, no farmer was observed weeding his field because most of them had left their fields immediately after they had sown their seed. Very few said that they had come back to see their fields once or twice and probably all of them had come to arrange for the harvesting. If, however, small plots were sown near the irrigated farms, the farmers and probably their families would do the weeding.

Cereal fallow rotation and spring ploughing of the fallow areas is another effective method used to control weeds. Spring ploughing is usually practised in the few areas where farmers or co-operatives own tractors for ploughing, as in Bujarrar, Bersis, El Fweihat, Benina, El Gwarsha and some parts of Es-Silg east of Slug.

The use of herbicides in the Benghazi Plain is not economically feasible at present because the increase of

yield obtained by using weed killers does not justify the expense. It is still in the experimental stage and previous results have failed, particularly in areas (Barga El Hamra) where rainfall is insufficient and fluctuates from one season to another.

6.2 - Legumes

Legumes are generally grown on a small scale and they are grown either irrigated in the coastal areas or unirrigated, notably in the northern part of the plain in the Mudiryas of Tokra and Tolmeita. The area cultivated under leguminous crops in the 1960 Agricultural Census was about 64 ha. whereas in the 1965 Agricultural Statistics it was 99 ha., or 0.2 per cent of the total cultivated crop land. This figure comprises 2 per cent of the irrigated land and about 0.1 per cent of the unirrigated land (Table 5.4).

Legume production under dry farming conditions in the Benghazi Plain is also affected by the general fluctuations of rainfall, thus varying from one season to another and from one Mudirya to another. According to the 1965 Agricultural Statistics the average yield per hectare of leguminous crops was about 10.5 qtls. (Table 6.2).

The total production of legumes in the 1960 Agricultural Census was 678 qtls. whereas in the 1965 Agricultural Statistics it was more than 34.6 per cent higher (Table 6.2).

Legume production varies, however, from one Mudirya to another, but generally it is concentrated in the irrigated

areas around Benghazi (Appendix Table 6.2 and Fig.6.2).

6.2.1 - Broad Beans

Broad beans (VICIA FABA) have always been the most abundant legumes produced in the Benghazi Plain. In the 1960 Agricultural Census they comprised about 92 per cent of the total legume output, whilst in the 1965 Statistics they comprised 84 per cent.

Broad beans which are considered "the poor man's meat" in the Benghazi Plain and elsewhere in Libya, are a winter crop, and therefore they compete with the sowing of cereals. They are grown under both irrigation and dry farming systems and generally they are used either as green vegetables in winter or as dry beans at any time.

Local varieties "BALADI" (unnamed mixture) have shown the best yields so far and have always outyielded all other imported varieties for breeding purposes (Table 6.5). Nevertheless, some farmers have shown interest for the lower yielding Cyprus variety because of its large seeds.⁽¹⁰⁾ Trials for irrigated varieties have not been undertaken yet, but the Cyprus and the Sharps' S.M.N. Tripolitanian varieties have proved to do well.

The average yield per hectare in the 1965 Agricultural Census was about 9.9 qtls. This, however, varies from Mudirya to Mudirya, but, generally, it is high in the moister north and lower in the steppe area in the south (Appendix Table 6.2 and Fig.6.2).

The most common plant diseases affecting broad beans in the Benghazi Plain were the APHIDS which at present are adequately controlled by spraying with nicotine solution. An unidentified type of fungus sometimes attacks and when it occurs, the damage is estimated at between about 30 per cent and a total loss of the crop.⁽¹¹⁾ However, the most serious damage to broad bean production is caused by the shedding of the flower before setting of germination. No remedy has been found for this problem yet.

6.2.2 - Chick Peas

Chick peas (CICER ARIETINUM), although produced in a small quantity in the Benghazi Plain (17 qtls. in 1960 and 89 qtls. in 1965), are very important and desirable vegetables because they form an essential ingredient in most of the local dishes. They are sold as roasted or boiled and have a subsidiary use as a coffee substitute.

The area sown in the 1960 Agricultural Census was 8 ha. with an average yield per hectare of 2.1 qtls. whilst in the 1965 Agricultural Statistics it was about 6 ha. with an average yield per hectare of about 14.8 qtls. (Table 6.2).

The most common type of chick pea is the dark small-seeded local variety (HUMS BALADI). Since 1955, an imported variety, a large white-seeded unnamed variety from Cyprus, has proved a great success in all Cyrenaica and it is gradually replacing the local variety.*

*No variety trials for chick peas were carried out in the Benghazi Plain.

Chick peas do not interfere with the sowing of cereals and are usually sown after the cereal season is over. Therefore they can be grown in rotation with wheat in Es-Sahel.

Due to the high cost of hiring labour and the unavailability of harvesting machines, the large scale growing of chick peas is not feasible at present. Nevertheless, production could be increased by bringing more small areas under chick pea cultivation. In 1965, only five of the 13 Mudiyyas were growing chick peas (Appendix Table 6.2), and production is not sufficient by any means for Benghazi's consumption, and many have to be imported from Jabal El Akhdar, notably from El Marj Plain.

Damage from insects and diseases is relatively low, the real problem comes from birds at sowing time and birds and hares after germination. Chick peas, in general, require little weeding.

6.2.3 - Peas

Peas (*PISUM SATIVUM*) are almost entirely grown under irrigation in the Benghazi Plain and are picked as green peas and sold as vegetables, but they are not as popular as broad beans or chick peas. Therefore, their production is very limited and is generally confined to the areas where good water for irrigation is available near the large market of Benghazi.

The area cultivated in 1960 was about 14 ha. with an average yield of about 13.4 qtls. per hectare. Whilst in

1965, it was only 5 ha. with an average yield of about 14.4 qtls. per hectare (Table 6.2), El Gwarsha alone produced about 30 per cent of the total in 1965 (22 qtls.) and the peas are grown only in El Gwarsha, El Fweihat, El Kweifya and Sidi Khalifa Mudiryas (Appendix Table 6.2).

The Dutch Pauli variety is considered best in Cyrenaica as a whole. Trials at El Fweihat carried out in 1955-1957 revealed that Zelka Conservo and Black Eye Susan are the most promising varieties as dried peas (Table 6.6).

The most serious damage caused to the peas is by the bee-weevil (*BRUCHUS PISORUM*),⁽¹²⁾ while relatively slight damage is caused by the unidentified fungus which attacks the broad beans. Pigeons and hares do some damage to the crop during the germination period. Weeding is not a serious problem and it is generally less necessary than for broad beans and chick peas.

Other minor legume grains which are not widely grown in the Benghazi Plain and are not taken in any agricultural census or surveys are dry and green beans, lentils (*LENS ESCULENTA*) and fenugreek (*TRIGONELLA FOENUM GRAECUM*). These legumes (vegetables) are abundantly grown in the Jabal El Akhdar from where they are imported, notably from El Marj Plain, to Benghazi City and then to the rest of the Benghazi Plain.

6.3 - Vegetable Production

Vegetables in Libya in general and in the Benghazi Plain

in particular, are considered among the farmers to be the most profitable cash crops throughout the year, especially the early maturing or off-season vegetables, such as tomatoes, cucumbers, green chilli peppers and lettuces.

Vegetables in the Benghazi Plain are grown on all types of soils, notably on regosols and terra rossa.

Almost all kinds of winter and summer vegetables are grown in the Benghazi Plain, particularly in the coastal areas, where underground water is available in good quantity and quality. It is worth emphasising here again that the cultivation of vegetables depends, almost entirely, on the availability of good underground water and not on the intrinsic fertility of the soils. Therefore, most of the vegetable production is not affected by rainfall fluctuation.

Vegetables generally occupy almost the entire summer cultivated areas. According to the 1960 Census of Agriculture there were about 2,366 ha.* under vegetables, while in the 1965 Agricultural Statistics, there were about 1,474 ha. of which 72 per cent were irrigated. According to the 1965 Agricultural Statistics, vegetables occupied about 0.6 per cent of the total crop land. This includes 41.5 per cent of the irrigated land use type and about 0.6 per cent of the unirrigated land use type (Tables 5.3 and 5.4).

In general, although the quality of vegetables produced in the Benghazi Plain is relatively good, the return yield per hectare is low and the present total production does not

* This figure is not reliable for the actual figure does not exceed 1,000 ha.

meet the local demand. Owing to the high degree of employment caused by the oil companies and to the higher standard of living and increased expenditures, the demand for vegetables and fruits has expanded at an unprecedented rate. Thus farmers are paying more attention to the growing of vegetables than to any other agricultural commodity. Nevertheless, they are still not yet able to meet the local demand. Thus, Benghazi (the only big consuming market in the area under consideration) will have to depend on the vegetables imported daily mainly from Tripolitania and to a lesser degree from abroad, for a considerable time to come. For example, in 1967, Benghazi consumed about 113,287 qtls.⁽¹³⁾ of vegetables, while the Benghazi Plain produced only about 46.8 per cent of this total. 24.9 per cent were imported from Tripolitania and 28.3 per cent from abroad.

According to the 1960 Agricultural Census, the total production of vegetables in the Benghazi Plain was about 34,937 qtls., while in the 1965 Agricultural Statistics it was about 56,237 qtls. (Table 6.7). Although the cultivated area of 1965 was 42 per cent lower the total production was 61 per cent higher than that of 1960. This results from improved cultivation techniques, the application of fertilizers and insecticides and the well selected seeds distributed by the government to the farmers at a subsidised price.

In the areas remote from Benghazi Market, vegetables are mainly grown for family consumption and the little surplus

which may be available is probably sold in the nearby village markets. Transport problems (to be discussed in Chapter 10) constitute the major factor making the remote farmers reluctant to attempt any vegetable cultivation for marketing. The water shortage in most areas, particularly in the hinterland and in the southern part of the plain also hinders vegetable growing.

Vegetable products in the Benghazi Plain consist of almost all kinds, such as tomatoes, different kinds of water melons, pumpkins, coujets, marrows, squashes, cucumbers, snake cucumbers, potatoes, onions, garlic, carrots, red and green chilli peppers, sweet green peppers, cabbages, cauliflower, turnips, aubergines (egg-plants), okra (lady fingers), green beans, peas and broad beans, lettuces, spinach, coriander, radishes, parsley, leeks, celery and mint.

The most important vegetables grown in the Benghazi Plain are tomatoes, which comprised about 36 per cent of the total value of vegetable crop in 1965 and water melons with about 26.8 per cent (Table 6.8).

Tomatoes have become increasingly popular in the Benghazi Plain, particularly after 1962, as a result of the rising standard of living caused by the petroleum impact. Tomatoes are grown almost entirely in the coastal areas on all types of soils. The best tomato yield is, however, obtained from the dry cultivated tomatoes in the coastal regosol areas (Plate 6.1). Irrigated tomatoes are found mainly in areas

where underground water is available in a relatively good quantity and quality, as in El Fweihat, Benina, El Haw-Wari, El Thama and Sidi Khalifa, while the unirrigated tomatoes are found almost everywhere in the plain notably in the coastal sand dune areas, like Shat El Bedin, Er-Ragta, Karkura, El Murrah, Et-Terriya, Bu-Gtefa, Ganfuda, El Kweifya, Deriana and Aseila. Tomatoes are generally the best vegetables for salt tolerance, and flourish in the areas where brackish or salty underground water is available. The unirrigated tomato crops are unreliable, and at the planting stage, should be irrigated by fresh water, either from the thin layer of the local underground fresh water or imported fresh water from other areas. Such is the case in Ganfuda where the farmers bring the water from El Gwarsha and sometimes even from Benghazi (see Chapter on Irrigation) to irrigate their tomato seedlings.

The production of the unirrigated tomato crops fluctuates according to rainfall, and is also affected by the northerly winds which sometimes blow very strongly and bury the small plants and then destroy them completely. If the wind blows at the germination period it causes a total loss in production, such as occurred in 1965 when the wind swept almost the whole coastal area of the Benghazi Plain.

Tomato production, as was mentioned previously, has increased considerably in the last few years. According to the 1960 Agricultural Census it was 10,222 qtls. while in the

1965 Agricultural Statistics it reached 12,972 qtls., an increase of 27 per cent. The average yield per hectare in 1960 was only 14.7 qtls. whereas in 1965 it was about 34.7 qtls. (Table 6.9).

Table 6.9 shows a considerable contrast in the 1965 yield per hectare from place to place according to the differences in soil type and water availability. For instance, in the southern part of the Benghazi Plain, the yield in the coastal sand dunes varied from 20 to 25 qtls./ha., while in the areas of poor quality and meagre quantity of irrigation water (e.g. Slug and Jardina), the yield was less than 15 qtls./ha. In the irrigated areas with good or reasonable underground water and terra rossa type of soil (e.g. El Gwarsha, El Fweihat and Benina) the average yield was 35 qtls./ha. Still further north, with better soils and reasonably good water and higher annual rainfall (Tolmeita and Tokra areas) the yield was 47 and 38 qtls. respectively (Table 6.9).

The tomatoes grown in the Benghazi Plain (except Bu-Shuk) are, however, of unknown local varieties which are characterised by their small size and low quality, unlike those of Tripolitania which is famous for its varieties such as the "TAJURI" and "JANZURI" with good yields and excellent qualities. It is worth mentioning, however, that the production of tomatoes in Tripolitania has been facilitated by its physical advantages (sandy soils and plentiful good quality underground water), and has been encouraged since 1954 by the establishment of about

eight Tomato Processing Factories with the creation of a contract system for purchasing the tomato production, at an agreed price between the farmers and the factories. This will not be feasible for the Benghazi Plain or even Cyrenaica as a whole for many years to come, because the present rate of production in the Benghazi Plain does not meet the local demand. For example, the 1965 tomato production provided about only 26 per cent⁽¹⁴⁾ of the total consumption of Benghazi City. The rest (74 per cent) was imported almost entirely from Tripolitania.

Another important vegetable crop is water melons, which accounted for about 26.8 per cent of the total value of vegetable production in 1965 (Table 6.8). Water melons and all other melons are grown in the Benghazi Plain as summer crops and are almost entirely cultivated under irrigation. The best quality water melons, up till now, have been grown on the regosols in the coastal sand dune belt. The total production of water melons has increased considerably since 1960. It was 6,597 qtls. in 1960 and about 18,171 qtls. in 1965 (Table 6.10). According to the 1965 Agricultural Statistics the average yield per hectare was about 46 qtls. and the best average yield per hectare of 55 qtls. was recorded at Benina, where good plentiful underground water is available, fertile residual terra rossa, and machinery and modern agrotechniques are used.

Onions ranked third in the 1965 vegetable production

with regard to the total vegetable value, although they only accounted 5.6 per cent (Table 6.8). In 1967, Benghazi market absorbed about 31,269 qtls.⁽¹⁵⁾ of onions of which about 80 per cent were imported from abroad. This figure, however, represented about 78 per cent of the total imported vegetables in weight. Although onions (dry and green) grow well in most parts of Libya, especially in the sandy and sandy loam soils and they (garlic as well) do not require a large quantity of water,⁽¹⁶⁾ they are not, however, widespread in the Benghazi Plain because they cannot compete with other more profitable vegetables. The production of onions and garlic, generally, has increased in the Benghazi Plain since 1960 with regard to total production and the yield per hectare (Table 6.11). The yield per hectare of dry and green onions was comparatively low in 1960, and by 1965 had increased from 13.2 to 32.3 qtls. and from 14.7 to 33.7 qtls. respectively. The yield of dry garlic had increased from 7.4 qtls. in 1960 to about 16 qtls. per hectare in 1965.

Although potatoes are considered one of the main items of the diet of most people, their production has decreased in recent years. According to the 1960 Agricultural Census it was about 119 qtls. and in 1965 it reached only 90 qtls. (Table 6.7). At the same time their importation has increased. For example, in 1966 Benghazi imported about 9,638 qtls.⁽¹⁷⁾ and in 1967 the imports reached 20,194 qtls. with an increase of about 77 per cent, or about 17 per cent of the total

imported vegetables. Some 91 per cent of the imported potatoes were from Tripolitania and only 9 per cent from abroad. Despite the importance of potatoes, there is little interest among farmers in growing them in the Benghazi Plain, because they require too much work with a relatively low yield (the average yield per hectare in 1960 and 1965 was 10 and 15 qtls. respectively, compared with 39 qtls. in Tripoli), and are affected by the superior quality and low price of imported potatoes. An additional factor which affects potato production is the strong competition of the more profitable vegetables, like tomatoes and lettuce.

Other minor vegetables, their production, yield and value in the Benghazi Plain according to the 1960 Agricultural Census and the 1965 Agricultural Statistics are displayed in Tables 6.7 and 6.8.

To sum up, the problem of the shortage of vegetable production in the Benghazi Plain cannot be solved at the present time or even in the near future. Therefore, Benghazi, for most of its consumption, will have to depend on imported vegetables for a considerable time to come. The only possible alternative is to increase the present production rate through the application of modern agro-techniques, well selected seed varieties and the rational manuring on the existing production potentiality as well as the reclamation of new areas where good underground water could be found.

During the field survey of 1967, the writer was told by

Mr. Rafa Zeew⁽¹⁸⁾ (who owns one of the two largest modern commercial farms in the Benghazi Plain) that the local authority had proposed to offer him and some other big vegetable growers in the Benghazi Plain all the labour force they required for each farm on condition that they would guarantee to supply Benghazi market with all its vegetables in order to stop the importation of vegetables from Tripolitania and abroad. This proposal was, however, dismissed by the said farmers and instead they proposed to the Government that, in order to secure a supply of vegetables to Benghazi market at a low price, the government must subsidise their production of vegetables by at least 50 per cent. For example, if a kilogramme of potatoes costs today say 10 piastres (2/-) the farmer should sell it to the wholesale agent for only 5 piastres (1/-) and the government ought to subsidise the farmer for the other 5 piastres (50 per cent). The wholesale agent then gets a commission of 10 per cent (5 mills.). The grocer or retailer must not sell it for more than 8 piastres (10d.) per kilogramme. Naturally, the government resented this proposal and at the same time left the door open for more reasonable negotiations. As far as the writer knows, no settlement has yet been reached.

In any case, the two proposals, offered by the government and the farmers, are unjust to the majority of the vegetable growers, because the benefits of the suggested proposals will be confined to the big farmers only, whose annual income is

already high, ranging between 10,000 and 300,000 Libyan pounds.

The government proposal is unpractical because the amount of labour needed for each farm varies from one season to the next. In addition, the landlords would not be able to control the workers, since they know well that they are paid by the government and not by the landlords. Therefore, they would not work (as in the case of most governmental jobs) as they would if they were employed by the landlords. Moreover, it probably would, as some farmers hinted, provide an illegal source of income for some farmers and some of the governmental personnel in charge of such a project. The farmers' proposal, if it ever comes into effect, gives to a handful of farmers the opportunity of monopolising the local market for their production, and thus depriving the majority of the vegetable producers of a good price for their production. Most of the small farmers would, no doubt, desert their farms and migrate to Benghazi City and aggravate the situation of the shanty dwellers, a problem which the government is striving hard to abolish or at least eliminate.

In the light of the present agricultural potential and labour availability, these big farmers would not be able to produce any significant quantity of vegetables more than they can produce at present to meet the daily increasing demand on vegetable production. For, if they could, they would have done it without any hesitation, since they have the capital,

good land and experience and there is no need for government assistance or encouragement. Consequently, the government must help the small vegetable growers in the first place and devote more money and time to improving the quality and the yield of the existing vegetable crops as well as to bringing new areas under vegetable and fruit cultivation to meet at least most of Benghazi's needs.

6.4 - Tree Crops

The Benghazi Plain, with its Mediterranean climate, with abundant sunshine and a long growing season, and with a variety of soils and low relief could be expected, like similar areas in Tripolitania, to produce a great variety and large quantities of fruit crops. Nonetheless, its record is disappointing for there are few trees yielding a small quantity of poor quality fruit. This is, however, due to the history of the land use in the area under consideration, since most of it has always been farmed by the Bedu, who disdain settled agriculture and, of course, the planting of any fruit tree. It is wishful thinking to expect the Bedu people to plant and care for any tree which will not yield for 5 to 8 years. Thus since the early days (at least since Turkish times) fruit trees in the Benghazi Plain have been grown mainly in backyard gardens in the urban centres of Benghazi, Tokra and Tolmeita.

Systematic fruit tree cultivation was not known before the Italians introduced it in the 1930s, when most was

carried out in very small plots usually owned by Italian entrepreneurs. Most orchard plantations of vines and olives were established in the Jabal El Akhdar areas. The introduction of well selected varieties by individual farmers started only after 1960 when an orchard scheme was undertaken by the Ministry of Agriculture to encourage all farmers to plant fruit trees. Since then the Ministry has encouraged the private farmers to plant well selected varieties by distributing the nursery plants, occasionally free of charge and often at a subsidised price of 3 piastres (7d.) per seedling. However, these newly planted trees have not yet increased for most of them are not even fruitful yet.

The fruit trees growing now in the Benghazi Plain are therefore of less importance than cereal and vegetable crops. Most of the fruit trees are old and need to be replaced by newly selected varieties, in order to improve the quality, as well as the yield per tree. The rest of the plain, where unirrigated orchard trees can grow successfully, is almost entirely devoid of fruit trees except for a few scattered and self planted trees, mainly figs and olives. These trees are found near the escarpment, around the settlements in the coastal areas and in the dolinas or sink-holes.

According to the 1965 Agricultural Statistics, fruit trees occupied about 33.1 per cent of the irrigated land and only 0.8 per cent of the unirrigated land and about 0.2 per cent of the total arable or cultivated land (Tables 5.3 and 5.4).

The number of fruit trees in the Benghazi Plain according to the 1960 Agricultural Census was 274,400 of which 175,100 were productive. According to the 1965 Agricultural Statistics there were 369,011 trees of which 160,910 were productive (Table 6.12). The number of fruit trees increased by about 34.5 per cent, but the productive trees decreased inversely by about 8.8 per cent. This is due to the effect of the strong Ghibli winds which destroyed fruit production at the flowering stage in 1965.

The total fruit production of 1960 was 18,464 qtls. whilst in 1965 it was 27,704 qtls. The grape crop comprised about 78.7 per cent of the total value of 1965 fruit production, with figs, in second place accounting for only 9 per cent of the total value (Table 6.13).

The quantity of fruit consumed per capita in 1967 in the Benghazi Plain was about 44.5 kgs. per year (the Benghazi Plain supplied only 36 per cent of the total consumption and 30.1 per cent from the rest of Cyrenaica), while modern nutritional studies reveal that the human need of fresh and preserved fruits is about 100 kgs. per capita per year in order to maintain a good health.⁽¹⁹⁾ Consequently, there is a deficiency in fruit consumption of about 55.5 kgs. per person per year. This is mainly because the Bedu people rarely eat fruits.

Since the potential for fruit production in the Benghazi Plain at present is limited, the rest of the fruit required

(about 64 per cent) to meet the present demand has to be imported every year. Nevertheless the fruits imported from Tripolitania and abroad in 1967 (54,086 qtls.) supplied only 33.9 per cent of the total needs. Thus, Benghazi has to increase both production and imports of fruit.

6.4.1 - Vines

Viticulture in the Benghazi Plain is practised exclusively for the production of table grapes. Owing to the physiographic and climatological features, grape growing for wine production is not favourable in the Benghazi Plain, and thus such cultivation has been confined to the Jabal El Akhdar areas notably in El Beida and Massa.

Irrigated and unirrigated vines for table grapes are found scattered here and there everywhere in the Benghazi Plain. Compact plantations are found on a small scale in the coastal sand dune areas which in some places, such as Shat El Bedin and Er-Ragta, are considered to produce an excellent quality of table grapes. Such grapes are the most prolific fruit crop in Cyrenaica as a whole. In fact, it is considered the most profitable cash crop in the traditional agricultural activities of the Benghazi Plain, especially for the farmers of Shat El Bedin, where the average annual income from grapes reaches about £L.1,000. These vines, which are supposedly well cared for, are cultivated by the Bedu (semi-nomads) who have almost no knowledge of what vines need. The success of these vines, with their high yield (a vine may produce even

more than 100 kgs.) can therefore be attributed to the excellent variety of the vines and to the availability of abundant fresh subsoil water, for once a tree has taken root in the sand dune it remains alive for a very long time. Proper training of these farmers in viticulture will, undoubtedly increase the production of table grapes horizontally and vertically as far as the potential of the sand dunes allow or until the production meets the local demand and allows export of a reasonable quantity to other parts of Libya. Although these table grapes are characterised by their resistance to decay and ability to withstand long transportation distance, their export to foreign markets is not feasible, because they ripen just at the time (July-September) when external markets are already overloaded with all kinds of superior grapes.

Climbing vines are another types of grape growing in almost every garden and farm in the Benghazi Plain. They are usually trellised over the roofs of most houses in rural areas and in the traditionally built Arab houses of Benghazi City. These grape varieties are mostly of good quality and are exclusively for table use.

Trimming is usually done each year by cutting the long shoots. Unfortunately, due to the carelessness of most farmers these vines are often attacked by Phylloxera and sometimes are devastated by birds.

Trials of grape varieties have all been carried out in

the Jabal El Akhdar areas. In the Benghazi Plain the local variety of "saw-wadi" is the best variety with regard to quality and yield. Other less important varieties imported from Italy⁽²⁰⁾ (Pancerpecce, Regina and Funchiaciatta) are also found among other minor local and Tripolitanian varieties.

The number of vines in the Benghazi Plain in 1960 was 107,600 of which 69,700 (64.7 per cent) were productive. According to the 1965 Agricultural Statistics the number of vines was 121,450 of which 60,290 (49.4 per cent) were productive. The average yield per productive vine in 1960 was 7 kgs. while in 1965 it was 15 kgs. (Tables 6.14 and 6.15). This 111 per cent increase is due mainly to the improved agrotechniques in recent years, especially by the application of fertilizers (manure) and insecticides. The total production of grapes in the Benghazi Plain in 1960 was 4,827 qtls. whereas in 1965 it was 9,029 qtls. with an increase of about 80 per cent (Tables 6.14 and 6.15). About 66 per cent of the total production of 1965 came from El Magrun Mudirya alone, notably from Shat El Bedin and Er-Ragta (Appendix Tables 6.3A. and 6.3B).

The future of viticulture for table grapes in the Benghazi Plain is undoubtedly bright and both yield and production will probably increase enormously. And more of the semi-nomadic Bedu of the southern part of the plain will be attracted to undertake grape cultivation and eventually settle down and practise sedentary agriculture, a phenomenon which has already

started since 1965. Even more people will be attracted after the establishment of the nearby Petroleum Terminal at Ez-Zweitina (opened on 23rd April, 1968) unless they are attracted to work in the harbour instead of working in agriculture.

6.4.2 - Fig Trees

Fig trees can grow almost everywhere in the Benghazi Plain and they survive on all types of soils, particularly on regosols, in the fissures of the rock outcrop and in the wadi outlets on the escarpment as well as on the lithosols (Plate 6.2). But the bulk of the fig trees (over 80 per cent) grow in the coastal sand dune belt.

There are many local varieties of fig trees growing in the Benghazi Plain (Bater, Sultani, Saw-Wadi, Khadduri), but unfortunately their production is unsystematic and large quantities of poor yielding varieties are grown, especially in the traditional horticulture areas of El Gwarsha, El Fweihat, Tokra, and Tolmeita as well as on the coastal sand dune belt. About 80 per cent of the fig trees grow without irrigation and care. Thus, little attention is paid to grafting, pruning and improving varieties. In general, fig trees grow isolated and scattered mixed with other trees or in pure orchards such as in Shat El Bedin and Er-Ragta.

The fig varieties grown in the Benghazi Plain cannot be used as dry figs "shleih" like those growing in Tripolitania (e.g. Bater variety). Therefore, they have to be sold as

fresh fruits. Since most of the figs are produced in remote areas, because of the high cost of transportation compared to the market return for the fruit, the fig crops are mostly left on their trees and are used mainly as animal feed. Although figs ranked second (9 per cent) in value in the fruit production of 1965 (Table 6.13), the farmers had little profit from them except in what they and their families and draft animals ate. If, however, a new method of bleaching and drying is introduced the market price will undoubtedly rise and consequently the yield and production will be increased 3 or 4 fold in a very short time.

The number of fig trees in the Benghazi Plain in 1960 was 41,100 of which 30,500 (74 per cent) were productive. In 1965, it was 20,509, of which 15,830 (77 per cent) were productive (Tables 6.14 and 6.15). The average yield per productive tree in 1960 was 17 kgs. while in 1965 it was 24.6 kgs. The best yield of 30 kgs. was obtained from El Magrun, El Kweifya and Tolmeita Mudiryas (Appendix Tables 6.3A and 6.3B)

6.4.3 - Almond Trees

Almond trees are usually found scattered or mixed with orchard trees in the horticultural areas. Compact plantations of recently grown trees are mostly found in the modern commercial farms at Benina and El Fweihat, while newly planted plantations are found in En-Nawaghia, El Fweihat and El Haw-Wari. Almond trees grow on all types of soils in the Benghazi Plain, are considered drought resistant and they grow, like olives, without irrigation.

The almond varieties grown in the Benghazi Plain are mostly local (Kaseh, Hesh, and Murri). Some Italian varieties such as Romana and Romana Bandula are also grown in the modern commercial farms.

The number of almond trees in the Benghazi Plain in 1960 was 15,100 of which 7,400 (49 per cent) were productive, while in 1965, it was about 20,670 of which 5,560 (26.8 per cent) were productive. The number of almond trees had, thus, increased by about 36.8 per cent since 1960 (Tables 6.14 and 6.15). According to the 1960 Agricultural Census the average yield per productive tree was 7.5 kgs. while, according to the 1965 Agricultural Statistics, it was 8.5 kgs. The total production of almonds in 1960 was 557 qtls. whilst in 1965 it was only 473 qtls. with a decrease of about 17.7 per cent despite the fact that the number of almond trees has increased by about 36.5 per cent. The decline in production is the effect of the Ghibli winds of 1965 on the crop at the flowering stage.

Almonds are very important as an agricultural commodity, because they are in great demand, do not need irrigation. Therefore, almond cultivation must be encouraged, and compact plantations created in the areas suggested for olive plantations (see Chapter on Irrigation).

6.4.4 - Date Palms

Due to the exceptionally favourable climatic conditions of the Benghazi Plain, palm trees grow wherever underground

water is available near the surface. They are almost entirely grown without irrigation, except at the planting period. Palm trees in the Benghazi Plain are concentrated in the coastal belt, notably in Karkura, Bu-Gtefa, Ganfuda, El Thama, El Kweifya, Sidi Khalifa and Tokra.

Prior to the discovery of petroleum, palms were the most important tree crop, with fresh and baked dates forming an essential item in the diet of the rural population. At present, with the rising standard of living and, accordingly, the changed taste of most people for bread, macaroni and rice, dates, except for the excellent qualities which are usually imported from Tunisia, have become undesirable fruit. Although dates in 1965 were ranked fourth in value of production (Table 6.13), they were mostly consumed by the farmers themselves and their animals. This is due, firstly to the fact that the dates produced in the coastal area are not of a good quality compared to the imported dates or even those produced in the oases of the interior. Nevertheless a small quantity of excellent date varieties (Khadrai and Horra) are sold in Benghazi market as fresh fruit. Secondly, the unavailability of labour and the high cost of maintaining, pollinating and harvesting the dates, in addition to transportation problems, hinder the development of date production in the Benghazi Plain. Thus most of the palm trees, especially those grown in remote areas, are consequently neglected and are buried under the sand dunes (Plate 6.3).

The most profitable way to utilise existing palm trees is to cut fronds, which cost 2 piastres (5d.) each and are sold to the vegetable cultivators in the sand dune areas to be used as windbreaks. The palm tree, in addition to its dates and fronds, provides good shade for the protection of vegetable crops (Plate 6.4). Its timber is used to build roofs of houses, head gears for wells and posts for fences. The leaves **around** the heart are used for the fabrication of mats, baskets and boxes for pressed dates. Ropes are also made of the fett-fibre (ver. leaf). Date syrup (Rub) and alcohol are produced from the processing of dates, and a local alcoholic beverage called "Laghbi" is also made from the sap.

The palm tree varieties grown in the Benghazi Plain are mostly imported from Tripolitania and are of a poor quality and yield. The introduction of new varieties is feasible only in the irrigated farms and should be mainly for the production of fresh dates for sale in Benghazi's market. The date varieties which can be grown in the Benghazi Plain are Hellawi, Lemsi, Horra and Hammuri from Tripolitania, where they are growing in similar conditions and have excellent quality and yield as fresh dates.

The number of palm trees in 1960 was 28,300 of which 17,900 (63.3 per cent) were productive. According to the 1965 Agricultural Statistics, the number of palm trees was 129,091 of which 33,840 (24.2 per cent) were productive (Tables 6.14 and 6.15).

Table 6.15 shows also that the number of trees has increased by about 35.4 per cent in the six years despite the neglect of cultivation and the continuous decline in production. The wide contrast between the number of trees of 1960 and 1965 is because the 1960 Agricultural Census enumerators counted only the trees where farmers were found, but most of the trees are found isolated mainly in the sand dune areas far away from the villages and settled farms, and are visited by the farmers only in the harvesting period in the summer. In contrast, in the 1965 Agricultural Statistics the number of trees was estimated according to the actual number of palm trees growing. The average yield per productive tree in 1960 was 24.8 kgs., whereas in 1965 it was 29.6 kgs.* The total production of dates in the Benghazi Plain in 1960 was 4,440 qtls. whilst in 1965 it was 10,010 qtls. with an increase of about 225 per cent, resulting from the larger number of productive trees and not of the newly planted (after 1960) palm trees, because the date palm does not produce before 6 to 10 years.

It is worth mentioning that although El Gwarsha Mudiya contains about 61 per cent of the total palm trees in the Benghazi Plain, it contributed only 12 per cent of the total production in 1965, whilst El Kweifya Mudiya, with about 27 per cent of the total palm trees (78.5 per cent of the total productive palm trees in the Benghazi Plain) produced about 75 per cent of the total date production (Appendix Tables 6.3A and 6.3B).

* A well cared for palm tree can produce even more than 100 kgs.

6.4.5 - Olive trees

The olive trees in the Benghazi Plain are usually grown sporadically in the irrigated areas. Compact plantations were not known until recently and they are found mainly in small plots around Benghazi and Benina. Outside the irrigated areas, olive trees are self-planted "Zag Tair" and doubtless descendants of the varieties which supplied the old Cyrenaican commerce with the oil for which it was famous. In some parts, notably in the wadi beds and near the escarpment in the northern part of the plain, wild olive trees grow with sometimes abundant crops. No care is devoted to the wild olives and they are mostly found as bushes in the forest areas. Their valuable fruit serves only as food for the goats, which eat the fruit and sometimes the shoots and branches. If they were uprooted and planted in the cultivated areas, they would probably prove very productive since they are well adapted to the local environment.

The olive as a tree is omnipresent and as a food it is consumed in some form or other in almost every food every day. The olive tree, in general, is well adapted to the climatic conditions of the Benghazi Plain and northern Libya as a whole. It suits all types of soils and is found mixed with all types of trees. In addition, the olive tree is very resistant to low rainfall, high temperatures and strong winds.⁽²¹⁾

The olive trees in the Benghazi Plain and Libya as a whole, are as old as, at least, the human society, but they

have become famous only since Greco-Roman times. The ancient centres of the olive plantations in the Benghazi Plain do not exist at the present like those of Tripolitania, in Tarhuna and Msellata, and El Gharib on the Jabal El Akhdar.

The origin of the present growing varieties of olive trees is unknown, and no new variety trials were undertaken in the Benghazi Plain. Both the Italians and the Libyan authorities devoted all their efforts and time to improving olive trees in the Jabal El Akhdar areas, where climatic conditions are more favourable. However, an increase of olive trees in the area under consideration is urgently needed for the production of olive oil to meet at least some of the local need, for at present all the oil is imported from Tripolitania and abroad, mainly from Spain, Italy and Greece. There are, however, vast areas (see Chapter on Irrigation) suitable for successful olive tree cultivation as a dry farming crop. Extensive irrigated olive tree plantations are not economically practical, because citrus tree cultivation is more profitable and requires less work.

Indeed, most of the irrigated olive tree plantations in Tripolitania have been converted to citrus growing for they are more profitable and require less work.

The number of olive trees in the Benghazi Plain in 1960 was 43,500 of which 20,500 (47 per cent) were productive. In 1965, it was 50,730 of which 32,480 (63 per cent) were productive. About 60 per cent of the total number of the olive

trees and about 83 per cent of the productive trees in 1965 were found in El Gwarsha Mudirya alone (Appendix Tables 6.3A and 6.3B).

The average yield of a productive tree in 1960 was 5.3 kgs. where in 1965 it was 9.9 kgs. According to the 1960 Agricultural Census, the total production of olives in the Benghazi Plain was 1,078 qtls. whilst in the 1965 Agricultural Statistics it was 3,216 qtls. with an increase of about 198.2 per cent. The poor production of 1960 was due mainly to the bad rainy years of 1958-59, which affected adversely almost all dry cultivated crops in the Benghazi Plain.

The annual fluctuation of the olive production which is common in all Libya, is related to the rainfall fluctuation and it may vary as much as ten to one (Fig.6.4). It has been observed also, that every good productive year is followed by a poor or bad year.

6.4.6 - Soft Fruits

Soft fruit production in the Benghazi Plain is not very important and it represents only 3 per cent of the total value of fruit production (Table 6.13). One of the main reasons for the lack of soft fruits in the past is their need for plenty of fresh water and care which the Bedu farmers were not able to meet. Soft fruit cultivation has increased considerably in recent years, notably since the Ministry of Agriculture encouraged farmers by distributing well selected fruit varieties at a subsidised price of about 3 piastres (7d.) per seedling.

Although soft fruit production is not very important, its value per unit is high, and if developed, would be both profitable to the farmers and useful to the consumers.

Before dealing with each type of soft fruit, it is worth noting that the decline of production of 1965 was due primarily to the effect of the Ghibli winds and the strong northerly winds at the flowering stage.

6.4.6.1 - Pomegranates

Pomegranates are not of great importance and they are grown mainly as ornamental trees in most of the irrigated farms in the traditional horticultural areas and in the back yard gardens in the Benghazi Plain. Nevertheless, their number and production has surpassed all other soft fruit types (Tables 6.14 and 6.15).

The pomegranate varieties grown in the area under consideration are of a local origin and there are two main types; one is early maturing "Baladi" (summer crop) and the other is late maturing "Tajuri" (autumn crop).

The number of pomegranate trees in 1960 was 9,300 of which 6,000 (64.5 per cent) were productive, whilst in 1965 it was 9,913 trees of which 5,120 (51.6 per cent) were productive (Tables 6.14 and 6.15). The average yield per productive tree in 1960 was 13.5 kgs., whereas in 1965 it was 15.5 kgs. The total production of 1960 was 810 qtls. whilst in 1965 it was 764 qtls., about 80 per cent of which came from El Gwarsha, El Kweifya and Benina alone (Appendix Tables 6.3A and 6.3B).

6.4.6.2 - Apples

Apple cultivation in the Benghazi Plain dates back to Greek times when Benghazi or Hesperides was well known for its golden apples of Aphrodite. At present the productive apple trees are of poor quality and are of local varieties, (Hammuri, Khadduri, Miski, Gares and Bay-Yudi). New imported varieties, mainly from U.K. and Italy, such as Malus Communis, M.M.109, M.M.112 and M.M.13⁽²²⁾ have been grown in recent years on many farms. Generally, apple trees are grown in every Mudirya, but the best production still comes from the irrigated horticultural areas of El Gwarsha, El Kweifya and Tokra (Appendix Tables 6.3A and 6.3B).

According to the 1960 Agricultural Census, the apple trees numbered 2,400 of which 1,300 (54.4 per cent) were productive, while, according to the 1965 Agricultural Statistics, there were 4,450 trees of which 1,160 (23.8 per cent) were productive. The average yield per productive apple tree in 1960 was 9.9 kgs. whereas in 1965 it was only 3.6 kgs. (Tables 6.14 and 6.15), with the total production of the same years being 129 and 42 qtls. respectively.

6.4.6.3 - Apricots

Apricot trees in the Benghazi Plain are grown mostly under irrigation. The productive trees are found mainly in the horticultural areas of El Gwarsha, El Kweifya and Tokra. Experimental trials in Tripoli and Garian proved that apricots and peaches are well adapted to dry farming and are almost as drought-resistant as olives and almonds.

The local apricot types of Murri and Lozi are the most common varieties in the Benghazi Plain. Italian varieties⁽²³⁾ (Canino, Bulida and Reale D'Imola) are grown in some modern farms. In recent years, however, apricot trees have been planted on almost every farm with perennial irrigation. Nevertheless, the whole production of 1965 came from El Gwarsha, El Kweifya and Tokra (Appendix Tables 6.3A and 6.3B). Some of the new varieties are early maturing and thus, in spite of their meagre production, fetch a very good price.

The number of apricot trees in the Benghazi Plain in 1960 was 3,900 of which 2,100 (53.8 per cent) were productive. According to the 1965 Statistics it was 3,607 trees of which 1,000 were productive. The decrease in the number of productive trees is due to the felling of the old trees. The average yield per productive tree in 1960 was 16.5 kgs. whereas in 1965 it was only 8.5 kgs.

The production of apricots fluctuates enormously from one season to another and it too often suffers from the catastrophic attack of the Mediterranean fruit fly (*Ceratitis Capitata*). In general, apricots have a good market in Benghazi City, but unfortunately their season is very short, being 14 to 24 days. The apricot production of 1960 was 347 qtls. whilst that of the 1965 Statistics was only 85 qtls.

6.4.6.4 - Peaches

Peach trees are found scattered among other trees in orchards. They are productive only in El Magrun, El Kweifya,

Sidi Khalifa and Tokra (Appendix Tables 6.3A and 6.3B), and all are of poor quality and yield.

Most of the varieties grown in the Benghazi Plain are of local origin but some imported varieties, such as Vincitore, Blazing Gold, Cardinal, Belladi Georgia and Blake, mainly from Italy and Tunisia, have been distributed to the farmers by the government in recent years.

The number of peach trees in the Benghazi Plain in 1960 was 1,200 of which 700 (58 per cent) were productive. In the 1965 Statistics it was 4,277 of which 1,650 (38.6 per cent) were productive (Tables 6.14 and 6.15). The peach production of 1960 and 1965 was 71 and 47 qtls. respectively. Although the number of trees and productive trees have increased by about 256 per cent and 135 per cent respectively, the production has, however, decreased by about 51 per cent. This, as was mentioned previously, is due to the effect of the Ghibli winds.

6.4.6.5 - Plums

Plum tree cultivation is also of a minor importance in the area under consideration. The trees, which are grown sporadically among other fruit trees, are confined to the irrigated areas in Es-Sahel region (Appendix Tables 6.3A and 6.3B).

Most of the plum varieties grown are of local origin (Hammuri and Bay-Yudi) and all are of a poor quality and yield. Some new imported varieties such as Methly, Florentia, Santa Rosa, Formosa and Shiro have been introduced in recent years.

There were 700 plum trees in 1960 all of which were productive, while in 1965 there were 4,608 trees of which 1,290 (38.6 per cent) were productive. The average yield per productive tree in 1960 was the lowest of all soft fruits, being only 0.4 kgs. In 1965 it was 2.7 kgs. (Tables 6.14 and 6.15). Plum production in 1960 was accordingly very low, being only 3 qtls. whilst in 1965 it was 35 qtls. This increase obviously resulted from the increase in the number of productive trees (by about 87 per cent) and not an improved yield.

6.4.6.6 - Pears

Pear trees grow only in the irrigated gardens of El Magrun, El Gwarsha, El Kweifya and Tolmeita (Appendix Tables 6.3A and 6.3B)

The varieties grown in the Benghazi Plain are mostly of local origin but newly planted Italian varieties of *Pyrus Betulaifolia*, *Moscatella*, *Cocia Precoco*, *Spantile Bianca* etc.⁽²⁴⁾ are also found in most areas.

The total number of pear trees and the number of the productive trees in the Benghazi Plain in 1960 was 400 and 100 respectively, whilst in 1965 there were 4,754 and 1,540 trees respectively. The average yield per productive tree in 1960 was 5 kgs., whereas in 1965 it reached only 1.8 kgs. The plum production of 1960 and 1965 was 5 qtls. and 28 qtls. respectively (Tables 6.14 and 6.15).

6.4.7 - Citrus

Although citrus cultivation is a flourishing agricultural

enterprise in the coastal areas of Tripolitania, it is not very common in the Benghazi Plain, mainly because it needs abundant fresh perennial water for irrigation. In addition to this, most agricultural activities in the past were practised within an area of about $\frac{1}{2}$ km. from the seashore, so that the salty winds and sea drizzle affected the citrus trees.

The main citrus fruits grown in the Benghazi Plain are oranges and lemons and they are of local varieties, such as Demmi with light or thick skin and Hilwi, as well as some Italian varieties (Doppio Sanguigno, Hammlin, etc.).

The distribution, the number of trees and percentages of the productive trees, the average yield per productive tree in kilogrammes and the production of citrus in quintals in the Benghazi Plain in 1960 and 1965 are clearly displayed in Tables 6.14, 6.15 and Appendix Tables 6.3A and 6.3B . However, the number of trees and production of tangerines and grapefruit were not recorded in the 1965 Agricultural Statistics. Appendix Tables 6.3A and 6.3B shows also that the citrus production came almost entirely from El Gwarsha and El Kweifya.

The only way to increase citrus production in the Benghazi Plain is to plant well selected varieties in the areas to be irrigated by the effluent water from the new sewage purification plant in El Gwarsha and from the Wadi El Gattara Dam in En-Nawaghia and Benina.

In conclusion, it may be said that, according to the

present evidence of fruit production, varieties planted, transportation problems and the disorganised and unstable market prices, local fruit production will not be able to meet the present growing demand for many years to come, because of the steadily rising standard of living in the area under consideration. Moreover, there is a rapid increase (mainly by migrants from the rural areas) in the urban population, who consume most of the fresh and preserved fruits. Consequently, a long term plan for fruit production development, by the growing of new and well selected varieties in the existing and new agricultural areas (through the fruit nursery of El Fweihat), must be undertaken by the Ministry of Agriculture as soon as possible.

The short term programme, which is carried out by the government at present, should continue with the distribution of nursery plants to all farms at lower prices or even free of charge, as well as encouraging farmers by the establishment of many demonstration farms throughout the Benghazi Plain. Prizes for the best products of all agricultural commodities must be initiated by the government in order to stimulate farmers. Through these measures it is hoped that future fruit production will come closer to meeting local demand.

6.5 - Industrial Crops

The growing of industrial crops for market sales is not common in the Benghazi Plain. Consequently, their very small

production is not even recorded in the 1965 Agricultural Statistics, although some industrial crops were recorded in the 1960 Agricultural Census. The area cultivated under industrial crops in 1960 was only 3 hectares. The only crops cultivated were tobacco (2 ha.) in El Gwarsha and castor beans (1 ha.) in El Magrun, which produced 5 qtls. each.⁽²⁵⁾

CHAPTER 7

FOREST AND GRAZING LANDS

7.1 - Forest Land

Data concerning natural forests in the Benghazi Plain does not exist and the only available information is about private forests which was reported in the 1960 Census of Agriculture. The forest area accounted for only 5 ha.⁽¹⁾ of which 3 ha. were in Tolmeita and 2 ha. in Gamines.* According to the 1967 field survey (in regard to the land use classification), the area designated as forest land is estimated at about 100,162 ha. or 16.7 per cent of the total area of the Benghazi Plain (Table 5.3).

The forest land in general falls under three major categories (the composition of the forest has already been discussed in Chapter 4 and their tentative distribution is shown in Figs.4.3 and 5.1). The first category or type is "wood land" which includes areas of real forest land with dense trees and understory of small bushes, as well as some herbs and grasses. However, this portion comprises about

* Gamines has no forest, so the above-mentioned figures are unreliable.

only 1.7 per cent of the forest land. The second type of forest is the "brush land," characterised by its sparse tree cover with the trees, in some parts, only one metre high. This brush land amounts to about 96.8 per cent of the forest land or 16.2 per cent of the total area of the Benghazi Plain. The afforested and reafforested lands represent the third category of forest land, and comprise about 1.5 per cent of the forest land (Table 5.13.).

The forest of the Benghazi Plain or northern Cyrenaica as a whole was formerly (at least during the Greco-Roman times) much more extensive and richer than today.⁽²⁾ Unfortunately at present almost the whole forest, except the northern part, has been destroyed through the ages by human misuse, animal over-grazing and fire. Nevertheless, the natural wood forest east of Tolmeita enjoys better natural conditions and is consequently more developed than the brush forest immediately to the south of it.

In addition to the value of the wood, the forests have indirect benefits for they have a favourable influence on climate, the hydrology system, soil protection and the health of the people. Moreover they make good pasture grounds for animals. The forest areas of Bersis, El Bakur and El Gwarsha are used as recretaional grounds for visitors from Benghazi City during weekends, religious festivals and other special occasions. Thus, it may be said that the indirect benefits of the forests in the Benghazi Plain are greater than their output of wood.

The forest lands technically are under the jurisdiction of the state and the tribes merely enjoy the right of usufruct, but in effect the tribes consider them as their own (see Chapter on Land Tenure). Thereby, the government can exercise little control over the forest land, except the afforested lands, which are usually fenced-off and well guarded, so that animals and even people are not permitted to trespass.

The Benghazi Plain suffers from a shortage of timber and its own product is not suitable as sawn timber for constructive purposes. There is also an increasing shortage of wood for fuel, roof poles and timber suitable for agricultural implements. All these forest by-products are in great demand in the area under consideration and the only means of satisfying this need, at present, is by imported timber from abroad.^{*} Messines,⁽³⁾ however, estimated that with proper control and management the forest land would yield at least 1 m³ of wood per hectare per year.

Data concerning wood or charcoal production in the Benghazi Plain are not available and the only existing information is that of the wood extracted in 1959. According to this, the Benghazi Plain produced 479 qtls. of wood, of which 418 qtls. were firewood and 61 qtls. round wood. About 68.7 per cent of this wood was extracted in the Mudirya of El Fweihat, 29.3 per cent in El Gwarsha and 2.0 per cent in Gamines. Table 7.1 shows also that wood extraction from the natural

^{*} No data are available.

forest was not included in the Census. This is due to the fact that wood cutting in the natural forest lands was, and to a certain extent still is, illegally practised. Thus, wood extraction from these forests was not recorded.

With a short-term planning programme of scientific management the forests of the Benghazi Plain and the Jabal El Akhdar could be made to supply all the local needs for small timber. With long-term planning it would be possible to develop their potential to supply some larger timber for constructional purposes since many tree species are qualified to do so. Nevertheless, all this, as said before, depends on the attitude of the Bedu and their willingness to accept or refuse any sort of control or reform of the forest land on which they live and graze their animals.

Since no adequate forest service is in operation in the forest areas, all manner of abuses can be expected even in areas declared to be protected as 'strict reserve.' The Bedu do not recognise such procedure and they encamp with their families anywhere they want, even within the protected forest area particularly in the tribal lands.

Goats are also a major devastating factor to forest growth and, as stated previously, nothing can be done about this problem. As can be seen in Plate 4.7, the foliage remaining out of the reach of the goats is devoured by camels. The illegal and random cutting of trees has contributed to the thinning of the stands of the forest species. This has

left the forest status in a very poor condition with an open character.

Fire outbreaks, caused mainly by either careless shepherds or camping visitors, are not uncommon in the forest areas, notably in the northern part east of Tolmeita. For example, the forest area from Wadi Belgasem at the escarpment (12 km. east of Tolmeita) to the seashore about 200 metres wide was burnt in 1957 by a shepherds' fire, after making tea. The worst thing about this incident is that this area was predominantly of *Juniperus Phoenicia* trees which once destroyed by fire can never germinate from the same trunks as the other trees do.

One of the most recent and serious threats to the destruction of the brush forest has been their unorganised clearing for cereal cultivation. This programme was initiated by Bujarrar Co-operative in 1964. This operation is increasing every year, and it will increase further, particularly since the Ministry of Agriculture announced at the beginning of 1968 its willingness to clear any forest land for any farmer on request and free of charge.

From the point of view of the economic importance of the forest as a wood and timber producer, the value of each tree species will be assessed individually.

Juniper (Shaara) tree is the most abundant tree species in the northern part of the forest land. Its growth is slow and it reaches between 4 and 12 m. high when fully grown.

It yields an excellent hard wood which is used for fuel, as a fire wood or charcoal, as well as for light industry lumber, such as roofs of houses and stores and posts for fencing. Juniper trees are widespread mainly because its fodder is not desirable to goats and camels, whereas *Lentiscus* suffer heavily from grazing, for the goats browse its leaves and branches.

Pistacia Lentiscus (Battum) tree is also widespread in the forest land. It yields good fire wood and excellent charcoal. Its fruit contain a high proportion of oil similar to olive oil, but, unfortunately, this is not exploited commercially yet, because even the olive oil industry is at present declining for reasons mentioned earlier. *Lentiscus* leaves contain a considerable amount of tans which are used in the local industry.

Arbustus Pavarii (Shmari) is rarely found in the forest land. It yields a hard pink wood used mainly for fire wood and charcoal. It produces a red fruit similar to raspberry which is picked up by the Bedu and they say it is a good medicine for stomach pains.

Pinus Halepensis (Sanober) is found in isolated stands in the northern slopes of the first escarpment and in its wadis' beds, east of Tolmeita. The Aleppo pine yields good timber for making furniture and house roofs, and its wood is considered the best type for both sawing lumber and fuel wood. Its fruit contains a good proportion of oil.

Quercus Coccifera (Ballut) is found also as isolated trees, mainly in the wadi beds east of Tolmeita, and yields good timber for fire wood and charcoal.

Wild olive (Zeitun) is found in many parts of the forest land, notably in the wadi beds near or at the escarpment. It is still considered a forest tree and its fruits and shoots are grazed by goats. However, its development for oil processing has not been decided yet, because even the olive trees grown in the irrigated areas are, at present, neglected due firstly to the high cost of labour and, secondly, the cheap imported vegetable and seed oils. The wood of olive trees is ideal for most agricultural equipment, especially ploughs, and it is an excellent timber for charcoal burning as well.

Carobs (Kharrub) are found mostly in wadi beds (Plate 4.8) in the forest land. Carob wood is not, however, good for lumber, but its fruits provide good nourishment for livestock and they give a good syrup (Rub) for the people as well.

The economic benefits of the understory vegetation lies in their importance as local medicines used mainly by rural people. The most important medical bushes and herbs are Zaatar, Harmal, Zheria, Klil, Rubiya and Berbesh. In addition to their importance as medical plants, their flowers are considered excellent grounds for bee-rearing.

7.1.1 - Afforestation

Afforestation practices in the Benghazi Plain started during the last years of the Italian rule in Libya. Most of

the trees planted then were around Benghazi City and along the road sides from Benghazi to Tika (18km. long) as well as in the centre squares of all villages, in order to protect the roads and the settlements from the Ghibli winds and to provide shade and wood for fuel.

Since independence the Libyan government has launched a programme concerning forest activities. Consequently, a "Forest Department" was established to undertake the responsibility of preservation and reafforestation of the existing forest land and to afforest new areas, especially in the coastal area near the settled centres. Messines,⁽⁴⁾ in 1952, believed that afforestation in the Benghazi Plain was a more important enterprise than natural forest preservation. He suggested that about 600 ha. in the Es-Sahel area should be devoted to crop planting of hard wood Eucalyptus and about 400 ha. in Barga El Hamra to conservation planting of hard wood Eucalyptus. Eucalyptus are the best recommended plant species for afforestation in the Benghazi Plain, especially Eucalyptus Gomphocephala, Eucalyptus Cameldulensis and Acaccia Picnantha. The latter tree species is very desirable for the high tanning content in its bark. The Eucalyptus tree stands the drought very well and it can survive on salty water and in marshy land. It does not compete with other crops or shrubs, for it prefers deep soils and can tap successfully subterranean water well outside the range of other trees.⁽⁵⁾ Therefore, Eucalyptus can make a significant contribution to

forest production in the Benghazi Plain, in addition to creating new recreational resorts for the people of Benghazi City.

Tamarix Articulata trees have proved to be very successful when grown in the sand dunes, preferably for sea-shore sand dune fixation, for they tolerate salt and withstand sea winds, spray and storms.⁽⁶⁾ Thus, they are considered the best tree species for dune fixation in the Benghazi Plain. Messines,⁽⁷⁾ in 1952, proposed also that about 2,000 ha. of coastal sand dunes ought to be stabilised or fixed by afforestation within a period of 20 years. Fifteen years later (1967) the Forestry Department had accomplished only 1,450 ha. of the total proposed area of 8,400 ha. for afforestation, reafforestation and dune fixation (Table 7.2). Nothing has been done for dune fixation, except for a few scattered Tamarix trees in the dune area between Dar El Araibat and Sidi Sweiker west of Deriana.

The Forestry Department has established a nursery for raising seedlings at El Fweihat experimental ground. From 1955 to 1967, it planted an area of about 1,450 ha. with about 877,306 plants. About 135 ha. are in the Es-Sahel area (north of Benghazi), 1,158 ha. in the steppe or marginal land in Barga El Hamra and about 157 ha. are private and scattered mainly along the road sides and around the settlement centres (Table 7.2 & Fig 4.3). It is difficult, however, to estimate the areas planted privately because of the different reasons

for which the trees were planted, such as wind breaks, boundary demarkation or shelter belts, but, generally, it never exceeds 100 ha. In recent years, the Forestry Department has increased its activities to encourage the planting of trees by private growers. Seedlings, therefore, are supplied free of charge and they are delivered also freely to the planting sites, in addition to the frequent visits by experts and agricultural extension guides to give supervision and technical advice.

The afforestation, which was initiated by L.A.J.A.S. in 1956, has already proved a great success and has transformed formerly treeless regions to dense forest land. It is in the district south of Benghazi that afforestation has made particularly striking progress (Plate 7.1). Consequently, the aim must be to continue to utilise suitable similar areas for the same purpose.

Since afforestation has proved a great success in the controlled and fenced-off areas (outside the tribal land), a long term plan for afforestation and reforestation development should be undertaken as soon as possible by the Ministry of Agriculture, including certain measures such as increasing the Forestry Department's budget and authority, establishing new nurseries for seedlings throughout the Benghazi Plain and the encouragement of private growers to plant more trees on their farms.

7.2 - Grazing Land

The Benghazi Plain is an area of steppe grasses, and the predominant type of land use is grazing. After the ground has been watered by winter rains, grasses, flowers and herbaceous plants grow in spring and early summer only to wither during the summer drought. The quality of pasture and its duration vary considerably from north to south in the Benghazi Plain. The best grazing land is naturally found on deep terra rossa in depressions in favourable rainfall areas in the north (Plates 4.9 and 4.10). In the south of the plain, the precipitation declines gradually until the land becomes true semi-desert and at its poorest, the seasonal pasture shades into unproductive land. This wide variation in the quality of grazing land cannot be indicated on a map as changes are too gradual. Therefore, the general patterns of the vegetation zones (Fig.4.3) are used in this context. The vegetation in the steppe area consists of steppe grasses, dwarf-shrubs and brush. Grazing is abundant only during the rainy season and for the rest of the year the animals subsist on dry grasses and shrubs (the Bedu people do not, due to their instability, know how to utilise the dry grass, particularly in good years when the grasses are lush and abundant).

One can ask what the Bedu do during the drought years. The answer to them is very simple; everything is in the care of Allah (God). Thus, the number of livestock decreases enormously by either starvation and eventually death or

enforced selling at a very low price every drought year. Fortunately, the government in 1963 started a programme for saving the livestock by distributing hay and other animal feed at a subsidised price, particularly during summer seasons and drought years. Unfortunately, the present ratio (40 kg. per head) of distributed animal feed is not sufficient for those who own a great number of animals.

The grazing land of the Benghazi Plain is of the unimproved grazing land use type,^{*} which by Desito includes all natural grazing grounds. In the Benghazi Plain grazing practice is traditional, and the grazing lands are owned largely by various tribes of which the Awaghir, El Fwakhir, El Urfa and Ed-Dersa are the main ones, all except the Ed-Dersa (which will be discussed in Chapter 9) having occupied the present territories for many centuries. The grazing land, in general, is communally held and each member of the tribe presumably has the right to graze wherever and whenever he pleases inside his tribal land. Any member of any tribe may graze the land of another tribe, on condition that the sheikh's permission is granted first. For example, the Bedu of Sirte in Tripolitania and Marmarica in drought years graze their livestock on the lands of El Awaghir in the Benghazi Plain, notably in Barga El Hamra.

Overgrazing and range abuse over the centuries have deteriorated the grazing land, so that most of the palatable forage species have been abraded and instead are replaced by

^{*}Improved pasture does not exist in Libya.

undesirable species of little or no grazing value. Thus plants have become sparse and the yield has decreased considerably.

Grazing lands occupy an extensive area of about 499,957 ha. or 83.3 per cent of the total area of the Benghazi Plain (Table 5.3).

For the purpose of clarification the unimproved grazing land use can be classified under the following subdivisions:

7.2.1 - Unimproved grazing associated with wood land

7.2.2 - Unimproved grazing associated with brush land

7.2.3 - Unimproved grazing associated with rotation cropland (fallow)

7.2.4 - Unimproved grazing associated with lithosols and rock outcrops.

7.2.1 - Unimproved grazing associated with wood land. This land use type occurs in the northern part of the Benghazi Plain, which represents the wood forest in the vegetation regions (Fig.4.3). It is characterised by fairly tall Macchia trees with an undergrowth of relatively thick herbaceous plants and grasses. This sub-class occupies relatively small grazing grounds of 1,750 ha. (Table 5.3) most of which is covered with dense forest on sloping and undulating relief, that makes it difficult for the sheep and camels to move easily and freely. Therefore, the predominant animals in this area are goats and some cows (Plate 7.2). The goats are raised successfully in this part since they graze the grasses in the lowland areas and wadi beds and browse the

tree branches and leaves on the slopes of the first escarpment as well. In summer, when most of the grasses are withered the flocks move up to the first terrace of the Jabal El Akhdar, where the forage is abundant during almost the whole summer. Due to the favourable climatic and physical conditions of this locality, the animals graze all the year round on fresh green grasses, unlike the rest of the plain, where in summer and drought years, especially in Barga El Hamra, the animals have to be fed on hay and other animal feed, or they will starve and finally die. According to Messines,⁽⁸⁾ this sub-class is the only area which can truly be called a 'range land' for the natural grasses and herbs here remain green for several months of the year.

The vegetation of this area, as was fully discussed elsewhere, is of Mediterranean steppe. Therefore, the most predominant range plants (mostly annuals) are Slender Oats (*AVENA BARBATA*), foxtail broom (*BROMUS BRUBENS*) and *STIPA TORTILES*. Other minor grazing plants are several species of wild oats and brooms which are good forage plants.

7.2.2 - Unimproved grazing associated with brush land. This is the most important sub-class, occupying an area roughly estimated at 96,962 ha. (Table 5.3). It embraces the area between Tolmeita in the north and Sidi Khalifa in the south (see Chapter 4). In general, it coincides with the brush forest vegetation zone (Fig.4.3) where short to medium grasses and herbs are abundant and scattered beneath and in between

the shrubs and short trees during several months of the year. Extensive and lush grasses and herbs are found in scattered areas, mainly in the depressions and wadi beds (Plates 4.9 and 4.10). This grazing region provides most of the grazing grounds for the sheep, goats, cattle and camels. Although this area is relatively rich in forage, its animals are not numerous like those of the following two sub-classes, because most of the tribesmen who live in this area move their animals between the plain and the first escarpment and first terrace. Moreover, most of the people of this area are engaged in sedentary irrigated agriculture.

7.2.3 - Unimproved grazing associated with rotation crop land or fallow land. This sub-class of grazing land embraces the whole uncultivated arable land throughout the Benghazi Plain, especially Barga El Hamra, which includes roughly the coastal Mediterranean and semi-desert vegetation zones (Fig.4.3). It occupies about 35.6 per cent of the grazing land and about 29.7 per cent of the total area of the Benghazi Plain (Table 5.3) and it is well spread all over the area under consideration. In the northern part this land is grazed mainly by goats and some cattle, in the centre by sheep, goats, cattle and camels and in the south chiefly by sheep and camels. The south-eastern part of the plain is grazed by camels alone, because here vegetation is scarce, trees are scattered and stunted and the very sparse semi-desert scrub, mainly zyziphus, is found in the wadi beds at the escarpment.

The forage growth in the southern portion of this sub-class depends entirely on the quantity and frequency of the rainfall. In good rainy years, the grass and herbs shoot up forming a lush carpet of colourful plants. This provides good pasture and produces good feed even during the summer. As the summer heat approaches, the splendour of spring flowers is soon over. If, however, the rainfall is delayed or does not fall, the range land in this part becomes worthless and consequently the livestock are subject to starvation unless something is done to save them.

The range land of this sub-class is not rich in pasture, but in general its northern part always has some grass cover. Barga El Hamra is generally dryer than the northern part and the Asphodel (Arb. SIRAS) gives way to Legium Spartium and Pituranthos Tortuosus which offers a reasonable animal feed.⁽⁹⁾

7.2.4 - Unimproved grazing land associated with Lithosols and Rock Outcrops. This is the most extensive sub-class and yet the least important one with regard to grazing forage. It covers about 223,174 ha., 44.6 per cent of the grazing land or 37.2 per cent of the total area of the Benghazi Plain (Table 5.3).

The grass cover in the lithosol areas is scanty and provides very limited seasonal grazing pasture. It is generally grazed by goats in the north and by camels in the south of the plain. The rock outcrop areas are almost completely devoid of any vegetation, except in some places where

broken rock outcrops allow some pockets of scant bunch grasses to grow.

7.3 - Poisonous Grasses

Moreover, there are some grass species which can be dangerous if they are grazed by animals. In winter, for example, the Kalakh grass is the most dangerous plant species, whereas in summer the Bugratu is dangerous only to goats. However, generally, any grass replenished or rehabilitated after spring rainfall is deadly dangerous to livestock.

The native grass is not tall so that it cannot be harvested for summer feed. Nonetheless, there are some grass species, such as wild artichokes, which are cut mainly by sedentary people around Benghazi and used as green fodder or dried as hay for summer. Most of the wheat and barley straws are used for animal feeding during the summer or drought years.

Most of the grasses grow very rapidly after the first rainfall. Thereafter, the livestock graze quickly the more palatable grass and leave the plants which grow or persist during the dry season, which are generally woody and relatively useless for animal feed. It is impossible, however, for the palatable plants to compete with the plants which have little or no value, unless good management and grazing control are introduced. But, unfortunately, it is very difficult, if not impossible, at present to improve the range land in the Benghazi Plain, owing to the dearth of water on the one hand and the hindrance of the traditional way of life of the Bedu people on the other.

Animal fodder from cultivated lands, except on a very few modern farms at Benina, El Fweihat, and El Haw-Wari, is unknown to the Bedu. The only known cultivated fodder to the Bedu is the dry straw of wheat and barley. According to the 1960 Agricultural Census, there were 35 ha. cultivated with forage which produced 305 qtls. Since then, although data are not available, the area and production have, undoubtedly, increased. This is because more farmers have kept more animals on their farms.

Trial grazing on areas sown with wheat and barley in Benghazi Plain has failed drastically. Therefore grazing of cereals grown for grains should not be attempted again.⁽¹⁰⁾

However, there is a general lack of supplementary fodder crop in Cyrenaica in general and in the Benghazi Plain in particular. Fodder crops such as alfalfa or clover are not cultivated in the Benghazi Plain, except in small plots where alfalfa is grown mainly for cattle fodder on the modern commercial farms. Fodder crops could probably be grown under irrigation in the whole area of the coastal strip, but as was mentioned previously, it would be more profitable if the available water were used for vegetable growing.

Reseeding to increase the forage is not feasible in the Benghazi Plain because any reseeding must have at least one full growing season without any grazing followed by light grazing toward the second season. This is, of course, impossible with the pastoralism of Cyrenaican Bedu. If it

is necessary to reseed in order to obtain good perennial forage, the local grass species, due to their adaptability to the local environment, stand a much better chance of survival. In such a case it was suggested⁽¹¹⁾ that the re-seeding of pure stands of a single species would be better than a mixture. The following grass species are recommended for seedlings⁽¹²⁾ rice grass (*ORYZOPSIS MILIACEA*), Mediterranean orchard grass (*DACTYLUS GLOMERATA*), bulbous barley (*HORDEUM BULBOSUM*), desert needle grass (*STIPA LAGASCAE*), and perennial rye grasses (*LOLIUM PERENNE*). In addition to these five grasses, there are other good perennial forage species, such as ECHINCHILON FRUTICOSUM (shrub said to be more nutritious than clover and alfalfa), GENISTA CAPITILLATA (shrub), POLYGONUM EQUISETIFORME (shrub-like woody root), Plantain (*PLANTAGO ALBICANS FORBE*), ERODIUM SP., MEDICAGO SP., clover, FORBES, *salsola* sp. etc.

The most important problem of the range land is that there are too many goats roaming the grazing, destroying the forest and range grounds. The proper remedy for this problem is to reduce the number of goats, improve the livestock breeds and introduce supplementary feed as well as to control the grazing land and prevent over-grazing. The trouble is not how to find a suitable solution to this problem but, in fact, how to apply certain rules, because any programme to reduce animal numbers or to control grazing land will be met with considerable resistance and resentment by the Bedu and

probably will create an endless problem for the government. Consequently, the present situation of the range land will remain as it is and any proposal for its improvement in the Benghazi Plain or Cyrenaica as a whole is out of reach as long as the present systems and traditions of the Bedu prevail. Thus, the government will have to continue its present programme of rationing out the hay and other animal feed to farmers at a subsidised price every year, until a reasonable solution to this problem can be found.

CHAPTER 8

ANIMAL HUSBANDRY

The Bedu, who comprise about 90 per cent of the rural population of the Benghazi Plain, are by practice and tradition shepherds first and cultivators afterward.⁽¹⁾ Thus animal husbandry has always been the most important source of income.

Throughout history pastoralism has always been the major land use practice in the area under consideration, and it was probably practised by ancient Libyans even before cultivation.⁽²⁾

The predominant animals in the Benghazi Plain are sheep and goats, camels, cattle, donkeys and horses. However, as has been mentioned elsewhere, goats and cattle predominate in the northern part (forest) of the plain, with sheep and goats in the middle, and sheep and camels in the south. Donkeys and horses are found everywhere, notably in the areas where mechanised transportation is rare or difficult to operate. Most cattle raising is found in the irrigated areas (Benina, El Fweihat, El Haw-Wari and El Gwarsha), where irrigated fodder crops, mainly alfalfa, are available.

Poultry are very widespread and are found in almost every household, tent, cottage and cave in the rural areas, but they are more abundant in the settled areas near the coast.

The sheep and goats in Barga El Hamra are more constant in their movements. They cannot graze in areas too remote from water supplies during the dry seasons, whilst in the south and south-west of the plain the camel, which is the chief grazing animal, is capable of walking long distances (about 300 km. radius) without water.

The traditional boundaries of livestock movement in the Benghazi Plain are well known among the Bedu. For instance, the northern limit for sheep in normal years is Sugba, about 20 km. east of Tokra. Their number increases southward, toward the open grassland (steppe) until they reach their maximum in Slug; then their number decreases gradually toward the south of the plain, due to the lack of water, till the northern boundary of the camel area. In drought years the sheep realm moves northward until they reach Sidi Abdalla just west of Tolmeita (Fig.8.1).

Goats are found everywhere but traditionally they predominate in the forest area in the north, particularly at the escarpment and wadi beds, and in the rough grazing land, where sheep cannot survive.

Although camels roam everywhere in the Benghazi Plain, their traditional northern limit in normal years is well marked with a hypothetical line running from Er-Rajma on the

escarpment to Shat El Bedin in the south-west of the plain, crossing Wadi El Gattara and passing through En-Nawaghia, west of Jardina and through Es-Sanyurat area, about 10 km. west of Slug, and then through El Magrun and finally Shat El Bedin, in addition to some areas around the marshland and sebakh throughout the Benghazi Plain. In drought years, camels move farther north until they reach Bersis, about 15 km. west of Tokra (Fig.8.1).

The southern limit of cattle is Wadi El Gattara and traditionally their number increases northward according to the increase of the grassland. However, since fodder crops for animal feed have been introduced the cattle number has increased considerably in the irrigated areas, particularly in El Fweihat, Benina and El Haw-Wari.

Animal migration in and out of the Benghazi Plain occurs according to the conditions of the pasture on the plain, as well as in Sirte and Marmarica plains. In drought years the animals of Benghazi Plain move northward to the richer forest lands of Deriana, Tokra and Tolmeita, whilst the animals of these areas mount the escarpment up to the first terrace to enjoy better grasses on the mountain and on the wadi beds of the tribal land of their owners. Some of the shepherds of Barga El Hamra take their flocks to El Abiyar on the first terrace, or sometimes even around Taknis and Jades El Abeed on the second terrace of the Jabal El Akhdar.

In rare cases, the shepherds of Barga El Hamra take their

flocks to areas farther away, such as the Sirte or Marmarica plains (Figs. 8.1 and 8.2), if the pasture there is good. If the pasture is good in the Benghazi Plain, especially in Barga El Hamra, and it is poor in either Sirte or Marmarica or both, the shepherds will bring their animals to graze in Barga El Hamra. The animal flocks of Marmarica follow the southern slopes of Jabal El Akhdar (Es-Shaafa) where they can find some grass to graze and some water to drink on their way to the Benghazi Plain, whereas the animals of the Sirte plains, owing to the long barren and waterless route, travel on lorries, which costs the owner an average of about 48 piastres (10/-) per head. The camels, on the other hand, with their admirable resistance to water and food shortage, walk all the way until they reach their destinations in Barga El Hamra or sometimes proceed toward the Egyptian border (Fig.8.2).

The seasonal migration of the animals in the Benghazi Plain occurs usually between the plain and the mountain and between the interior of the plain and places or villages where water for human and animal uses is available. For example, the shepherds of El Huta in Bersis bring their animals from El Hemda (their second habitat) down to the plain in the early spring until after harvesting, then they take them back about 20 days after they complete the harvest. The shepherds of Ed-Dersa in the far north, east of Tolmeita, take their animals up to the first terrace around Batta,

usually at the beginning of summer to graze the lush grasses which last for longer than those on the coastal plain and then they come back after the first winter rain. El Urfa shepherds east of Tokra graze their animals in El Marj and Farzugha areas, whereas the shepherds of Barga El Hamra sometimes take their flocks to El Abiyar during the late spring and early summer (Fig.8.2). In summer almost all the animals of Barga El Hamra gather around the wells and cisterns or near the coast, where water and food are available. In general, camels gather around Slug where the government (since the Italian rule) has built wells and taps for animals watering free of charge.

The number of animals and their production depends entirely on the pasture condition and its duration. However, the total number of animals in the Benghazi Plain according to the 1960 Agricultural Census was 182,786 head of which 47.9 per cent were sheep and 40 per cent goats. In the 1965 Agricultural Statistics it was 284,450 head of which about 64.5 per cent were sheep and 26.4 per cent goats (Table 8.1). It would appear, therefore, that there was an increase of about 55.5 per cent in the number of animals. This increase was mostly in the number of sheep, which was about 109.6 per cent. The unusual increase in the number of sheep came partly as a result of the distribution of the subsidised animal feed by the government after 1963, which led farmers to report that they had more animals than they really possessed in order to

get more fodder and probably sell it. The decrease in cattle resulted from the excessive slaughtering of calves. The fluctuation of livestock numbers in the Benghazi Plain is also caused by droughts (Figs.8.3 and 8.4). The rural area of Benghazi Plain had an average of about 4.5 head of animals per capita in 1960, whilst in 1965 it was about 4.4 per capita (Table 8.1).

Before the discovery of petroleum the Benghazi Plain and Cyrenaica as a whole exported livestock mainly to Egypt and Greece, but since 1960 animal production has not kept pace with the local needs. For example, in 1965 the Benghazi Plain produced about only 25 per cent of the local consumption. Since then the country as a whole started importing the same product it used to export. This came, of course, as a result of the rising standards of living owing to the petroleum impact on every aspect of life, especially in the urban areas. However, it will not be easy to fill the gap between present animal production and local consumption since the improvement of livestock for more production and better productivity is not likely to be effective unless adequate fodder crops can be provided. This, as was noted elsewhere, is not feasible for many years to come. Thus Benghazi has to depend on imported livestock (mainly for meat consumption), some from other parts of Cyrenaica and mostly from abroad, especially Bulgaria, Yugoslavia and Turkey.

8.1 - Animals

8.1.1 - Sheep

Sheep are the most important animals in Libya in general and in the Benghazi Plain in particular, being the most numerous and desirable mainly for their meat. Sheep are also the most useful animals giving, in addition to meat, milk, purified butter (Arb. SAMN), cheese, wool, skins and manure.

The sheep of Libya are of the well known Berber fat-tailed variety which is common in all North Africa and some Mediterranean countries. Their colour is mainly white and a mixture of white, brown and black. They are characterised by their fine adaptability to the local environment and their resistance to dryness, and their ability to live on the minimum rough pasture,⁽³⁾ their fat-tails being the life saver from which they draw in periods of scarcity of water or drought years. The sheep do not need water during winter, or when the grass grows, till the end of spring, whilst in summer they require water for drinking every second or third day and each sheep drinks about 10 litres in each drink.

The average weight of sheep is about 35 kgs. for the ewe and 45 kgs. for the ram. The lamb is about 20 kgs. Each flock of sheep (the average is 150 heads) usually contains 2 to 3 rams for fecundation. It is estimated that in good years, each 100 ewes crop about 70 to 80 lambs. The ewe as well as the she-goat crops once every normal year (preferably

in November) and once every other year in drought years. Twin lambs are very rare and it is unhealthy for both the lambs and their mother because of the rough conditions of the pasture. Heavy losses of lambs, by abortion, are not uncommon, particularly when the autumn rains are delayed or fail to fall. Castration to fatten the animal is unknown in Cyrenaica, for it is an indignity to the ram, which the Bedu admire.

The lactation season starts at the beginning of the spring and lasts until about mid-May. The length of the lactation season and the milk produced, however, depends entirely on the availability and the duration of the pasture. On average, however, the ewe produces about $\frac{1}{4}$ litre ($\frac{1}{2}$ pint) of milk daily and about one kilogramme of samn during the whole season.

Wool production varies between 2 to 3 kgs. per ewe and from 3 to 5 kgs. per ram per year. The local wool, which is generally coarse and mixed in colour and grade, is mostly used for clothes (Baracan or Jard), tents, carpets and rugs. The quantity and quality of wool vary however from one sheep to another as well as from one flock to another under the same environmental conditions. The sheep shearing season starts at the end of spring and ends before the beginning of summer.

About 75 per cent of the sheep were raised under tribal holdings (Appendix Table 8.1A). The official number of sheep

varies from year to year, partly according to the fluctuation of pasture, or in fact the rainfall. Fig.8.3 shows clearly that the number of sheep continuously declined from the drought season of 1958-59 until 1963, when it increased rapidly and steadily despite oscillations in annual rainfall. On the other hand, the proper interpretation for this unusual fluctuation, is because of the animal taxation, which was in effect until 1962. The farmers did not report the exact number of their animals but, inversely, they tended to decrease their numbers, using the droughts as a mere excuse. When the government started distributing animal fodder at a subsidised price in 1963, the farmers suddenly increased the number of their animals, regardless of pasture conditions.

The sheep number also varies from place to place according to the vegetation density and the physiographic regions. Sheep in general predominate in the open steppe pasture land. For example, in the steppe area of Slug, Jardina, En-Nawaghia and El Gwarsha, sheep in 1965 comprised between 72.2 and 76.4 per cent of all livestock in these areas. Further south in the plain where pasture and water are scarce, the sheep ratio reached only 49 per cent in El Magrun Mudirya, whereas in the forest land in the north the percentages between Tolmeita and El Kweifya were 15 to 50.4 respectively (Fig.8.5).

The rural area of the Benghazi Plain has an average of about 220 head of sheep per 100 persons in 1960, whilst in 1965 it was 290 heads per 100 persons (Table 8.1).

8.1.2 - Goats

Goats are second only to the sheep in importance as meat and milk producers. Although goats are more productive (in milk and meat) than sheep, unfortunately they are very harmful to the forest and tree plantation areas. Nevertheless, goats are extremely important animals to the Bedu in the forest land where sheep and other animals cannot graze freely or climb the slopes of the first escarpment and its wadi beds. In addition, goats prefer forest to grass while the sheep prefer grass. Thus any programme or even suggestion to reduce the number of goats in the Benghazi Plain and in Es-Sahel in particular will meet with considerable resistance and strong protest. Therefore, goat breeding has to remain in the Benghazi Plain and no restrictions or obligation could be imposed as long as the Bedu way of life and political influence exist.

The local goat is characterised by its long legs, medium hair and horns. Black, white or brown colours are equally common and are variously combined. Maltese goats, which are famous for their milk yields, are not very common in the Benghazi Plain, as they are in Tripolitania, and the few which are found in some private farms around Benghazi are stall-fed goats raised mainly for milk consumed by the farmer's families.

The water requirement for goats is the same amount and at the same time as for sheep.

The average weight of a she-goat is about 30 kgs., and

the goat and the kid are 40 kgs. and 15 kgs. respectively. The fecundation and kid production of the she-goat are like those of the ewe, except that in the northern part of the plain (east of Tolmeita) every 100 she-goats crop about 150 kids in good years,* and only 50 in drought years. The ratio of males and females of the new kids (lambs as well) is often equal. The best month for the she-goat to crop is February, after which the new kid avoids the cold winter spells of December and January. The new born kids are very delicate, and they have to be kept inside tents for at least 20 days after their birth, unlike the new born lambs which follow their mothers and graze immediately after birth. The kids also do not graze before they are 25 days old.

The normal she-goat produces about $\frac{1}{2}$ litre (about 1 pint) of milk per day during the whole season and gives between $\frac{1}{2}$ to $\frac{3}{4}$ kg. of purified butter (samn) monthly as well. The lactation season starts at the beginning of spring and lasts longer than that of the sheep, until about the 20th of June.

Goats' hair is used mainly by the Bedu for making tents and rugs. The shearing period usually starts at the beginning of summer and lasts for a few weeks. The average yield per goat is about $\frac{1}{2}$ kg. per year.

The number of goats, according to the 1960 Agricultural Census was 73,058 head or 40 per cent of all animals, whereas in the 1965 Agricultural Statistics, it was 75,206 head or

* A good year here means free from disease, whereas in Barga El Hamra, it means a good pasture.

26.4 per cent of all animals (Table 8.1.). About 69.5 per cent of the 1965 number of goats were raised in tribal lands (Appendix Table 8.1A). The increase in the number of goats from 1960 to 1965 was only 2.9 per cent whilst sheep increased by about 109.6 per cent.

The rural area of the Benghazi Plain had an average of about 180 goats per 100 persons in 1960, whereas in 1965 it was 120 head per 100 persons (Table 8.1).

The fluctuation in the number of goats is less marked than that of the sheep. Fig.8.3 shows a sharp decrease in the number of goats in 1958, resulting from the sharp fall in the rainfall total. From 1959 the goats gradually increased, until they reached their maximum number in 1963, in spite of the decrease of rainfall to below average (170 mm.) in 1962. This unusual increase of 1962 was probably because goats are more resistant to drought, while the big decrease in the number of sheep allowed the goats to graze and browse most of the rough pasture. Moreover, their meat is less desired, since mutton is available in a large quantity at a low price, owing to the enforced sale of the sheep at a low cost lest they should starve and die. After 1963, the fluctuation in the number of goats was relatively normal.

The ratio of goats to other livestock varies from north to south in the Benghazi Plain. For instance, in the forest area in the north, where they predominate, it was 43.0, 61.5 and 47.4 per cent for Tolmeita, Tokra and Deriana respectively,

whereas in the irrigated areas around Benghazi in the centre of the plain it was between 11.5 and 21.2 per cent. The proportion of goats decreases southward until it reaches 11.9 and 16.4 per cent in Jardina and Slug respectively, but increases again to about 39.5 per cent in El Magrun, where the range land is too rough for the sheep and suits the goats (Fig.8.5).

8.1.3 - Cattle

The most common cattle variety in the rural area of the Benghazi Plain is the local light red or brown coloured short horned and small sized primitive cattle.⁽⁴⁾ This type of cattle, which originated from brachyceros (BOS TAURUS BRACHYCEROS), is widespread in North Africa and some Mediterranean countries.⁽⁵⁾ The local cattle are characterised by their hard work, meat and milk, though they are less productive than other imported varieties. They are also well adapted to the local environment and have a strong resistance to diseases and lack of food.

The Italians introduced the Pantellarian, Brown Swiss, Friesian and Jersey types as dairy herds. At present some excellent varieties, mostly from Holland are raised in the vicinity of Benghazi City, mainly to provide Benghazi with some of its fresh milk, which is unfortunately lacking, and about 99 per cent of the people of Benghazi City are deprived of it, using instead dried or tinned imported milk.

The cattle which are raised on pasture lands in the Benghazi Plain are kept mainly for breeding and meat production.

The use of cows for work in the Benghazi Plain is not very common unlike those of Tripolitania, where they are primarily yoked for drawing water from wells in the traditional farms.

Beef is mostly consumed by the foreign community but is almost unknown to the rural population: milk and butter are, however, very common. The average weight of cows varies greatly according to the pasture conditions. In general, it is about 270 kgs. and that of bulls up to 450 kgs.⁽⁶⁾

The normal cow crops once every year, but there is a local type known as GANDUZ which crops once every two years. The cow lactates the year round and stops only when it is pregnant. The Ganduz type, however, lactates the year round as well. Milk production per cow is, in general, not as high as that of other excellent varieties of cows, or in other words is not as good as that of cows fed on cultivated fodder crops. However, the average is about 4 litres per day. (Foreign cows, stall-fed, produce up to 20 litres per day).

Most of the cattle are found in the northern part of the Benghazi Plain (forest) where they comprise about 27.3 per cent of the total cattle number and their ratio to other livestock is about 67.7 per cent. Deriana alone has about 23 per cent of the total number of cattle in 1965 (Appendix Table 8.1A).

According to the 1960 Agricultural Census, the number of cattle was 6,245 head, or 3.4 per cent of the total number of animals. According to the 1965 Agricultural Census it was reduced to 5,302 head (Table 8.1). About 50 per cent of the

cattle in 1965 were raised on tribal lands.

In 1960, the Benghazi Plain had an average of about 15 head per 100 persons, while in 1965 it was 8 head per 100 persons (Table 8.1).

The fluctuation of the number of cattle is not very pronounced because they are few but well cared for. The best ways to increase their number and to improve the breeding structure, in order to meet the domestic needs for milk and meat, are firstly, to cross-breed the local cows with excellent imported breeds and, secondly, to raise them on farms and feed them on cultivated clover and alfalfa. This trend has, in fact, started on a very small scale on the Government Experimental Farms and in some private modern farms. Nevertheless, a wider programme, which will include all irrigated farms must be undertaken as soon as possible, under the auspices of the government with both good financial assistance and full supervision, starting with one or two cows per farmer at first.

8.1.4 - Camels

The most common breed of camel in the Benghazi Plain is the one-humped and intermediate type which is used mainly to carry light loads and for riding. There is also a smaller number of a heavy built type for working purposes. Camel herds are generally found in the deep south of the Benghazi Plain where they can graze farther from sources of water than any other domestic animal. Thereby, the further south one goes the more camels are found.

The average weight of camels is between 200 and 500 kgs. The she-camel produces one crop every two years, and the best breeding time for new camels is January. One strong camel is able to fecundate about 100 she-camels. The average milk production of a she-camel is about 10 litres per month. It produces also 5 kgs. of purified butter (samn) per year. The lactation season is like that of sheep. The camel also yields about 2 kgs. of hair per year.

The number of camels in the 1960 Agricultural Census was 6,270 head or 3.4 per cent of all the animals, whilst in the 1965 Agricultural Statistics, it was 8,971 head or 3.2 per cent of all the animals. Of these 86.6 per cent were raised in the tribal lands. The Mudiya of Slug alone contains about 65.8 per cent of all the camels in the Benghazi Plain (Table 8.1 and Appendix Table 8.1A). According to the 1960 Agricultural Census, the Benghazi Plain had about 15 head per every 100 persons, and in 1965 it had about 14 head.

The fluctuation in the number of camels is well demonstrated in Fig.8.4. After the drought season of 1958-59 the number of camels decreased sharply until 1962, then it rose steadily until it reached its maximum in 1966. The unusual decrease and increase in various years, despite the different trends of the rainfall fluctuations, are due to the same factors which affected sheep numbers.

8.1.5 - Donkeys

The local donkey is a small and tough animal. It carries

on its back loads exceeding 50 kgs. Prior to the petroleum discovery, donkeys were and to some extent still are, in some areas, the most important working animals. They were engaged in most of the farm work and rural transport. Without these hardy, patient and economical animals, scattered small plots of cultivation, notably in the coastal sand dune areas, forest land and in the desert areas, would be impossible. In addition to being used as a means of transportation between the villages and Benghazi market, they are used also for cereal ploughing and cart-drawing. Unfortunately, this animal is unlucky since it finds little or no care or kindness. It receives little food and in recent years has been neglected and mostly is left to feed itself on rough pasture and garbage. Thus donkeys nowadays have become worthless animals, costing only between 50 and 150 piastres (10/- to 30/-) per head in 1967.

Although the significance of the donkey as a draught animal has diminished in recent years and mechanisation has replaced it in transportation, ploughing and drawing of water, for many farmers it still is very important as a working animal.

Donkeys are found everywhere, and their number and value increase in areas far away from Benghazi and the coastal dual-carriageway. For example, Slug alone contains about 29.4 per cent of the total number of donkeys (Appendix Table 8.1B), owing to its location in the interior of the plain very remote from Benghazi.

The she-donkeys and hares produce one crop every year.

Their milk is used by humans only in rare cases but taken as medicine especially by infants.

The total number of donkeys in the 1960 Agricultural Census was 6,562 head, or 3.6 per cent of the total number of animals, whereas in the 1965 Statistics it was 7,630 head of which 74 per cent were under tribal holdings (Table 8.1 and Appendix Table 8.1B). In 1960 there were about 16 head of donkeys for every 100 persons, whereas in 1965 there were 12 head.

The fluctuation in the number of donkeys contrasts with the usual general trend of animal fluctuation according to the fluctuation of pasture. Most animals, except the stall fed, were affected by the drought spells of 1959 and 1964 when they normally decreased and inversely increased in the rainy years of 1962 and 1965. The donkeys, however, increased in the drought years and decreased in the rainy years. This unusual phenomenon could perhaps be explained by the fact that during the rainy or good pasture years the number of other animals (mainly sheep and goats) increased enormously and competed strongly with the other animals for the grasses. They must have grazed the pasture extensively and left little grass for the less important donkeys. In the drought years, with the decrease in the number of other animals, the donkey did very well with little competition for the rough pasture and thus increased in number.

The other probable reason is that there is a correlation

between the fluctuation of the pasture and the life cycle of the donkeys, which is at present beyond our knowledge. Thus, in dry or drought years their fertility increases and in rainy or good pasture years it decreases. However, it is difficult to find a definite justification for this unusual phenomenon, since the death toll of donkeys is not known and the gestation period is also unknown, at least to the author. This problem would provide a very interesting subject for future research.

8.1.6 - Horses

The types of horses found in the Benghazi Plain are almost entirely of local or Berber breed and probably they result from the cross-breeding of ancient Libyan horses with light Arab horses.⁽⁷⁾ The local horse is characterised by its tremendous adaptability to the local conditions of little care and rough pasture. Nonetheless, it is the only privileged animal to be fed often on barley. Among the Bedu the horse denotes the wealth and prestige of the owner.* The horse is very rarely used as a draught animal in the rural areas of the Benghazi Plain but it is mostly used for carriage and cart-transportation in the urban areas, notably in the suburbs of Benghazi City, and some villages. It is also used as a working animal in some parts of the coastal plain, particularly where mechanisation is impractical for one reason or another. Here, it is mainly engaged in ploughing, harvesting and threshing. Yet, because of the lack of fodder crops and expensive

*At present the Land Rover is replacing the horse in this respect.

feed, most of the farmers in the poor areas like Gamines, El Gwarsha, Deriana, Tokra and Tolmeita, prefer to use donkeys instead.

The number of horses in the Benghazi Plain in the 1960 Agricultural Census was 3,123 head, 1.7 per cent of all the animals. In the 1965 Statistics, it was 3,839 head, 1.3 per cent of the total animals of which 71 per cent were owned by tribal holders (Tables 8.1 and Appendix Table 8.1B).

Because of the declining importance of the horse in the area under consideration, its price has accordingly fallen to about 20 to 30 Libyan pounds in recent years (before 1958 it was about £L.80).

The distribution of horses does not vary too much from place to place, except in Benghazi and Tolmeita where they are used for transportation (Fig.8.5). Tolmeita alone had about 20.2 per cent of all the horses in the Benghazi Plain.

According to the 1960 Agricultural Census, there were about 8 head of horses per every 100 persons, whereas in the 1965 Statistics, there were 6 head (Table 8.1).

The number of horses fluctuates from one year to another generally in the same manner as that of donkeys (Fig.8.4), nor is there any definite explanation for this unusual fluctuation.

The economic value of the horse, at present, is so poor that most of the farmers in the Benghazi Plain have started replacing it by machinery and motor cars. The only small

benefit gained from horses, at present, is by the sale of some lame, broken and old aged horses for export to Malta or Greece where they are slaughtered for meat.

In conclusion, it may be said that there is no need to spend money or waste efforts on improving by cross-breeding the horses or donkeys since mechanised transportation and agricultural machinery and equipment are gradually replacing them.

Although mules are to a certain degree important as hard working animals in some cultivated areas of Libya, particularly in the Italian farms of Tripolitania, they do not exist in the Benghazi Plain at all. This is probably because the Bedu, and Arabs as a whole, regard the horse as a noble animal and any cross-breeding with donkeys is regarded as an indignity to the horse or the mare.

8.1.7 - Poultry

Poultry-keeping in the rural areas of the Benghazi Plain is the least developed agricultural activity, because the Bedu consider it an affront to their manliness, and traditionally it is shameful even to talk about it. Thus poultry-keeping is exclusively a feminine pursuit, and since women are not allowed to talk to strangers, it is most difficult, if not impossible, to know the number, or the products, of poultry. Although good cash returns (for women only) are obtained, mainly from eggs, they are rarely included in the Bedu diet.

The chickens of the rural areas are mostly of the small

black native breed which are believed to be derived from the old Roman Black Fowl, which is still extant in the oasis of Zella⁽⁸⁾ (south of Sirte plains).

This type of chicken yields a very small sized egg and carries little flesh. They are left to feed from the fields and only rarely are they fed on grain. Thus, they always show signs of malnutrition.

Other minor poultry breeds, such as Rhode Island Red, Light Sussex, Brown Leghorn and old fashioned Rouden, are found in small numbers in Benghazi City and the surrounding areas. In the 1960 Agricultural Census there were 18,404 birds with 20,973 birds in the 1965 Statistics, of which about 48.7 per cent were raised on tribal land (Table 8.1 and Appendix Table 8.1B).

The number of poultry increases in the irrigated areas where they are kept in small farms, and decreases in the dry farming areas but, generally, they are more abundant in the northern part of the plain (Appendix Table 8.1B and Fig.8.5).

Due to the scarcity and high cost of the local meat, poultry for meat production has, in recent years, increased enormously as a substitute for animal meat. Seven modern farms, as a consequence, have been established in El Gwarsha and El Fweihat, merely to supply Benghazi with chicken meat. Poultry for eggs have not been introduced yet in the Benghazi Plain, whilst in Tripolitania they supply most of the eggs for Tripoli City. Thus eggs are still an expensive food

commodity in Benghazi being 30 to 36 piastres (6-8/-) per dozen. Private farmers and co-operatives must be encouraged to raise poultry for eggs. In addition, a plan must be made to increase the number and improve the quality of chickens by cross-breeding the local breed with excellent imported types. The methods of poultry-keeping must be developed in order to be able to supply most of the local needs for chicken meat and eggs.

Other birds such as pigeons, ducks and turkeys are very rare and their economic value to the farmer's income is negligible.

8.2 - Animal Diseases

Dangerous livestock diseases are not common in the Benghazi Plain, due mainly to the unfavourable dry climate for their development. Nevertheless, ecto-parasites cause considerable harm to the livestock population.⁽⁹⁾ Owing to the lack of pasture in most years, deficiency diseases are very common especially in drought years. Anthrax⁽¹⁰⁾ is the most dangerous disease which affects all kinds of livestock. Sheep and camel pox and Tuberculosis are also prevalent in the area under consideration. Newcastle disease is the most harmful disease affecting poultry and when it attacks, which often occurs, it wipes out about 20 per cent of the poultry population. Coccidiosis and fowl diseases also cause considerable harm to poultry. However, a well organised veterinary service to control animal diseases, particularly by preventive

vaccination will undoubtedly increase the number of animals and increase production, notably in wool, hair, milk and skins. Although veterinary inspectors are found in almost every Mudirya, since the area under consideration is so large, the inspectors are handicapped primarily because of the lack of transport facilities for making good inspection. Consequently a well organised veterinary service, supported by well trained staff, is more than essential to protect the national wealth of livestock.

8.3 - Animal Products

8.3.1 - Meat

Meat is desired by everybody, but not everybody can afford to buy it. Thus, the majority of the Bedu of Cyrenaica do not usually eat meat except at festivals and on religious occasions or when they entertain a respected guest. The rural population eat meat once or twice a week only if it is available in the nearby village; otherwise they might not eat it for months. Most of the urban people eat meat almost daily.

Small lambs and kids (mostly males) are usually sold for meat in the spring season. Rams, barren ewes and goats are also sold for meat. Cattle are very rarely sold for meat. For example, in the 1965 Statistics, there were only 7 cows killed in the whole rural area of the Benghazi Plain, and they were all killed in Tokra Mudirya alone (Table 8.2). Camels are very seldom sold for meat; according to the 1965

Statistics there was only one camel killed in Tokra. The camels killed almost daily, particularly in the poorer areas of Benghazi City, are all imported mainly from the Sudan and Chad Republics.

Benghazi City is, undoubtedly, the main consuming centre for meat in the Benghazi Plain. For example, in 1965⁽¹¹⁾ there were about 252,789 head of animals killed in the Benghazi Plain of which 87.3 per cent were killed in Benghazi City. The Benghazi Plain produced an estimated number of about 106,898 head of livestock in 1965. Thus the rest, about 57.7 per cent was imported, mainly from Yugoslavia, Bulgaria and Turkey, as well as from the adjacent areas of Jabal El Akhdar, Marmarica and Sirte.

Table 8.2 shows that about 92.5 per cent of the sheep were killed in Benghazi City, whereas about 63.3 per cent of the goats were killed in the rural areas. This contrast could be explained by the fact that the urban people can afford to buy the expensive sheep meat, whilst most of the rural people can buy only the cheaper goat and camel meats.*

Consequently, with the great demand and daily increasing consumption of meat, there is no immediate hope that the Benghazi Plain with the present production could produce enough meat to satisfy even the present local demand in Benghazi City. Therefore, Benghazi has to depend on imported livestock for its meat.

*The average cost of sheep meat is 85 piastres (18/-) per kg., goat's 50 piastres (11/-) and camel's 40 piastres (9/-).

8.3.2 - Milk

Despite the fact that milk is the most utilised animal product for the Bedu population, there are no data for its exact production in the Benghazi Plain after 1959. This is because milk production is not commercial but used almost entirely for family consumption in the rural areas. In 1959⁽¹²⁾ 13,886 litres of sheep milk, 21,161 litres of goat milk, 14,125 litres of cow milk and 11,511 litres of camel milk were produced. The quantity and quality of milk vary from place to place according to variations in pasture and livestock breeds. For example, sheep milk came mostly from the southern Mudiryas, whereas goat's milk came from the northern part of the plain, notably from Tokra, whilst camel's milk came mostly, of course, from the southern Mudiryas (Appendix Table 8.2).

Despite the relatively large production of milk in the Benghazi Plain, there is no fresh milk distributed in Benghazi City, except for a very small quantity provided by small farmers around Benghazi, and this is used mostly in cafes. Purified butter (samn) is almost the only milk by-product sold by the Bedu to townsmen and villagers. Consequently, Benghazi has to import its milk (usually dried or tinned) from abroad. Therefore the government must launch immediately a plan for raising cattle to supply Benghazi with its daily requirements of fresh milk (Tripoli is supplied by fresh milk provided by the surrounding rural areas).

8.3.3 - Wool and hair

Although the wool of the Benghazi Plain, as it was stated previously, is of an inferior quality, the surplus is usually sold either on the site to middle-men or sold in Benghazi Market, after which it is exported mainly to Italy and Greece. In 1967, a fleece cost between 35 to 65 piastres (7 to 13/-), depending on its type and weight. In 1959, the total wool production was 2,151 qtls. and in 1965 it was estimated at about 5,505 qtls. The bulk of the wool produced in 1959 came mainly from the southern Mudiryas (Appendix Table 8.2).

Goat and camel hair is mostly used in manufacturing tents and rugs and a very small quantity of each is sold. According to the 1960 Agricultural Census the Benghazi Plain in 1959 produced about 335 qtls. of goat hair and about 219 qtls. of camel hair. About 66.5 per cent of the goat hair came from Tolmeita, Slug and El Magrun alone. The estimated production of 1965 was 376 qtls. of goat hair and about 179 qtls. of camel hair.

Other minor animal products were eggs, which were reported in 1959 as being 1,628,900. The honey production was 39 qtls. Skins and hides were mostly used by farmers for milk and food storage (Appendix Table 8.2).

8.4 - Bee-keeping

Bee-keeping is not a very significant activity in the Benghazi Plain, except in the forest area where the bee-hives

are kept in a traditional way, in caves or on trees without any arrangement.

Bees' honey is delicious and has many different flavours similar to the flowers on which the bees feed such as Klil (Rosemary, MYRTUS COMMUNIS), Zaatar (THYMUS CAPITATUS), Shmari (ARBUSTUS PAVARII). The honey is used locally, mainly as medicine and is mostly sold in the market at a high price (£L.1.00 per kg.). Although wax as a raw material has an important role in modern industries, here it is neglected and usually is left as debris. In addition to the production of honey and wax the bees are also very successful agents for pollination in the cultivated areas.

The number of bee-hives in 1960 was 688, whereas in 1965 it was 1,049, with an increase of about 52.7 per cent (Table 8.1). About 85.9 per cent of the 1965 bee-hives were owned by tribal holders, and 95.3 per cent were in Tolmeita alone (Appendix Table 8.1B).

The average yield per bee-hive, according to the 1967 survey, was about 8 kgs. This low production of honey resulted from the disorganised bee-keeping and the lack of skill in following modern methods. Nevertheless, the governmental apiary in Ras El Helal on the coast further east is well developed by an English expert.

In order to improve the honey yields and production in the Benghazi Plain, the bee industry must be managed and directed systematically with modern equipment and techniques.

Besides, bee-keeping must be supervised by government experts and farmers raising bees must be financially assisted to encourage bee-keeping.

PART III

THE AGRICULTURAL ECONOMY

CHAPTER 9

LAND TENURE AND FARMING PRACTICES

9.1 - Land Tenure and Water Rights

9.1.1 - Land Tenure

The prevailing system of land tenure in the Benghazi Plain has had a great influence on the agricultural economy and its development, as well as on the agricultural land itself. Apart from rather small areas held as definite private property, most of the land is tribal or communal, held as joint and undivided property, generally by all members of the tribe.

Land tenure in the past was obscure and confusing but, during Turkish times, the mass of land became in theory 'state land' and the Bedu people were given the right of usufruct of the land to cultivate and graze their animals and were enforced to pay tax to the state on land and animals. However, the Ottoman Government during the second half of the

nineteenth century established the "Land Code System."⁽¹⁾

The Ottomans adopted a policy to organise the land and to define the rights of all holdings, which was aimed at keeping all land as state property. They meant to have complete control and submission of the tribes (the trouble makers) to their rule. Consequently, the government could deprive any disobedient tribe of their land whenever the local authority wanted to do so.

The Turkish law categorised the land, briefly, into the following types:⁽²⁾

1. Aradi El Mulk. The land is owned by individuals or privately. The owners have the full rights to benefit from their land's income. These lands can also be sold and bought, mortgaged and inherited.
2. Aradi El Miri or State Land. It is possible to get permission from the government to utilise permanently a piece of state land on an annual rental basis, but it cannot be owned indefinitely by one person, inherited or mortgaged.
3. Aradi El Waqf. These are lands which are dedicated to religious or cultural purposes. The Waqf land can be utilised on either rental or crop-sharing bases.
4. Aradi El Matrouka is land which is developed for the public interest.
5. Aradi El Mawat is dead or waste land which has not been cultivated before.

The Italians followed the same policy of the Ottomans' "Land Code System," which facilitated the confiscation of the tribal lands, on which they established settlements for Italian families. In the case of the Benghazi Plain, the Italians intended to establish a "Demographic Settlement" for the Libyans in the Butraba area, west of Tolmeita. However, the Italians were not able to complete this project, and therefore it was not handed to the Libyans, owing to the outbreak of the Second World War.

In 1921,⁽³⁾ the Italian government issued a new "Land Law" which required all private holders to report their properties and register them in the "Land Registry Department" in Benghazi City. Nevertheless, only a very few people did actually register their properties and the majority refused to do so lest they would pay more or new taxes.

Article 5 of the Italian law of 1921 put all Miri lands under the State ownership: "Are also a part of the patrimonial asset, while remaining under the regime of perpetual tenancy.... the tapu lands (erazi emiri or miri = tribal land)."

When Libya achieved her independence, the government took over full control of the state property in Libya, in accordance with the Libyan-Italian agreement of October 2nd, 1956, which states in Article 3, as follows:⁽⁴⁾

"The two governments declared that the Libyan State has succeeded to the Italian State in the rights to the "domanio publico" and on the "Patrimonio indisponibile."

No new Libyan basic land law has amended or repealed the basic Italian law of 1921, which is currently applied by the Libyan courts. Law No.28/1959 recognises, however, the existence of the Italian "domanio publico" and "patrimonio indisponibile."*

One of the most outstanding problems of the land tenure system in the Benghazi Plain is the endless tribal dispute over the utilisation of the land for shifting cultivation and grazing. This, of course, hinders the agricultural development of the area under consideration. Hence, any feasible solution to or breaking down of the present tribal land tenure system will undoubtedly lead to settlement and development of land and put an end to the tribal conflicts and disputes.

The present day land tenure system in the Benghazi Plain can be classified as follows:-

9.1.1.1. Private Domains

9.1.1.2. Communal Domains

9.1.1.3. Zawiya (Religious) Domains

9.1.1.4. State or Public Domains

9.1.1.1 - Private Domains

There is ambiguity of ownership of many areas, some of which used to belong to the Italians (State or private properties) and supposedly have been transferred to the government of Libya, but they are claimed by individuals and tribesmen.

*Literally translated to "public domain" and "inalienable assets."

Nor are accurate official data or maps available. The status of ownership is, therefore, based mainly on the 1967 field survey with the co-operation of the local authorities and experienced people in each Mudirya.

The private domains include all private lands which are registered in the "Estate Registration Department." With the registration, the private holders are provided with documents and boundary maps on request.

According to the 1960 Agricultural Census, the private holdings accounted for 302,720 ha. which belonged to 7,001 holders. Table 9.1 shows that almost all the land of the Benghazi Plain is privately owned, except for 138 ha. of tribal land and 45 ha. of State land. Thus, these census figures are not reliable, because, as was mentioned previously, all tribal lands, Matrouka lands and Mawat lands are in theory vested in the State.

According to the 1967 survey almost all the irrigated farms (2,561 ha) and the area of shifting cultivation between Gamines - Jardina - En-Nawaghia and Benghazi, are privately owned (Fig.9.1) notably by the people of Benghazi City, therefore this area could be roughly estimated at about 158,120 ha. (Table 9.2).

9.1.1.2 - Communal Domains

This category of land tenure includes all tribal lands. The irrigated and cultivated tribal lands belonging to each main tribe are divided amongst the members of their sub-tribes,

but the grazing lands and the uncultivable lands are not divided among the members of the tribes.

Legally speaking, as almost all tribal lands are not registered, they are considered as "State Domain," and the tribes and their members have only the right of usufruct in the land they occupy.

Selling and buying of the tribal lands is done according to tribal custom and usage. If, however, any person wants to register tribal land, the Estate Registration Department will not agree to register it unless the buyer provides the Department with a certificate signed by the sheikh of the said tribe and the elderly people of his family, stating that they renounce their rights to the land in which the tribesman has drilled a well or has planted some trees. The existing small farms (Swani, Sing, Sania) belong to the tribesmen who have exerted the efforts and incurred expenses in developing them. Although they have been subject to transfer by inheritance or sale, yet most of them have not been registered in the Estate Registration Department. This means that they are still vested in the State.

To understand the system of land tenure and tribal land usage, one should know the historical background of the tribes, their customs, their way of life, the prevailing social systems and their relations to the land. Briefly, the Benghazi Plain about 200 years ago was divided among the Jibarna tribes (Awaghir, Urfa, Mugharba, Jawazi and Araibat). Each

tribe knows its land, which includes plough land, pasture land, wells and cisterns. The tribal area is vested in the tribe which has the full right in it and it is considered exclusively for the use of its own members. The tribesmen have the right to veto any transfer of land to outsiders so that tribal lands cannot change hands without the consent of the tribe as a whole.

The tribal homeland, "Watan," is usually distributed among the families (Beyout) of the tribe in such a manner as to give equal conditions of soils, water and grazing. Thus, one may find a family or "beit" of the tribe having part of its land in the coastal area, with another part in shifting and grazing lands in the hinterland or on the mountain. Moreover, it is often found that the same tribe or its sections have part of their land in one area and the other part in other distant areas belonging to other Mudiryas or Mutasarri-fyas. For example, the El Baraghtha of Tokra are found also in El Kweifya, Benina, Jardina, Et-Terriya and Tika (Fig.11.1). Sometimes a tribe might possess an area which might not have been used at all and yet it still belongs to the tribe and no-one can claim its ownership. This is because during the lams-year^{*} (Touch-year) segments of the same tribe were scattered over wide areas and each segment laid a claim to the land it cultivated or grazed that year.

The tribal system of land tenure manifests all the weaknesses of inherent communal ownership and it is a source

* The Lams-year was about 200 years ago, when the various tribes of Cyrenaica met together and settled their tribal conflicts and disputes, and as a consequence divided the land between them.

of endless and sometimes bitter disputes on land and water rights between both tribes and members of the same tribe. However, all the bad effects of tribal holdings on the land use were mentioned in previous chapters.

According to the traditions and customs of the Saadi tribes (see Chapter on Population) of Cyrenaica, which include all the tribes of the Benghazi Plain except the Murabteen tribes, all women are excluded from inheriting immovable properties including land, wells, and cisterns. This was in order to prevent the transfer of tribal lands to another tribal member through marriage. They believe that, since the tribal land was obtained by right of conquest and only men can defend it against intruders, women (defenceless) should not inherit it. In this respect, children are also excluded from tribal land inheritance. Nevertheless, a widow may stay in her late husband's tribe and enjoys a life interest to his right in land and water.

The customary law of excluding women from inheritance is against the general Islamic rule, which permits both males and females, regardless of age, to share the father's property in a ratio of two to one. The civil law also protects the woman's right of inheritance and confirms and supports the basic Islamic law rule, but in Cyrenaica both are disregarded. In order to avoid or escape from the civil law rule, women are obliged to renounce their right to their brothers, or relatives, if they have no brothers, in a written contract.

Consequently, it may be concluded that tribal tradition is stronger than the religious rules and government laws, a fact which faces the authority in every plan or project for agricultural development. Up till now, nothing could be done about this problem owing, as has been mentioned many times before, to the strong social and political position of the Bedu of Cyrenaica and their influence on the local authority.

According to the 1960 Census of Agriculture, the area of tribal land was 138 ha. owned by 27 holders, whilst in effect the real area under tribal tenure is estimated at about 399,966 ha. or 66.7 per cent of the total area of the Benghazi Plain (Table 9.1 and Fig.9.1).

9.1.1.3 - Zawiya Domains

This type of tenure is the estate of the Sanussi Zawiya (Waqf), a religious endowment made by the tribes or individuals for religious or charitable purposes. All Zawiya land in the Benghazi Plain was established before the Italian occupation.

This land is meant to be utilised by the Ekhwan (the Sanussi brothers) and their followers. The shifting cultivation segments of the Zawiya were sown, harvested and threshed voluntarily by the Bedu of the district. Every family or Beit had to send one or more of its members, provided with animals and seed for sowing. In addition, he had to support himself and his animal with food and shelter during the whole season. These obligations were met partially because of religious

beneficence but mostly the people were afraid of being punished by the Ekhwan if they did not participate. However, this system ceased immediately after the Italian occupation. At present, the Zawiya lands are leased, for a nominal fee, to anyone who applies to the "Sanussi Zawiya Department" for them, for a period of 2 to 3 years which can be extended for an indefinite length of time. The Zawiya Department does not necessarily follow tribal customs in leasing its property and consequently there are farms occupied by farmers who do not belong to the tribe of the surrounding area, e.g. the two farms north-west of Sidi Khalifa (Fig.9.1) which are occupied by farmers from Fezzan.

According to the 1967 field survey, the Zawiya lands in the Benghazi Plain accounted for about 723 ha. or 0.01 per cent of the total area of the Benghazi Plain. Of these, 38.3 per cent are found in Deriana Mudirya alone, where one of the main Sanussi Zawiyas in Cyrenaica is located, and about 66.9 per cent of the Zawiya land is found in the Es-Sahel area (Tables 9.2 and 9.3 and Fig.9.1).

9.1.1.4 - State or Public Domains

This category of land tenure includes all areas of Aradi El Miri, Aradi El Matrouka and the former Italian lands (ENTE).

These lands which were inherited from the Italian Government (see above) can be classified as follows:-

- (i) Lands which are still under the direct control of the State Property Department, but mostly leased^{*} by farmers, such as the irrigated small farms around Slug, El Gwarsha, El Fweihat and Tokra, or dry farming areas, such as those of Ard Belarjam, east of Slug, ex-airports near El Gwarsha and Bersis and small areas in El Fweihat, Benina, El Kweifya, El Mabni, Bujarrar and Tokra (Fig.9.1).
- (ii) Holdings or land legally belonging to the State, but in effect owned by individuals or tribesmen with no fees paid to the State Property Department. Moreover, the State ownership is not recognised, because the people claim that these lands belonged to them before the Italians confiscated them. These holdings were re-occupied by the farmers immediately after the Italian evacuation in 1943. Some of them are found between the coastal dual-carriageway and the existing row of houses to the west of El Kweifya village, and the areas east of Benina, which were confiscated by the Italians for land reclamation (Fig.9.1) as well as many other unknown plots scattered all over the plain.
- (iii) Holdings in dispute between the government and the tribes, such as is the case of the Benina Airport

^{*}The standard rate of rent is 35 piastres (7/6d.) per hectare per year in the dry farming areas, and about £L.4 in the irrigated areas.

area. This land was claimed by the tribesmen of the area, but the government refused the claim because of the importance of the area under dispute, since it is the main airport of the whole of Cyrenaica. Nevertheless, the government pays annual fees to some of the previous owners. This gives a strong support to the juridicial claim of the rest of the claimants. This dispute is, however, still in progress.

Disputes between the government and individuals usually occur on small plots, mostly located in or near the settlements, such as the piece of land which is annexed to Gar Yunes military camp, and small plots around El Gwarsha village.

- (iv) Lands under ex-ENTE farms. This tribal land which lies in Butraba, about 15 km. west of Tolmeita, was cultivated by tribal people before the Italians confiscated it. The Italian Government intended to establish 50 farmhouses for Libyan farmers here as a part of their plans to develop the country and improve the life of the natives, but the Italians were not able to complete this project and hand it to the farmers, because they had to leave the country after their defeat in World War Two. Consequently, according to the Italo-Libyan treaty in 1956, these farmhouses were transferred to the Libyan Government. The right of the State in this land is clearly under-

stood and recognised by the present tenants. The lessees have to pay normal lease money to the State Property Department as rent for the use of the farmhouses and the land. This land is leased according to tribal custom, priority being given to those tribesmen who cultivated the land before the Italian confiscation, or who had some claim to it which was recognised by the tribe. Nevertheless, some of these farmhouses have been rented to farmers who are not from the tribe which lives in this area.

The State Property Department charges an annual rent amounting to 60 piastres (13/-) for a lease of the farmhouse. According to the contract, the tenant is required to cultivate the land with regard to government conditions and must follow government instructions. The farmer is also forbidden to sublet the farm or neglect it. If a tenant fails to pay the rent or co-operate with the authority (as the contract says) he is, supposedly, asked to vacate the farmhouse. However, although violations of the terms of the contract are quite numerous and often, nothing can be done about this problem, owing to the tribal political position.

In 1964, the State Property Department handed over responsibility for the improvement and development of Butraba (ex-ENTE) to the N.A.S.A. The latter

have done very extensive research on the area from all aspects and although many experts have come and written reports and gone, the situation until 1967 was still the same and no plan has been initiated yet.

According to the 1960 Census of Agriculture, the State land comprised only 45 ha. in Tolmeita Mudirya, where it was occupied by one holder (Table 9.1), whereas in the 1967 survey, it was estimated at about 41,191 ha. or 6.9 per cent of the total area of the Benghazi Plain. About 29.7 per cent of the State land occurs in Tolmeita Mudirya, 11 per cent in El Gwarsha and 11.3 per cent in Benina (Tables 9.2 and 9.3 and Fig.9.1).

9.1.1.5 - Size of Holdings

There is a vast contrast in the size of land holdings in the Benghazi Plain. Holders range from landless, crop-sharers to rich large holders. However, the size of holdings varies from dry farming areas to irrigated ones. In general, the holdings in the irrigated areas are very small plots, notably in the sand dune areas, where good water is scarce and the little available has to be shared with other tribesmen. The existing fragmentation of the rural holdings is a serious hindrance to modern agricultural techniques. Yet no account or even general information has ever been available about this vital subject apart from some unreliable data from the 1960 Census of Agriculture (Table 9.4). Even this concerns

the whole Mutasarrifya of Benghazi, but in general, the size of holdings in the Benghazi Plain does not differ from that of Benghazi Mutasarrifya.

Table 9.4 shows that in 1960 only 0.05 per cent of the holdings of Benghazi Mutasarrifya were less than 0.5 ha. and 2.1 per cent were over 200 ha. About 76.8 per cent of the holdings consisted of between 5 and 50 ha. and occupied about 42.1 per cent of the total area.

The average size of holdings in the Benghazi Plain according to the 225 farms surveyed in 1967 was about 2.8 ha. in the irrigated land and 4.5 ha. in the shifting agricultural areas, with an average of 2 plots for every holder. In the coastal sand dune areas the average size of holding was 7.8 ha. with an average of 4 plots per farmer. The average size of the dolina or sink-hole holding was about 2 ha. in the irrigated dolinas and about 21 ha. in the dry farming dolinas (Table 9.5).

The size of holding varies, however, from Mudirya to Mudirya, according to the variations in the availability of good underground water, good soils and the vastness of the area. For example, in Jardina, where water for irrigation is very scarce, the average size of the irrigated farms is the smallest in the Benghazi Plain, being 1.8 ha. whilst in El Fweihat and Benina, where good water for irrigation is abundant the average irrigated holdings are 28 and 178 ha. respectively. The average size of the shifting cultivation

holding in these Mudiryas varies inversely to the average size of the irrigated holdings. For example, Jardina with its small-sized irrigated holdings has one of the largest holdings of 58 ha. of shifting cultivation, whereas El Fweihat with its relatively large irrigated units had no dry or shifting agricultural holdings (Table 9.5).

The lithosols and sandy areas in the south of the plain (with low and erratic rainfall and scarcity of underground water) definitely do not provide a reasonable standard of living, as is evidenced by the fact that the average gross income of a person, according to the 1967 survey, engaged in agriculture was £L.100 or less per year. Thus most of the cultivated holdings are relatively large and each farmer has to cultivate several plots in order to gain a reasonable crop production.

Fragmentation in the Benghazi Plain is confined mainly to the irrigated areas, notably in Tokra (Fig.9.2), El Thama, Deriana, El Gwarsha and Gamines. In these areas the plots are so small (average 0.25 ha.) that economic working and the use of modern machinery are very difficult to accomplish. The small size and fragmentation of holdings in these areas are the main obstacles to agricultural development and prosperity. Thus most of the young people of these areas either migrate to Benghazi for work or work in other jobs, as teachers, porters, police, road workers and practise agriculture part-time. However, the more intensively the land is used the

smaller are the holdings, the reason being that the more valuable the land is with regard to the availability of good irrigation water, the more coveted and therefore subdivided it is. In the sand dune areas where vegetables are grown much spade work is done making small plots more feasible and even more economic than larger plots. Attention must be drawn to the fact that the arrangement of plots which are irregular (Fig.9.2) in shape and size shows little or no relationship to the topography, but results mainly from the justice of the Islamic inheritance law, which insists on fixed or equal shares. Every heir demands his or her due and usually each plot is divided accordingly. In the tribal land, the land is not divided and the heir remains on the same land.

9.1.1.6 - Causes of Fragmentation

Since water is the vital factor in agricultural practices and its availability is very scarce in the Benghazi Plain, the pressure on land where this element is found is increasing steadily. Thus there is intense competition for water resources and the associated lands which are small in size and patchily distributed. The Islamic law of inheritance, as was mentioned before, has required the division of the property into special shares, the tribal tradition and the passionate love for land which does not allow the farmers to sell their shares (even those who have left their farms and live in Benghazi for one reason or the other) have all contributed a great deal in

causing fragmentation. The fragmentation of holdings, however, is found mostly in or around the villages where good water is available.

9.1.1.7 - Leasing and crop-sharing

Some farmers who find it economically difficult to live on their holdings alone, or farmers who do not own any land, usually obtain land in the following ways.

9.1.1.7.1 - Ard Ijar or tenancy land. This land is leased according to a written contract or, most often, a verbal agreement between the landlord and the lessees. This agreement permits the lessee to cultivate the farm, or a part of it, for a period of 2 to 3 years in return for which the farmer pays a certain amount of money every year, usually between 2 to 10 Libyan pounds to the landlord. This category of land tenure is found mainly in the State land or Sanussi Zawiya properties (in El Gwarsha, Slug, El Kweifya, Sidi Khalifa, Tokra and Tolmeita). The tribal land is usually rented by one tribal group to another and it is most often planted with cereals under the dry cultivation system.

9.1.1.7.2 - Ard Muzaraa or crop-sharing metayage. In the past the crop sharing system of land tenure was much more common, because crops were very important. But with the spreading of the money from petroleum and as a result of the improving standard of living of the rural population, monetary rents become more prevalent.

Crop sharing today takes place largely in the small

irrigated areas (e.g. Gamines, El Gwarsha, El Thama and Tokra) between farmers coming mainly from Tripolitania and the local villagers.

There are several types of crop sharing of which the Mugharsa (tree planting system) is the most important for the poor landless farmers. This type of metayage is mostly practised in the private domains at El Gwarsha, Gamines and Tokra. The poor farmer or Mughares signs a contract with the landlord in front of the Mudir of the area and usually two other witnesses. Upon the agreement, the land (usually virgin land) allocated to the Mughares is divided into equal plots. The Mughares must dig a well and plant a number of fruit trees in each piece of land as well as a shelter for his family if he is married. The landlord does not provide any financial help in this type of metayage. Half the income from any other crops planted by the Mughares and sold in the market should be given to the landlord.

When the contract (usually between 5 to 10 years) is terminated, the partners or their heirs presumably divide the land equally. If, however, the Mughares fails to fulfil his obligations according to the contract agreed upon, the landlord will either allow him to continue longer or ask him to vacate the land in which case he will be compensated for his partial investment and efforts put on the land.

The other types of metayage are as follows:-

Ard Taakir (precarious land). In this type of metayage a

farmer rents a piece of land or farm, usually about 2 ha. from the landlord for about 70 to 100 Libyan pounds per year (this was in 1967). A written contract must be signed between the farmer and the landlord, or sometimes it is agreed verbally in front of two witnesses. If, however, the rented land contains fruit trees, the landlord has the right to receive a third of the value of the fruit sold.

Muzaraat En-Nusf (half and half crop sharing). In this type of metayage the landlord provides the land and water pumps. The rest of the agricultural equipment (seeds, fertilizers, labour, wages, etc.) are paid for equally by the tenant and the landlord. When the products of the farm are sold, the benefits are divided equally too. The contract between the landlord and the farmer in this type of metayage is confidential.

Muzaraat Et Thilt. This type of crop sharing is known either as a third or fourth crop sharing. The landlord provides everything needed for cultivation and the farmer provides his hand work only and consequently gets a third of all products. If, however, the farmer hires a labourer to help him, the landlord has to pay a third of the cost. This type is found mainly in Tokra, El Gwarsha and Gamines.

Muzaraat El Muzaraa (sowing and harvesting). This type of metayage is practised in the shifting cultivation areas. The capitalists provide the farmer or a group of farmers with the seed (usually wheat and barley) for sowing and provide also

the food required during the sowing period. During the harvesting period the farmers take what food they need from the harvested products. The remainder of the output is divided between the landlords or capitalists and the farmers. This land which is used for sowing is usually a part of the tribal land. If such land is not available, the capitalists rent the Ijar or Taakir lands. This type of investment is widespread among the Bedu tribes of the interior of the plain, notably in Barga El Hamra. The capitalists are mostly from Benghazi City and the shop-keepers of the villages. Ard Iarah (loaned land). Land is loaned usually between fellow villagers and relatives or tribesmen. The period of contract or agreement in this case is unlimited and the landlord has the right to take over his land whenever he chooses.

9.1.2 - Water Rights

Water is a very scarce and precious asset in the Benghazi Plain. Legally speaking, all water is state property. The Italian law of land ownership and water rights of 1921 is still in effect in Libya, because it has not been repealed or amended by the Libyan government. This basic law defines the expressions "domanio publico" and "Patrimonio indisponibile" with regard to water rights as follows:⁽⁵⁾

Article 3. "A part of the public domain (domanio publico)..... the water courses, and their beds (wadis), natural springs, fountains wherever

within the town districts (the fountains) are a part of the Municipal public domain"

Article 4. "Are also a part of the patrimonial assets (beni patrimoniale) the Sebakh."

However, the Italian laws are no longer suitable and revision is very necessary because many changes have occurred in different aspects of life in the country.

The new proposed water law also retains water rights in the hands of the State. Article IV of the proposed water law declares:⁽⁶⁾

"All water; surface as well as underground is a State property."

Since all wells and springs are subject to the State ownership and control, all Greco-Roman wells and cisterns which exist in the tribal land are considered State or public property and their waters should be available to everyone, not to be privately owned or made exclusive to the use of a particular tribe in which area the wells or cisterns are found. Yet very few tribesmen recognise the state ownership of wells and they believe that they are bound to their land ownership, which itself, legally, is vested in the State. Nevertheless, there are recognised public wells and their waters are made available to all people, such as the wells around Slug, Esh-Sheleidhima, El Magrun, Jardina, Benina, Deriana, Tokra and Tolmeita. The government has also installed three windmills and tanks on public wells; one east of El Magrun village,

the second at the end of the eastern side of the Butraba settlement and the third at Sidi Abdalla, west of Tolmeita (Fig.3.6). They supply drinking water for animals grazing in the neighbourhood. In addition, one engine pump has been installed on a well in the central square of Slug village to provide water for both domestic and animal purposes. A great number of animals are watered from these wells; in accordance with a time-table agreed by each Mudir and the sheikhs of each area.

It seems that this action by the Ministry of Public Works was very much appreciated by the Bedu and villagers here, and many others in other areas are looking forward to further measures of this kind. It is hoped that the government will take further steps toward developing the water supply (for domestic and animal purposes) by digging or rehabilitating more wells, particularly in the remote areas of Barga El Hamra and installing on them engine pumpe or windmills. This, of course, will eliminate the pressure on the existing few wells and consequently it will stop the endless disputes between the tribes about wells for watering their animals. Sometimes, the Mudri has to lock the well and prohibit any use of the water unless the two disputing parties settle their quarrel and agree to use it according to the rules and regulations.

Wells for irrigation in tribal lands are used by the owners of the irrigated farms only, and everybody in the area respects and observes this tradition, simply because these

wells are dug by the farmers for irrigating their farms. The old Greco-Roman cisterns, which are found everywhere in the Benghazi Plain are either owned by the tribe, if the cost of clearing and constructing are borne by the tribe, or owned privately if only one person of the tribe has borne the cost. The cost of cleaning a cistern depends upon the capacity of the cistern. However, if the cleaning operation is done privately, it will cost between £L.300 and £L.800, but if done through a governmental tender it will cost between 500 and 1500 Libyan pounds.

The privately owned cisterns are usually used for watering the animals of their owners or sometimes their water is sold to whoever needs it for both human and animal consumption. The rich farmers who own large flocks of animals usually buy the cistern waters at a cost of between 100 and 400 Libyan pounds for the use of the waters of the cisterns during the summer period.

Bitter and long standing disputes and fights over land and water rights are endless. If the disputes and conflicts over wells occur between members of the same tribe, the problems are usually solved and settled by the local Mustashar (Consultant). If, however, the disputes occur between two different tribes and the trouble is serious and cannot be solved locally, the Mudir of the area usually controls the water of the well or cistern and distributes it according to what he thinks is right, or sometimes he closes it, until a

solution is reached under the auspices of the "Committee for Settlement of the Disputes over Tribal Lands" which is organised in each Mutasarrifya in accordance with the Law No.9 of 1959 and its amendment of 1963.⁽⁷⁾ Nonetheless, water rights of wells and cisterns are regulated by long established customs and unwritten rules which seems to have always worked. This system is called the "At-Tawazun Al Qabali" (Tribal Balance or Equilibrium) which maintained peace between the tribes by respecting each others land and water rights.

9.2 - Present Agricultural Land Use Regions

Agriculture is the basis of the economy of the Benghazi Plain and almost the entire rural population are engaged in agricultural activities and their livelihood is based upon agricultural products.

According to the general appearance of the Benghazi Plain, it can be easily seen that there are three types of agricultural activities. Firstly, the irrigated and partly irrigated agriculture in the coastal region where vegetables and fruits are the chief products, secondly the shifting cultivation (mainly wheat and barley) areas, and, thirdly, the extensive livestock grazing areas. Thus the Benghazi Plain can be divided into three major agricultural regions each of which generally possess similar physical conditions and water availability. These land use regions are as follows:-

9.2.1. The sea-shore sand dune region

(a) Irrigated sand dune areas

(b) Dry farming sand dune areas

9.2.2. The Coastal Agricultural Region

9.2.3. The hinterland agricultural region

(a) Irrigated hinterland areas

(b) Dry and shifting farming areas.

9.2.1 - The sea-shore sand dune agricultural region

This area consists of marine sand dunes which extend between Bu-Mseid in the north-east of Deriana and Shat El Bedin in the deep south-west of the Benghazi Plain. This chain of sand dunes is interrupted in several places by water bodies. Thus they remain disconnected dunes.

The annual average rainfall of this region varies between 180 mm. and 260 mm. with the highest rainfall near Benghazi and the lowest along the southern fringes (Fig.2.11 and 9.3).

The soils of this region consist of whitish marine limestone grains. Although they contain some elements of chemical compounds, they are generally infertile and their farming depends entirely on the heavy application (10-20 cms. deep) of manure.

Many varieties of vegetables are grown in this area where good subsoil water is available, and it is the principal source for tomatoes in the Benghazi Plain. Fruit trees, particularly vines, figs and palm trees do very well here and the grapes, which are cultivated mainly in the southern part, are the best table grapes in Libya.

This region, according to the water availability and agricultural practices, can be divided into two sub-regions.

(a) The irrigated sand dune areas. These areas are very restricted, due to the water limitations, and are the focus of the settlements such as Sidi Khalifa, El Thama, Karkura, Er-Ragta and Shat El Bedin (Fig.9.3).

The agricultural practices here, although primitive, are very highly organised. Some farms have reached a commendable level. The fields are well tended and the texture and fertility of the light sandy marine soil have been improved by heavy manuring with finely divided compost of animal, vegetable and household residues.

The agricultural output of this region, especially in the areas near Benghazi, composes the bulk of that sold in Benghazi market. In the areas remote from Benghazi market, the agricultural emphasis is on the production of tomatoes and tree fruits, notably grapes.

(b) The dry farming sand dune area. This sub-region is much larger than the previous one, owing to the lack of subsoil water, and even if there is any, it is scarce, salty and unsuitable for irrigation.

The dry farming areas are scattered along the whole sand dune region, but the best known area is Ganfuda, about 9 km. south-west of Benghazi. Although this area receives high rainfall (250 mm. per annum) it does not have good subsoil water, owing to the effects of seabkh isolating the sand

dunes from the interior for most of the year. Thus, the farmers have to carry fresh water a long way to irrigate their plants until the first rain falls in autumn. Other parts of the dry farming sub-region are from north to south: Aseila, Deriana, El Kweifya, Gar Yunes, Bufattah, El Murrah, Karkura, Er-Ragta and Shat El Bedin. Tomatoes, water melons, marrows and pumpkins are the main cultivated vegetables in these areas. However, the vegetable yields here are very low and the production is small and precarious, because if the rainfall is delayed the small plants wither and die. It is even worse if it fails to fall. A strong sea-wind may also destroy the whole plants. Thus, the farmers of these areas earn a very low income and they often lose their crops, in which case they are compensated by the government for their losses. As a result of this situation, most of these farmers practise shifting agriculture of cereals with grazing activities outside their farms, in order to be able to support their families.

The agricultural potential of the sand dune region depends to a great degree on the availability of good subsoil water, the climatic conditions, on good and well distributed rainfall, light wind and normal temperatures, the availability of labour, the marketing and transport facilities and the cost and price relationships. However, a judicious combination of physical and human resources will allow the best exploitation of the agricultural potential of this region.

9.2.2 - The Coastal Agricultural Region

This region embraces the arable or cultivable land bordering the Mediterranean and extending from Tolmeita in the north to Esh-Sharafit, south-east of Gamines in the south of the Benghazi Plain.* This region varies in width from less than a kilometre to over 12 km. (Fig.9.3), and lies almost entirely below the 20 m. contour line.

The agricultural land, due to the physiographic variations, is not continuous but consists of relatively large and disconnected plots, with relatively deep residual and mostly transported soils. The annual average rainfall ranges between 190 mm. in the south and 350 mm. in the far north.

Although good land of Class I is limited, the central part (around Benghazi) of this region has good underground water available for irrigation and is considered one of the best agricultural lands in the Benghazi Plain.

The coastal agricultural region contains more than 80 per cent of the irrigated farms in the area under consideration. Excluding the Benghazi area, all the farming practices are of the subsistence type.

All kinds of Mediterranean vegetables and fruit crops can be grown here. Nonetheless, certain agricultural products grow better and are more productive in some areas than others. For example, the best quality pumpkins come from Tokra, snake-cucumbers from Deriana village, cucumbers from Gasr-El Ajuz, okra (lady fingers) from Sidi Khalifa, tomatoes from Deriana,

*Excluding the sea-shore sand dune region.

parsley from El Fweihat and El Gwarsha and mint from Gamines. The best citrus come from El Gwarsha, El Fweihat and El Haw-Wari and figs from the sink-holes or dolinas in El Kweifya.

The coastal region, in addition to its importance as an agricultural producing area, contains the bulk of the rural population in the Benghazi Plain. However, the importance of any part of this region depends on the availability of good underground water, the fertility of the soil and the proximity to Benghazi market, as well as the cost and facilities of transportation. Therefore, the best agricultural areas are those occurring within the sphere of Benghazi City (El Fweihat, El Gwarsha and El Kweifya), especially El Fweihat, with its alluvial terra rossa soils and abundant good underground water. According to the 225 farms surveyed the average annual gross income in El Fweihat is about £L.10,000 whereas in the other parts of this region it ranges between £L.300 and £L.1,000 per year.

9.2.3 - The Hinterland Agricultural Region

This region embraces the areas which were not included in the previous regions. In general, it occurs between the coastal agricultural areas and the first escarpment of Jabal El Akhdar (Fig.9.3). The hinterland region consists mainly of two distinctive vegetation zones, the forest land in the north and the steppe land in the south. Physiographically speaking, it varies from north to south but, generally, it has a similar agricultural aspect. This region is important for grazing and

shifting cultivation of mainly wheat in the northern part and barley in the southern part. There are also some irrigated and unirrigated small farms or gardens and a few large commercial farms at Benina.

The annual average rainfall ranges from less than 100 mm. in the south to more than 350 mm. in the north, near Ras Tolmeita. However, in the northern part of this region, notably from El Mabni, north of Deriana, and northward, the harvest is to a certain degree always guaranteed while in the rest of the region, where the rainfall is scarce and erratic, the success or failure of a crop is a matter of extreme uncertainty. The soil mantle of this region, in general, is of clayey residual or transported terra rossa in the north and alluvial red loamy soils and brown-yellowish sandy or sandy loam soils in the south.

Owing to the great contrast in the agricultural activities in this region, it is better to divide it into two sub-regions, (a) the irrigated areas and (b) the shifting and dry farming areas.

9.2.3.1 - Irrigated Areas

The irrigated areas of this sub-region consist of three distinct agricultural realms:

(i) The Benina agricultural area. This area is, so far, the most important agricultural area, not only in the Benghazi Plain but also in Cyrenaica as a whole. It falls into Class I of the land capability classification and contains the best

and richest underground water in the Benghazi Plain, in addition to the excellent residual terra rossa. Here the largest commercial farms are found, which were established after the discovery of the Benina underground water reservoir in the late fifties. The agricultural potential of this region is very promising, but unfortunately most of the surrounding area, where more land could be brought under irrigated cultivation, are communal or tribal domain.

(ii) The other relatively newly-established large irrigated commercial farming area is found around En-Nawaghia (Fig.9.3). Although this area has less fertile soils than Benina, because of the newly discovered underground water, it is likely to be one of the best irrigated agricultural areas, particularly for citrus and orchard plantations, in the Benghazi Plain in the near future. The land here is vast with a good soil mantle and is mostly privately owned, particularly by the people of Benghazi City (Fig.9.1).

(iii) The other less important irrigated areas are those small gardens around Slug and Jardina villages where small irrigated farms and backyard gardens of mainly subsistence agriculture exist.

9.2.3.2 - The shifting and dry farming sub-region

The shifting and dry farming area consists of all areas other than the irrigated land in the hinterland region. This area represents about 80 per cent of the total area of the Benghazi Plain. The northern part of this sub-region is

occupied mainly by forest vegetation and in between exist small patches of clear land where shifting cultivation, mainly of cereals, is practised in winter time, then it remains idle or is partly used as grazing ground for the rest of the year. Owing to the space limitation and intrinsic fertility of the terra rossa in this area, fallow land is not very common. The rest of this sub-region, where the land is almost level with plenty of good land for cereal cultivation is, unfortunately, not well endowed (Fig.5.1). Thus large areas are left fallow and many plots are probably left without cultivation for several years. This is due mostly to the erratic nature of the rainfall on the one hand and the sparse population on the other. However, with the introduction of mechanisation, which has already started in some parts, this sub-region or the whole hinterland region, if fully utilised, will produce a tremendous amount of cereals (mainly wheat) which will meet the needs of the Benghazi Plain, which at present have to be imported, mainly from abroad.

The dry farming areas in this context embrace negligible unirrigated small gardens, planted with some orchards, mainly fig trees, and some vegetable crops, for family consumption (Fig.9.3).

9.3 - Methods and Types of Farming

The traditional agricultural practices in an area dominated by the Bedu people, such as the Benghazi Plain, is the subsistence type of shifting cultivation of mainly wheat

and barley, with the grazing of flocks of sheep, goats and camels. At present, however, all kinds of agricultural practices are to be found; ranging from the traditional dry farming and livestock raising to the entirely modern or commercial irrigated farming. Generally, there are two types of farming existing in the Benghazi Plain: (1) shifting and dry farming and (2) sedentary irrigated farming.

9.3.1 - Shifting and Dry Farming

This, so far, is the most prevalent type of farming in the Benghazi Plain. It is also the most precarious as it depends entirely on the availability and frequency of the rainfall, which in itself is erratic and often deficient.

Shifting cultivation, under which cereals (mainly wheat and barley) are grown under dry farming conditions, means that cultivation is not necessarily practised on the same plot every year; rather it follows the rain. Usually, the farmer cultivates an area and then might not use it for 3 to 5 years. In this arrangement the cultivator starts sowing and ploughing after the rain has fallen. Seeds are broadcast on scattered patches where sufficient rain has fallen, and then followed up by ploughing with a wooden or iron plough drawn by animal, usually camel or horse, or tractor. The autumn rains determine the area to be sown, whereas the harvest depends upon the spring rains. The most suitable time for sowing cereals is from October to November (Table 9.6). Nonetheless, wheat is always sown after the first heavy

rain no matter when this occurs, because when the ground is wet three things can be achieved in one operation, namely ploughing the land, sowing of the seed and cutting the weeds. In general, early sowing of wheat and barley is preferred to late sowing (i.e. in November or early December), because early sowing gives higher yields. Abu Sharr,⁽⁸⁾ suggested that for most of Cyrenaica sowing of wheat should be before 15th December.

The sowing rate per hectare varies from north to south in the plain as well as between wheat and barley. Normally, 45 to 50 kgs. for wheat appears quite adequate for the Benghazi Plain. For barley, Abu Sharr⁽⁹⁾ suggested that a rate of 40 kgs. would be suitable for the coastal plain. This rate, however, varies from the north to the south of the plain, due to the variations in the soil texture and rainfall distribution, but, in general, 40 kgs. in the south (Barga El Hamra) and 50 kgs. in the north (Es-Sahel), so most farmers said, would be reasonable.

In the heavier soils (terra rossa) of the Benghazi Plain and the sloping areas near the escarpment, notably in the northern part of the plain, shallow ploughing 5 cm. deep is preferable for both wheat and barley. In the yellowish-red soils of southern Barga El Hamra, shallow ploughing is precarious, because cereals here are usually sown early, and the seed germination might occur after the first rain and then if the rain delays or early Ghibli winds blow, the small

plants will wither and die. Therefore, deeper ploughing of 10 to 15 cms. is more desirable in this area.

No fertilizers (manure) are applied, except for that obtained by pasturing livestock on the ground after harvesting or during grazing, when the land is laid fallow. After the area has been sown, it receives little or no attention, because as soon as the sowing is over, the cultivators return either to their farms in the coastal area, secure a job, tend their sheep, goats and camels, or perhaps just remain idle. The majority of the cultivators return to their fields at the harvesting time in summer to gether their crops. Almost all cultivators in the Benghazi Plain are merely interested in the multiplication of the seed sown and not in yield per hectare.

The harvesting of wheat and barley starts from April to May (Table 9.6) and sometimes it extends well in July, owing to the shortage of labour. During the harvesting season, farmers are usually accompanied by their families (not during the sowing period) and in most cases their children have to leave their schools, without exams., in order to accompany their families.

The traditional method of harvesting the cereals is very primitive and it takes longer and costs more than mechanisation. The ripe grain is either pulled out of the ground by hand or cut with a simple sickle (Plate 9.1). It is then carried by donkey to a threshing floor. The use of machinery in sowing,

harvesting and threshing is more profitable than the traditional method, in addition to saving time by about 80 per cent. For instance, the sowing of 7 ha. takes 3 days, while in the traditional way it takes about 40 days. The harvesting and threshing is done by one operation (Plate 9.2). Nevertheless, even if machinery for ploughing and harvesting were available, it could not be used everywhere in the Benghazi Plain since most of the plots are small and isolated by clumps of shrubs, and sometimes the crop is interspersed with brush trees or rock outcrops in the forest area in the north, and by dwarf plants, lithosols and rock outcrops in the southern part of the plain. Moreover, the overwhelming majority of the shifting cultivators only cultivate small patches of land scattered over a wide area, most of which are inaccessible to machinery, and therefore only the well-to-do people who can afford to cultivate vast areas in comparatively better locations have benefited from mechanisation. However, farmers have begun to realise the benefits of mechanisation in the shifting cultivation of cereals, and most of them, particularly those in Barga El Hamra, are very eager to use machines but, unfortunately, there are not enough to serve every applicant. In addition, most of the machinery is used by influential people. For example, if a combine-harvester is allocated for Slug Mudirya, then it might be stopped at Deriana or Benina by some notable person who probably did not even apply for it, so that it probably will not reach the

ordinary farmer until he has lost most of his grain with the scattering of ears by dessication and the ravages of birds. The situation is aggravated if the machine is broken on its way to the Mudirya or in the field. Thus many farmers who are aware of these problems find themselves bound to the old tradition whatever the cost.

Threshing, according to the traditional method, is carried out after the harvest is accumulated and **heaped** on a clean solid floor. It is performed by employing three or more animals fastened together with their heads close to each other (Plate 9.3). One man drives the animals and others are employed in heaping fresh corn upon the floor and removing the straw which by this process is broken into small lengths while the grain is after all but imperfectly separated from it. After this operation is over the grain is winnowed by hand against the wind to separate the grains from the small straws and other debris. Mechanised threshing however is also done in the normal manner (Plate 9.2).

Traditional dry farming of crops other than wheat and barley employs a system of crop rotation extending over 3 to 5 years in the hinterland and 2 to 3 years in the coastal areas. These crops are mainly legumes (chick peas and broad beans) which are cultivated mostly in the northern part of the Benghazi Plain, notably in the Bersis, Bujarrar and Tolmeita areas. Chick peas are very suitable to the local conditions, because they are planted after the cereal sowing season is

over (usually from March to April) and do not compete with the cereals. Broad beans, however, are sown in winter (from October to November) and autumn and thus compete with the sowing of cereals. In general, early sowing immediately after the cereal sowing is completed, is preferable. Chick peas are broadcast in the same manner as cereals and they are harvested from June to July (Table 9.6). Dry cultivated broad beans are sown by hand behind the plough in alternate furrows. Late sowing (after December) of broad beans decreases the yield considerably. Since they are winter crops they require weeding. Green (vegetable) broad beans are harvested between February and March and the dry broad beans between April and May.

Other dry farming crops are cultivated in the same manner, but are not important to the agricultural economy of the area under consideration. Nevertheless, their dates of sowing and harvesting are shown in Table 9.6.

9.3.2.- Land use combination of the Benghazi Plain and Jabal El Akhdar in shifting cultivation

The farmers who cultivate land in both the plain and mountain are engaged in dry farming of cereals and grazing in both areas. The advantage of cultivating both areas is the early ripening of the harvest in the plain (20 to 40 days earlier). This is done in time for them to work on the higher mountain crops, in addition to providing them with an earlier income and feed for their animals. The farmers who cultivate both areas have naturally acquired rights to lands in the

plain, in addition to their regular lands on the mountain and vice-versa. If, however, the land on the mountain and the plain belongs to the same tribe, as is the case in the area between Tokra and Tolmeita, which belongs to El Urfa and Es-Dersa or in Es-Silg area which belongs to El Ashaibat and El Fwakher (Fig.11.1) tribes, the farmers have the right to cultivate wherever they please and whenever they want. Whereas when these lands belong to different tribes special permission from the sheikh has to be obtained first, as in the case of El Huta in the Bersis and El Hemda areas. This system, however, always creates problems between the tribes (see Chapter 11).

A fringe benefit for the farmer himself is living in the mountains, which is climatically preferable to the plain with its scorching heat, often aggravated nearer the coast by the high humidity. The livestock also benefits in this respect, for in the northern part they are transferred to the mountain and kept in the fresh mountain air, with its lush grass, immediately after the heat starts increasing and the grasses wither.

9.3.3 - Sedentary Farming

This type of farming includes all kinds of irrigated agriculture, but in general, there are two major types existing in the Benghazi Plain:

(1) Subsistence farming. The land is intensively cultivated, the irrigation water being drawn from the phreatic aquifers

to irrigate most cropping activities, usually with the aim of producing two crops per year. This type of farming caters for the needs of the farmer's own family, with but a small amount of produce available for marketing.⁽¹⁰⁾

(2) Commercial irrigated farming, where farming practices are mostly carried out by machinery and the cultivation is intensive, and produce intended for market.

9.3.3.1 - Subsistence Farming

The traditional or subsistence farming type embraces about six systems or methods of farming, owing to the variation in the types of soils, the quantity and quality of available water for irrigation, the proximity to Benghazi market, the manpower and experience and transportation facilities.

A. The Saniya Farming System

The saniya (plural - swani) or specialised horticulture type⁽¹¹⁾ of farming prevails mostly in the coastal area of the Benghazi Plain, particularly near Benghazi City. The swani or small gardens are separated from each other by stone embankments, mud retaining walls or barbed wire (Plate 9.4). The irrigation water for these gardens is usually drawn by animal-dalu, engine pump or windmill from a water table 5 to 10 m. deep. The swani are irrigated through mud ditches and the small irrigated plots of jdulas are flooded by water every 4th or 5th day. These gardens are characterised by the practice of close inter-cropping of field and tree crops.

Most of the swani, particularly those near Benghazi are orientated, primarily to the production of cash crops (mainly vegetables) for Benghazi market. The swani are distinguished from the commercial farms in the same area by their small size on the one hand and their type and method of farming on the other. They constitute the most intensively utilised land in the Benghazi Plain, because the inter-cultivation of the fruit trees is equally as important as the field crops. The tree crops are mostly for commercial production for their high returns, particularly at the present time, when the government has put some restrictions on the importation of fruit from abroad. The majority of farmers in the swani employ traditional equipment and hand tools, but in many areas they have started installing engine pumps and windmills as well as using modern tools and machinery to keep pace with more modern and well developed commercial farms nearby.

These farmers use little fertilizer and the small quantity of manure available is not applied properly, and if commercial fertilizers are used, the farmer usually does not use the required kind and amount, because simply he does not know. Often a farmer will use some kind of fertilizer recommended to him by another farmer, who probably used it with different types of crops on different soil. The swani farmers mostly do not follow a rotation system (probably due to the fragmentation of the cultivated plots). Of the 225 farms surveyed in 1967, only 29 per cent of the farmers followed a partial

or complete rotation system. Even these farmers, who claimed that they were following a rotation system, in fact do not follow a proper scientific rotation, and all that they do is to lay aside a piece of their land uncultivated (fallow) for some time.

In winter, when the rains irrigate the swani, most of the farmers lie idle, and some of them leave their farms and families and go to the hinterland to sow wheat and barley in the shifting cultivation areas. The pruning and trimming of the trees is done arbitrarily. However, most of these fruit trees are planted from seed and they are, generally, of low quality and yield. A great problem to this farming type is the heavy growth of noxious weeds which compete with the growing plants throughout their life. Weeding is a very expensive job, if it is done by non-family farm labour, due mainly to the high cost and scarcity of farm labour on one hand and the necessity for frequent cuttings during the year on the other.

In general, the swani near Benghazi have a better chance than remote swani of adopting new methods and techniques of farming and, of course, better farming returns, due to the proximity to Benghazi market and the close supervision, guidance and assistance of the Ministry of Agriculture in Benghazi. The farming system in the remote swani is very traditional and backward. Here the farms are usually cultivated by elderly people, women and children. (The young people

migrate to Benghazi for work). The field crops and tree fruits are cultivated mainly for family consumption and any surplus is usually sold in the nearby village market. Consequently, the farmers of the remote swani have less opportunity to raise their standard of living than those near or in the sphere of influence of Benghazi City.

In conclusion, it may be said that the lack of an adequate knowledge of farming is a big handicap to the farmers in the area under consideration, as most farmers even in the better developed areas, do not recognise yet the importance of adopting improved agricultural practices, namely crop rotation, the use of proper fertilizers, the use of machinery, modern equipment and tools, as well as improved seeds and plant varieties, etc.

B. The El Thama Farming System

This type of farming is practised in the irrigated coastal sand dune area of El Thama and El Monastir. The cultivation here is entirely of market orientated vegetable crops.

The method of farming in these areas is performed by dividing the sand dune area into very small plots of an average of about 200 m. (Plate 9.5). Each plot is separated from the other by palm tree fronds, which at the same time are used as windbreaks. The terrain is prepared for cultivation by spreading manure (Jalla) over the ground and then turning it in with a hoe or spade. Each plot contains

between 2 to 5 shallow wells for irrigation. Then the land (see Chapter on Irrigation) is cultivated by four consecutive vegetable crops, before it is left fallow for a short period or remanured, and thus the cultivation continues season after season and year after year until the land is completely exhausted and, probably, finally is deserted.

During spring the most common cultivated vegetables are cucumbers and marrows. During summer, tomatoes are best as a cash crop. Carrots, onions, radishes, aubergines and spinach are the most common vegetables cultivated during autumn (Fig.9.4) and since lettuce is the most profitable vegetable crop in the Benghazi area, it is cultivated here the year round.

The times of planting and harvesting of vegetable crops are shown in Table 9.6.

The general characteristics of this type of farming are, firstly, that it specialises in vegetable farming and all production is market orientated. Secondly, it is very intensive farming in which a small plot contains several kinds of vegetable crops cultivated in a disorganised manner with one crop planted in small rows, scattered all over the plot, and sometimes intermingled with other crops (Fig.9.4 and Plate 9.5). This is probably due to the smallness of the irrigated plots and the desire to secure at least one crop if the rest fail. It is worth mentioning here also that the farming system in this locality is almost entirely based

on the metayage system because most of the land is owned by people from Benghazi City.

There is another type of irrigated farming in the sand dune areas which is similar to the El Thama type, but the vegetables are inter-cropped by fruit trees, mainly figs and vines. Nevertheless, they are less important, as vegetable producers than the El Thama type, because they are very remote from Benghazi market such as Er-Ragta and Shat El Bedin and the produce is relatively inferior in quality.

C. Trough Farming System

Ganfuda has been one of the best tomato producing areas in the Benghazi Plain since the Italian occupation. Its fame, in fact, is indebted to the skill and struggle of its farmers. The sand dune area here is surrounded by sebakh water for most of the year.

The cultivated land is divided into long troughs 20-40 metres wide and about 100 metres long. The trough (MJAR) or plot is ploughed by hoe to a depth of 1 to 1.50 m. in order to reach the humid subsoil. It is manured, then divided into small Jdulas of an average of 1 x 2 m. and they are separated from each other by either palm tree fronds or esparto grass, in order to protect the small plants from the wind and drifting sands (Plate 9.6a). Each Jdula is planted with three or four seedlings and when they grow, only one plant is left and the rest have to be pulled out, due to the limited subsoil moisture. The new plants have to be irrigated by water

imported, as mentioned elsewhere, from as far as El Gwarsha and Benghazi (about 9 km.) until the first rain and then they will depend completely on the rain for their growth. It often happens that, owing to dryness or wind damage, the farmers have to plant their plots twice or even four times with new plants until the plants grow properly. Each trough is cultivated for at least three consecutive years and then it is left fallow for three years (Plates 9.6a and 9.6b).

Owing to the scarcity of water this area has only two growing seasons; summer, when water melons, pumpkins, peppers, and cucumbers are cultivated, and winter with mainly tomatoes, radishes, carrots, and onions. The most damaging elements affecting trough farming in Ganfuda are first the frost which is particularly dangerous to peppers, and, second, the wind which causes a lot of damage to all vegetable crops.

Trough farming is more successful in Ganfuda than in the remote areas like Jarrutha and Bu-Gtefa because of the proximity of Benghazi market. Nevertheless, the farming here is marginal and most of, if not all, the people are poor.

D. The Muhr Farming System

The Muhr type of farming is the most prevalent in the coastal sand dune areas, particularly where underground water is scarce or brackish, such as at Deriana, Aseila, Jarrutha, Bussufon, Karkura, El Murra, Shat El Bedin and Er-Ragta.

The cultivated land units or plots here are very small averaging about 12 m^2 , each one called "Muhr", and they

usually are far away from each other. The farming usually starts with the removal of the sand from a chosen spot for a depth of about 0.80 to 1.50 m. until the subsoil water (Tush-Shani) is reached. Then the water surface is covered with manure for a thickness of 10 to 15 cms., after which the Muhr is covered with sand to a reasonable depth of about 20 to 40 cms. (Plate 4.5). Four plants of any crop must be planted first, and when they grow only one has to remain.

However, there is a systematic planting arrangement in the Muhr type of farming, the first crop planted in the Muhr is usually water melon, followed by radish or tomato for about 2 to 3 years. Each year the plot must be re-manured. After the third year the Muhr is planted with either a fig, vine or palm tree. In the sand dune areas of Deriana, Aseila, Jarrutha and Bussufon, where the subsoil water is salty and fruit trees do not thrive, the Muhrs are usually cultivated with barley, which is said to neutralise the soil (sometimes it is very alkaline). In the latter areas, however, the Muhr system has only one growing season in winter, because of the limiting factor of the salinity of the subsoil water which deteriorates the growing of summer crops.

E. The Tahweedh Farming System

This system of farming is practised mainly in the Gasr El Ajuz area, west of Deriana. The Gasr El Ajuz is considered some of the best (Class I) agricultural land in the Benghazi Plain, because it has a very fertile though thin layer of residual terra rossa and inexhaustible coastal wells of 3 to

5 metres deep with a 1 to 3 m. deep water level of a good quality water. But, unfortunately, the agricultural land is limited because it is bounded in the north by the drifting sand dune area and on the other sides by rock outcrops (Fig. 5.1).

The cultivated plots are separated from each other by barbed wire and are usually protected from the northerly sea winds by esparto grass (*Imperata Cylindrica* - see Plate 9.7a). Each plot is divided into small square planted with various vegetable crops. Fruit trees are few and mostly are not fruitful.

The small cultivated unit is prepared by the removal of the very solid clayey terra rossa (Profile 13) until the underlying limestone rock is reached. Then the ground is covered with manure 5 to 10 cm. thick. The manure then is buried under the transported terra rossa soil. When the plot is to be planted, small holes of 10 x 10 cms. are dug in the ground and covered with sand (Plate 9.7b) and then the seed is buried in them. This method or system of farming is known as "Tahweedh."

Most vegetables, particularly cucumbers and tomatoes grow here all the year round, thus this area is a very important vegetable producer, which supplies Benghazi market with a high proportion of its vegetable needs, especially with off-season vegetables such as cucumbers, tomatoes, and green chilli peppers.

F. Dolina Farming System

This system of farming is a complex of irrigated and dry farming of crops and fruit trees in the sink-holes or dolinas, which are found only in the El Kweifya (Karst topography) area. Here the irrigated area is very limited, due to the topography of the dolinas. The dolina, in general, consists of two distinctive farming areas (a) the horticultural land and (b) the crop land.

The horticultural land is usually found on the lower sides and the sloping edges of the dolina. The crop land is in the lowland in the middle and on levelled terraces. Each holding or plot is separated from the other by barbed wire. The well for each holding or cultivated plot is usually located in the side of the dolina on a relatively higher level than the cultivated area (Plate 9.8). in order to facilitate irrigation by gravity to all lower ground in the middle of the dolina, which contains good, fertile and relatively deep terra rossa soil (Profile 10). The crop land in the dolina is cultivated with cereals (mainly wheat) in winter under the dry farming system, and in the rest of the year it is cultivated with vegetables and legume crops under irrigation. The method of farming here is similar to that of the coastal traditional farming which aims mostly to produce crops for the consumption of the family on the farm. The rest of the plot or holding which is higher than the level of the well is mostly cultivated with fruit trees, like figs,

almonds, pomegranates, vines and apples. In some plots where the fruit trees are planted on relatively level terrain, some vegetable crops (parsley, mint, spinach and radish) are inter-cropped with the trees.

9.3.3.2 - The Commercial Farming Type

Since intensive petroleum exploration began in 1956 urbanisation has proceeded at a faster rate than market gardening has expanded in the Benghazi Plain. Although market gardening has expanded and developed considerably since 1960, yet it still cannot meet the increasing needs of Benghazi City.

Commercial or market-orientated farming is a relatively new undertaking in the Benghazi Plain and Cyrenaica as a whole, and it is very limited and confined to Class I areas at Benina and in some parts of El Fweihat and El Haw-Wari. The most important factors which led to commercial farming in these areas are the availability of a large quantity of good quality underground water, the intrinsic fertility of the terra rossa soils (though the cultivated land is limited at Benina) and the availability of capital and entrepreneurs, as well as the nearness of Benghazi market.

The land in this type of farming is intensively cultivated and fully mechanised. The land here is used more efficiently than in the other types of farming, with large units permitting the full and most efficient utilisation of agricultural machinery, full scale application of fertilizers and adequate manpower. The latter factor is of great import-

ance since almost all the farm labourers are skilled specialists imported from Palestine, Egypt and Tunisia.

The use of mechanisation and skilled labour in this type of farming, not only permits but demands higher output per unit of land^{*} and makes this advanced type of agriculture more selective as to the land cultivated. Therefore, the production per hectare and yield per unit are much higher than in the areas cultivated traditionally in the surrounding areas.

The most important recent development in commercial farming is the expanding cultivation of fruit trees mostly under irrigation. Irrigation here is practised with a well-organised system of concrete channels and compressed water pipes. Sprinkler irrigation, although the most suitable for commercial farming, is not yet possible for reasons already mentioned in Chapter 5.

In general, this type of farming is practised on two kinds of farm land. First, the entirely mixed-crop farming farms such as those at Benina, El Haw-Wari and El Fweihat where field crops and fruit trees are grown together with the raising of dairy livestock and poultry (Fig.9.5) and, secondly, mixed-crop farms, characterised by market-orientated field crops, vegetables and fruits, which also are found in the above-mentioned areas.

* No sufficient data are available to show the yield per hectare.

CHAPTER 10

FARM FINANCE, LABOUR AND EQUIPMENT

10.1 - Farm Income and Expenditure

10.1.1 - Farm Income

Most of the rural population of the Benghazi Plain, particularly the Bedu people, depend on agricultural income for their living. In general, however, there are two sources of income for the farmer; agricultural and non-agricultural income. The agricultural income consists of both cash and kind.

Unfortunately, there is no reliable information or data available to make an estimate of the farming returns, particularly in cereal and animal production, because the farmers, especially the Bedu, do not know or do not often remember the amount of grain, vegetables, fruit, meat and other animal products they consume. Besides, there are variations in prices from place to place and from year to year. Therefore the prices of the agricultural products which are used in this context are calculated according to the prices in Benghazi market in June, 1967. During the questionnaire survey of 1967, many farm products were still

in the fields and, therefore, most of the data has been calculated on the 1965-66 production. Consequently, the estimation of farm income in this respect is merely tentative.

(a) Agricultural income

Most of the farmers of the Benghazi Plain do not sell their wheat and barley, but consume them and save some for the next year's sowing or as a precaution against drought years. Hence, the main source of cash income for the Bedu or shifting cultivators, is from animal husbandry. For the farmers in the irrigated areas vegetables are the most significant source of cash income. In the 225 farms surveyed in 1967, vegetable crops accounted for the highest percentage (34.3 per cent) of the total agricultural gross income in the Benghazi Plain (Table 10.1). About 40 per cent of the vegetable sales came from tomato production. However, the tomato income varies from place to place. For instance, in Ganfuda, Aseila and Er-Ragta it formed more than 90 per cent of the farm income, whereas in the areas around Benghazi it represented only 20 per cent, because these areas could produce other probably more valuable vegetables (owing to the availability of good and abundant underground water) such as lettuces, peppers, water melons and onions. Pumpkin production accounted for about 23.6 per cent of the vegetable income, and came mainly from El Magrun, El Fweihat, Benina, Deriana and Tokra (Appendix Table 10.1).

Although grain is rarely sold, it ranked second in

importance to vegetables as a source of farm income in the area surveyed. It accounted for about 24.4 per cent of the gross income from farm products. Wheat, however, accounted for about 45 per cent of the grain income (Table 10.2) with about 43.5 per cent of the total wheat income from Jardina and Slug. Barley, despite its declining importance in the Bedu diet, accounted for about 29 per cent of the gross income from grain. Legumes, in spite of their importance as a cash crop, represented only 26 per cent of the total gross income from grain. Melon cultivation has in recent years increased considerably notably on the commercial irrigated farms at Benina and, to some extent, in the dry farming coastal sand dune areas. According to the 1967 survey, melons accounted for about 22.4 per cent of the total agricultural income whilst Benina and El Fweihaat alone accounted for about 92.3 per cent of the income from melons (Appendix Table 10.1).

Fruit cultivation, despite its importance and the great demand in Benghazi, was not significant to the farm economy in the area under consideration. It accounted for only 3.1 per cent of the gross agricultural income. More than 45.5 per cent of the gross income from fruit was obtained from the selling of grapes in El Magrun alone. From the point of view of contribution to gross farm income, fruit cultivation is significant only in the small irrigated areas of Tokra, Sidi Khalifa, El Kweifya, El Fweihaat, El Gwarsha and El Magrun. Other kinds of fruits, except grapes, are generally of little

importance as far as their income value is concerned.

Animal husbandry contributed about 15.3 per cent of the agricultural gross income in the 225 farms surveyed in 1967 (Table 10.1). It is worth mentioning here once again, that animals are responsible for the only important agricultural cash income for the Bedu people. Sheep and goat sales accounted for about 94 per cent of the total cash income from sale of animals with cattle and camels yielding only 4.9 per cent and 1.1 per cent (Table 10.3). Although animals provided the main cash income for the Bedu people in 1967, this had a little influence on the income structure of the sedentary agricultural people. For example, in Es-Sahel area, where irrigated farming is much more developed than in Barga El Hamra, the farm income from animal husbandry is smaller than in Barga El Hamra. More specifically, in El Kweifya where agriculture is of the dolina farming system and in El Gwarsha where agriculture is of the intensive swani type, animals made no contribution to the structure of the gross farm income. In Jardina where agriculture is given almost entirely to shifting cultivation of cereals and animal grazing, the cash income from animals accounted for about 56 per cent of the gross farm income (Appendix Table 10.1).

Cattle sales are very few and all are confined to the Es-Sahel area. Camels also are very rarely sold. In 225 farms surveyed in 1967 there were 31 cows sold for £L.1,354, and 6 camels sold for £L.305. Thus camels contributed almost

nothing to the gross farm income. The sale of wool and hair gave an income of £L.4,996.6 or 1.8 per cent of the gross agricultural income. Although chickens are a good source of meat, they are rarely sold in rural areas, but eggs are, of course, sold everywhere. According to the 1967 survey, chickens comprised only 0.1 per cent whereas eggs comprised about 3.5 per cent of the total agricultural income. Such income from unclassified, other less important agricultural products such as milk, honey, samn (purified butter) and pigeons accounted for about only 0.5 per cent (Table 10.1).

The general gross income from agricultural activities for the 225 farms surveyed in 1967 amounted to £L.279,884.8 which is equivalent of £L.1243.9 per household or £L.153.6 per capita.

However, a gross farm income of £L.1243.9 per household in the Benghazi Plain is unrealistic and it is, really, higher than the gross income of an average farm. This results from the big contrast between the small income of the small farms (the majority) and the huge income of the commercial farms; the lowest income of the commercial farms was £L.1000, while the highest income of the commercial farms was £L.150,000. The majority of farmers, about 71.6 per cent, in the area under consideration had a gross farm income of between £L.50 to 500 per year, 16.0 per cent had between £L.500 and 1,000, 11.5 per cent had between £L.1,000 and 10,000, 0.4 per cent had between £L.10,000 and 100,000 and 0.5 per cent had between £L.100,000 and 200,000 per year (Table 10.4).

This frequency distribution of incomes can be clarified still according to the functions or types of farming in the following manner:

1. Shifting cultivators had a gross farm income of £L.200 to 600 per year.
2. Shepherds had £L.400 to 1,500 per year.
3. Hired shepherds had £L.150 to 300 per year.
4. Small irrigated farms (swani) in the coastal area had £L.300 to 500 per year.
5. Irrigated sand dune farms had £L.200 to 400 per year.
6. Modern irrigated farms around Benghazi had £L.1,000 to 5,000 per year.
7. Commercial farms at Benina, El Fweihat and El Haw-Wari had £L.10,000 to 200,000 per year.

In conclusion, it may be said according to experience and observation that the general average of the gross farm income in the Benghazi Plain, in 1967, was about £L.350 per year.

The agricultural gross income in kind* (i.e. the value of crops and livestock products produced on the farm and consumed by the farmer or household) amounts in most areas, particularly in the shifting cultivation area, to more than the cash income.

It is estimated that in average productive years, the farmers do not sell more than 12 to 20 per cent of their cereal crops, whilst in dry or poor productive years, almost

* No data are available, because farmers do not know or remember what they have consumed.

the whole grain production, if there is any, is consumed by the farmers themselves. In general, farmers have more goats than sheep in the northern part (forest) of the Benghazi Plain, whereas in the southern part (steppe land) the sheep are mostly killed for meat consumption. Camels and cattle are very rarely consumed by farmers and they are mainly raised for sale. In the small irrigated gardens, the farmers consume most of their field crops and the surplus, if there is any, forms their cash income, whilst the commercial farms sell almost all their agricultural products for cash income.

(b) Non-Agricultural Income

Income from off-farm work of family members formed a significant part of the income of the farmers surveyed by the 1967 questionnaires, since about 63 per cent of the farmers received income from non-agricultural work. Of these farmers 20.2 per cent received governmental financial assistance, of which 37 per cent were in Deriana Mudirya alone (Appendix Table 10.2). The average income from non-agricultural employment per farmer was about £L.28.41 monthly. Some 74 farmers working off-farm received a total annual income of about £L.29,499, so that each farmer earned an average monthly income of about £L.33.22. Another 36 farmers were receiving social welfare assistance, at an average of about £L.10.56 per month. Only two farmers received a disablement pension at an average of £8.63 per month per head. Farmers receiving income from private enterprises (i.e. companies, factories and

firms) numbered only 16, and they earned an average annual income of about £L.369.06 or £L.30.76 per month (Table 10.5). Other minor sources of income such as merchandise, charcoal burning, grazing and quarrying played a relatively unimportant role in the non-agricultural farm income in the Benghazi Plain in the 225 farms surveyed in 1967, four of these 60 farmers earned an average annual income of about £L.399,22 or £33.27 per month.

10.1.2 - Farm Expenditure

Farm expenditure in the area under consideration accounts for only the cash expenses actually paid by the farmers on items like hired labour, seeds, fruit plants, hire of tractor and combine, water, feed and herding of livestock, maintenance of equipment, fertilizers, insecticides for vegetables and plants and transportation charges. The farm expenditure on items like family labour, home grown seeds, manure and rent of the land, which do not involve any cash payment, are not accounted in this context as farming expenditures. The cost of non-family labour was, however, the major item of farming expenses. According to the 1967 survey it accounted for about 64.4 per cent of the total farm expenses (Table 10.6). About 59.5 per cent of the hired labour force was located in Benina alone (Appendix Table 10.3). The seasonal farm labour force prevails mainly in the shifting and dry-farming areas as well as in most of the small irrigated traditional farms, while the permanent farm labour force is

located mainly in the modern coastal farms and the commercial farms at Benina and around Benghazi. Transport charges ranked second (12 per cent) in the farming expenses. The cost of seeds (3.2 per cent), fruit plants (1.4 per cent), hired machinery (5.8 per cent), water and feed for livestock (6.3 per cent), fertilizers and rent (0.4 per cent), were all of minor importance in the structure of farm expenditure (see Table 10.6). The general average expenditure per householder in the 225 farms surveyed was about £L.117.26 per year.

10.1.3 - Net Farm Income

The total annual net income of the 225 surveyed farms, including the income from the non-agricultural sector, amounted to £L.241,108.5 which is about £L.1,071.59 per household or £L.132.3 per capita (Table 10.7). This large average income is due to the effect of the high income of the commercial farms of Benina and around Benghazi, but, in reality, the net income of the majority of the farmers in the Benghazi Plain is in the area of £L.350 per household per year, which is equivalent to a per capita income of about £L.50. This figure is, moreover, supported by the household income survey carried out by the Ministry of Housing which gave an annual income of about £L.360 per year for about 80 per cent of the Libyan rural population in 1966.⁽¹⁾ It is worth mentioning here that, owing to the increasing budget of the petroleum revenue, the per capita income in Libya at the end of 1968 was £L.300.⁽²⁾ Although this figure is

probably right, since it was conducted by the National Statistics Department, yet it did not represent the real income of the majority of the people, who probably did not get even £L.100 per capita.

The present (1967) level of the annual net income of a rural family was estimated at about £L.350 from all sources, against this, the annual expenditure of the family was estimated to be about £L.516.70 of which the main family expenditures were food (45 per cent) and clothes (16 per cent) (Appendix Table 10.4). However, the above average family annual expenditure is not reliable because most (more than 85 per cent) of the households interviewed tried to impress the interviewer that they usually spend more than what they earn. Therefore, the following estimation by a trusted farmer is considered to be relevant as an annual expenditure of a rural family consisting of 8 persons* in the Benghazi Plain (see Table 10.8). The average annual net income of a family of 8 persons, in 1967, was about £L.350 and the average annual expenditure was about £L.375. The deficit of £L.25 is what the local farmer owes the merchant, a debt which may accumulate for two or more years, but the farmer might gain a good harvest and thus payback all his debts and probably save more cash.

However, to provide a decent, contented living for a rural family of 8 persons, due to the rising cost of living during

* 8 persons is the average number per household in the whole of the Benghazi Plain.

the coming years the household would need an annual income of 500 to 700 Libyan pounds. This could be achieved by applying modern agrotechniques in farming, which will involve the use of new improved varieties of crops, fertilizers, improved and better livestock breeds and good horticultural enterprises, as well as the use of modern equipment, tools and machinery.

10.1.4 - Agricultural Credit

The main source for medium and long term farm credit in the Benghazi Plain is the Agricultural Bank of Libya (established by the government in 1957 with a capital of £1,000,000) which advances loans to each farmer ranging from £L.300 to £L.10,000 for purchasing engine pumps, windmills, tractors and other farm equipment and machinery, as well as for the construction of agricultural buildings. At first the Bank granted only short and medium term loans for the purchase of engine pumps, windmills, tractors, etc. due to its limited capital, but in 1965⁽³⁾ it started granting long term loans for the improvement and the establishment of new farms. Until 1964 the interest rate was 6 per cent per annum, but since 1964 the Bank has granted loans to farms for agricultural needs without any interest. The medium term loan is usually granted for a period of 3-5 years and payment by the borrower starts after the second or even the third year after the loan is granted. This, however, depends on the condition of the agricultural products. The farmer who seeks a loan from the Bank usually

asks the sheikh of his tribe and the Mudir of his district to guarantee him to the Bank. Credit may only be granted after consulting the guarantors who must know the farmer very well. Nevertheless, the Bank sometimes faces difficulties in collecting the liabilities due, particularly from the Bedu people.

About 18.6 per cent of the 225 farm households surveyed in 1967 got loans from the Agricultural Bank. The amount of the loan varied from £L.150 in Jardina (small subsistence farms) to £L.6,000 in Benina (Table 10.9).

Unfortunately, some of the accredited farmers spent their loans on private and non-agricultural purposes such as building houses for rent, buying cars, and using them for hiring businesses, financing the marriage of their sons or remarrying themselves.

The second, less important source of credit is the Industrial and Estate Bank of Libya,^{*} which started in 1967 encouraging farmers to reclaim lands, establish new farms, build new houses and for farm construction purposes.[†] This bank grants loans up to £L.40,000 per farmer, without any interest and for a period up to 15 years, on the basis that the farmer pays an annual amount according to the sum of his loan. If, however, the loan is granted for the establishment or rehabilitation of a farm, the payment to the Bank will not

^{*}No data are available.

[†]This Bank was established in 1965, primarily to grant loans to Libyans to reconstruct and construct new houses.

start before the end of the fifth year from the date the loan is granted. However, not every farmer can obtain a big loan from this Bank, unless he is an influential person, such as an M.P., Minister, Deputy Minister or General Director.

The local traders, although granting only small amounts to farmers, are very important sources of farm credit. The farms in the coastal area and in the interior of the plain usually buy their goods like tea, sugar, tobacco, clothes, soap, flour, rice, macaroni, spaghetti etc. on credit from the village shops or Benghazi market shops. The debt is written down and is generally paid, either seasonally, if the indebted farmer practises irrigation farming, or once a year after the harvest, wool, hair or new lambs are sold, if the farmer is a shifting cultivator or livestock breeder. According to the religious principles, the traders must not take any interest from the farmers on the goods they buy on a credit basis, but they usually sell their goods at a price 10 to 15 per cent higher than normal and thus they gain a profit which is equal to and probably greater than interest. About 28.8 per cent of the surveyed households were indebted to local traders. The amount of the debt varied from £L.15 in El Gwarsha to about £L.122 in Sidi Khalifa per farmer per year (Table 10.9).

Farmers who obtained loans from private creditors (i.e. companies, usurers, friends, relatives) were very few, being only 3 per cent of the total surveyed households. The amount

granted thus varied from £L.60 to £L.250 per household (Table 10.9).

However, all the farmers who were interviewed, even those with an annual income of more than £L.100,000, asked for financial assistance from the government. The majority of them wanted it for buying windmills, engine pumps, fencing, concrete channels and cars.

10.2 - Farm Labour and Equipment

10.2.1 - Farm Labour

Owing to the present shortage of agricultural labour in the Benghazi Plain, the farm labour is mostly supplied by the farm families themselves. Nevertheless, most of the farms studied were also using permanent or temporary hired labour. Permanent farm labour is found mainly in the irrigated farms, notably in the commercial farms, whereas temporary labour is hired sometimes for harvesting and gathering crops in both irrigated and shifting cultivation areas. Owing to the scarcity of labour, wages are also very high in the rural areas, averaging between £L.1.00 to 1.50 per man per day, in addition (not in the commercial farms) to the free food, tea and cigarettes, and sometimes even a room and bed. Thus, most of the farmers in the area under consideration are more inclined to use labourers from the family rather than hired labour.

Permanent family labour consists of active and healthy adult farmers, mainly of the age group 15 to 60 years. Such

people comprised about 49.3 per cent of the total surveyed farm population (Table 10.10). Sometimes aged men of over 60 years are found as full-time farmers. According to the 225 farms surveyed, about 6.6 per cent of the farm family members were over 60 years, and were unable to participate in any agricultural activities, being either too old or with physical handicaps. However, the average age of a farmer in the Benghazi Plain is around 50 years.

In the shifting cultivation areas, women usually do not work in the fields, but they perform light work such as feeding and watering the animals, gathering wood for cooking and carrying water for domestic purposes. The children under the age of 15 years are also excluded from work in the fields and they usually graze sheep and goats and carry drinking water on a donkey's back. The position of the women in the small irrigated farms is, however, different from that in the shifting cultivation areas where the women participate and often do equal work with men, like drawing water from wells (Dalu-animal system), planting crops, cutting weeds, irrigating the fields and gathering the crops. Despite this, female labour per day is less than that of the men. Theodorou⁽⁴⁾ estimated that three women's labour days are equal to two men's labour days, and two children's labour days equal to one man's labour day.

The average size of the family in the surveyed farms is 8.1 persons. The maximum size of 11.4 persons is found in El

Gwarsha, where most women and children help in operating the small irrigated farms. The minimum size of 5.4 persons is found in Gamines (Table 10.10) in the class category of lithosols and greyish steppe soils with but small irrigated farms. However, the average strength of the permanent family labour force is about 2. This varies from Mudirya to Mudirya and place to place according to the type of agricultural activity. For instance in Tokra, where most of the farm layout (mainly from Tripolitania) is hired (see below) and the hired farmer has to exploit all the working members of his family in the inter-cropped irrigated small farms, the number is 3.7 persons. This is applicable to El Fweihat too, with an average of 3.5 persons, while in the areas of shifting or dry farming practices the strength of the permanent labour force is relatively low, being 1.6 persons in Slug, Gamines, Deriana and Tolmeita. The average area farmed per family in the area surveyed was 6.1 ha. This, however, varied from one place to another, the lowest being 4.3 ha. in Tokra and the highest 9.2 ha. in Slug.

About 36.4 per cent of the surveyed households were classified as permanent full-time farmers, 12.9 per cent as part-time farmers and the rest 50.7 per cent were engaged in shifting cultivation (Table 10.11). The shifting cultivators are considered as a farm labour force only in the sowing, ploughing, harvesting seasons, and in the rest of the year they normally remain idle. Thus, they might be

considered part-time farmers and most of them either have jobs with the government (including security and the Armed Forces) or receive government assistance. The high percentage of government employees in the rural areas is due to the direct and indirect influence of the oil boom, which allows the government to employ anyone who can read and write in offices and any youth may apply to the Army or Security Forces. Thus, large numbers of young people have been leaving the rural areas for Benghazi City and other urban centres, which provide extensive non-farm employment opportunities in various types of constructional and development projects for the oil companies as well as various positions in government departments. Consequently, farming is being left to the older people, women and children.

The primary cause of the migration of the farm labourers is the strong desire of the rural people for better earnings and a higher standard of living. For this reason the highest numbers of farmers living on their farms and working in non-agricultural activities are found near Benghazi and around the villages, where schools and other government offices are located. Migration to Benghazi from farms in the irrigated coastal area in Tokra, Deriana, Sidi Khalifa, El Gwarsha and Gamines, is very harmful to agricultural development, for these farms are now mostly neglected (Table 10.12), their wells are destroyed and their trees are withering or have been cut for firewood. However, migration of people from the

shifting cultivation areas should be encouraged in order to give the nomads and semi-nomads the opportunity to settle in Benghazi City and in the nearby villages to supply a labour force for the non-agricultural sector. The shortage of farm labour, which is becoming more and more serious as a result of the drift of farm labour to non-agricultural activities in Benghazi City and the nearby villages, is responsible for making farming a costly operation. Nevertheless, the steadily increasing mechanisation, particularly in the cultivation and harvesting of cereals through the Government Hire Service and private companies and co-operatives, has proved very helpful in tackling this problem. In recent years, the shortage of farm labour in the irrigated coastal small farms has been supplied by the illegal immigrants of Awlad Ali^{*} from Egypt. Although they are skilled farm labourers, the landlords cannot rely on them, because they are liable to be picked up by the police at any time and shipped to the Egyptian border. In addition, they could be dangerous to the security of the country, since they smuggle in and out of the country, hashish, gold, weapons and currency. Therefore farmers must depend on local farm labour and dismiss these intruders and help the local authority to find them.

The permanent or seasonal hired labourers usually do the major part of the difficult agricultural jobs. The farm

* Awlad Ali are of the same stock as the Bedu of Cyrenaica and they used to live in the eastern part of Jabal El Akhdar before they were driven out by the Saadi tribes of Cyrenaica in the second half of the 18th century.

labourer works for about 8 to 9 hours per day, starting at 7.30 a.m. to 12.30 p.m. and from about 2 p.m. until 5 to 6 p.m. after which he either stays in the farm or goes to his home especially if he is hired by daily payment. The family farm labourers however perform the work at any time of the day and sometimes he starts as early as 5 a.m. and stays as late as 9 to 10 p.m.

The duties of the hired farm labourer in the traditional irrigated farms differ from those in the shifting cultivation areas. In general there are two types of farm labourers in the irrigated traditional farms: (1) the Jabbad (drawer of water) and (2) Mkarwi (farming worker).

The job of the Jabbad is to draw out water for irrigation from the phreatic wells by means of a dalu-animal. This job, however, has decreased considerably in recent years, due to the rapid spreading of water pumps and windmills. The work of the Mkarwi is more difficult since it requires more skill and experience than that of the Jabbad. The Mkarwi ploughs a piece of land, clears it of debris and weeds and then plants it. He also irrigates the farm and takes care of the animals and plants. In addition, he might perform some extra work outside the farm for the landlord. In most cases, both the Jabbad and Mkarwi get their food, and sometimes their bed too, free from the landlord, in addition to their wages, which vary from place to place, but generally are between £L.050 to £L.1.00 for the Jabbad and between

£L.1.00 to £L.1.50 for the Mkarwi per day (in 1967).

The majabra people of the Jalo oasis, owing to their skill and patience, used to and, to some degree still do, supply the bulk of the best Jabbad labourers, whilst the Mkarwi are usually Tripolitanian farmers who have been coming into Cyrenaica since the 18th century.

With the establishment of the commercial farms at Benina, El Fweihat and El Haw-Wari, a new type of farm labourer has been introduced to Benghazi Plain. The landlords of these large, modern farms usually import skilled labourers from Palestine, Egypt, Lebanon and Tunisia to work on their farms. These farm labourers are paid on a monthly salary basis. They earn an average of about £L.40 per month plus their travelling expenses from their homes to the farms in the Benghazi Plain. In addition to this, they get free accommodation.

However, another type of farm labourer has been introduced to the Benghazi Plain since 1966, to fulfil two purposes: namely to solve the problem of the shortage of farm labour on one hand and to help the poor Libyan farmers who emigrated to Egypt and Tunisia³ to return to Libya and find a better way of life. The landlord usually signs a contract with 1 to 3 families in Tunisia or Egypt to work on his farm in Libya for a certain period, after which they will be free either to remain on his farm or leave it and go to somewhere else in Libya. The landlord usually divides his farm among these

³ These farmers migrated after the Italian occupation of Libya in 1911.

families and provides a house, tools, equipment, a water pump and all other farming facilities (Fig.9.5) to each family. Then he sells the farm products and after deducting the expenses, he shares the profit with the farmers.

However, it is too early to judge the success or failure of this type of farm labour enterprise, because it is still on trial in the area under consideration. Besides, this source of farm labour is not secure because the workers can break their contract for any reason and then can work wherever they want, particularly after they have acquired the Libyan nationality. This, however, is not the case with the imported alien farm labourers because they must leave the country within a short period after breaking the contract with the landlord. According to the well known rules of the "Labour Law," the imported alien farmers, whose contracts have been terminated for one reason or another, cannot be hired by any other landlord, unless they return to their countries and remain outside Libya for at least six months.

In the shifting cultivation areas farmers employ labourers for ploughing, sowing, harvesting and herding animals. The farm labour in these areas is usually seasonal and the work is undertaken either on the basis of a contract of partnership or the labourers are paid according to the common wages. The farm labour in these areas can be classified as follows:-

10.2.1.1 - Rabba. This type of farm labour is based on a

partnership system and it is the most prevalent type in the shifting cultivation areas. The Rabba makes a contract with the landlord in front of two witnesses to plough the land and harvest the crop, and he gets in return a quarter share of the crop, plus a cash sum of about £L.20 for the whole period, in addition to his monthly keep, the so-called Shahama which consists of foodstuffs and drinks (Table 10.13). In poor or dry years the Rabba's share of the crop is increased and sometimes it reaches a third or half the crop. The Rabba is also allowed to consume as much as he can (normally 1.5 kg. per day) from the harvested crop. Consequently, the labour of the Rabba costs about £L.0.80 per day^{*} or £L.21.56 per ha. per season. (Owing to the lack of information on the labour requirements for various agricultural activities, labour efficiency cannot be calculated, and therefore, the measurements used here are based on hectare of land per man equivalent). Farming is becoming more and more costly, due to the high cost and shortage of farm labour. Thus, many farmers who cannot afford such expenses are obliged to leave farming and migrate to the urban centres and oil fields.

10.2.1.2 - Muzara or cultivator. The Muzara is merely a labourer, who works for capitalists (mainly from Benghazi City) and does not share the products with the capitalist or landlord; instead he gets money (it does not differ too much from the wage system), in accordance with the amount of seed

^{*}The official labour wage since 1964 is £L.0.50 (11/-) per day.

the farmer can sow. Such a labourer has also to provide an animal for ploughing and pay for his own expenses. The capitalist or landlord provides the seed and pays the farmer after the crop is in. The average cost of this labour is about £L.1.50 per day.

The herding of animals is also done to a large extent, by hired labour. The herdsman (Rai) is either hired for the whole year (permanent) or seasonally (temporary).

The impact of petroleum on rural economic life, has produced a dramatic change in the nomadic mode of life of the Bedu. Consequently, many shepherds have left their traditional occupation to participate in various urban jobs and with the oil companies, where they get better pay and living conditions. Those who are still working as herdsman are no longer accepting the customary method of payment in kind. Instead they ask for extra cash in addition to the payment in kind and offspring privileges. In some cases, shepherds ask for monthly payment based on the number of livestock. All in all, the herdsman can be briefly classified as follows:-

10.2.1.3 - Rai Es-Seif (summer shepherd). This herdsman has to take care of the animals during the summer season. At the end of the contract, the new born animals are counted and the shepherd can choose one out of every twenty and he is usually given the privilege of choosing his share from among the previous year's lambs. If, however, the shepherd rears goats he takes one from every ten new born kids. In addition to

this, the shepherd sometimes gets his board and lodging free of charge from the owner of the herd.

10.2.1.4 - Rai Esh-Sheta (winter shepherd). In this category the shepherd takes custody of the herd (the herd usually consists of between 150 to 300 head of sheep and goats) during the winter season, during which he gets about £L.0.60 per head per season but the new born lambs and kids are reared free of charge.

10.2.1.5 - Rai Er-Rabi (spring shepherd). Here the shepherd takes the custody of the herd during the spring season only. The shepherd in this type of animal rearing lives with the owner of the herd and gets his lodging and food free of charge. During the three months of spring, the shepherd can help himself to milk, purified butter (samn) and wool. At the end of the season he has the right to choose one out of every 20 mature animals (which cost about £L.20). The shepherd is better off under this system than under any other. This results from shortage of the hired shepherds during spring when most labourers prefer to work in agriculture rather than grazing.

10.2.1.6 - Rai El Hasad (harvesting shepherd). This shepherd has to take care of the herd during the reaping period. Since harvesting absorbs the whole rural labour force, the owners of the herds, in order to secure shepherds, offer them either a profit equal to that obtained by a reaper in the field plus his food, or a salary equal to the average wage of a labourer

in the urban areas which is £L.1.00. The contract here is valid only for the harvesting period.

10.2.1.7 - Rai Ibil (camel herdsman). Since camel owners are mostly found in remote areas in the south-east of the Benghazi Plain and they are all real nomads, they still retain the traditional way of hiring herdsman. The camel herdsman usually takes care of a herd of about 30 head. In return he gets about £L.80 every six months, in addition to his lodging and food. The herdsman also gets trousers, a shirt, one pair of Bedu shoes and a hat every six months. The owner has also to provide the herdsman with sugar, tea, oil, tomato paste and cigarettes, which cost him about £L.0.50 per day, during the time when he rears the herd far away from home where he has to remain for some days or probably weeks.

10.2.1.8 - Rai-Shahri (monthly paid herdsman). This new type of hired herdsman or shepherd prefers to get monthly wages, as other labourers in urban areas or oil fields do. This system will probably prevail in the future and replace the traditional custody of livestock in the Benghazi Plain and Cyrenaica as a whole. In the shahri system the shepherd or herdsman takes custody of the herd (the herd is usually between 100-300 sheep and goats, 30-100 camels or 10-40 heads of cattle). The contract in this case stipulates a monthly basic payment per head. The price of hiring, however, differs from place to place and from time to time. In 1967, in general, it was £L.0.15 for each head of sheep or goat. The cattle

herdsman usually collects about 20 to 30 head of cows from different owners and gets £L.1.00 for each head per month. In this case the herdsman has to support himself. If, however, the whole herd which the herdsman is raising is owned by one owner or family, the monthly payment per head is only £L.0.50, but then he gets his lodging and food free of charge. The herdsman raising camels gets almost the same as the cattle herdsman (£L.1.00 per head per month). However, in the 225 households interviewed, there was only one cattle herdsman in Deriana.

In all cases the hired shepherd or herdsman can have as much milk as he can drink every day, in addition to purified butter (samn), and various gifts, grants, and charity which are usually presented on various occasions, especially religious festivals.

In conclusion, it may be said that, despite the scarcity and high cost of hired shepherds or herdsman, the raising of livestock is still highly profitable mainly because of the continuing inflation of prices of animal products, especially meat since the petroleum discovery and, secondly, the free grazing even for those who have no lands of their own.

10.2.2 - Farm Equipment

The value of farm equipment is not very high on almost all except the commercial farms of the Benghazi Plain, particularly on the shifting and dry farming farms. Table 10.14 shows that the average value of equipment per farm in

the 225 farms surveyed in 1967 was about £L.465.75. About 85.8 per cent of the total value was invested in machinery, 13.2 per cent in implements and only 1 per cent in hand tools.

The total value of equipment varies, however, from farm to farm as well as from Mudirya to Mudirya. The smallest average value per farm was found in Deriana (£L.137.22), Jardina (£L.177.30) and Tolmeita (£L.199) where most of the farming is dry or shifting cultivation and each farm family has one or two wood or iron ploughs and a few hand tools with an average value of £L.5. The largest average value per farm was found at Benina and El Fweihat, with £L.3020.56 and £L.2045.56 respectively (Table 10.15). Here each modern farm contains at least 2 electric water pumps (at an average cost of £L.511 each), one tractor (average cost of £L.1459), a car, cart and many modern hand tools. The high average value per farm at Gamines (£L.632.11) is due to the fact that two of the 15 farms surveyed contained 2 tractors and 2 cars. If, however, these two farms are excluded, the average value per farm will be between £L.200 to £L.300, which is a reasonable sum for the majority of Gamines farms.

For a better understanding of the types, value and distribution of farm equipment in the Benghazi Plain, it is best to treat each type separately.

10.2.2.1 - Farm Machinery

Mechanisation is not well developed in the area under consideration, and it has been introduced only recently,

mainly on the commercial farms and in some of the shifting cultivation areas.

In the 225 farms surveyed, only 30 tractors were found. 24 farms had one tractor each, two farms had 2 tractors each and four farms had 2 tractors. In some cases a tractor is owned by three or more farmers. However, the total value of the 30 tractors was £L.43,764 or 48.7 per cent of the total value of machinery (Tables 10.16).

From Table 10.16 it can be deduced that the number of tractors is small compared to the present needs. Moreover, the surveyed tractors probably comprise more than 80 per cent of the existing private tractors in the Benghazi Plain. However, the Ministry of Agriculture provides tractors, harvesters, threshers and seed drills to most farmers (upon request) in the Benghazi Plain through the main machinery services office at El Marj, but despite the growing number of government machines, particularly since 1966, the area under consideration still needs more than the present number. At the time of sowing and harvesting the government sends one machine to each Mudirya, in the Barga El Hamra area, whereas in the Es-Sahel area, where the forest prevails and the cultivated plots are too small to be operated by machinery, the government probably sends only one or two to the whole region³ (5 Mudiryas). The field work revealed that the government machinery services are mostly used by influential people, i.e. M.Ps, Military or Police Officers, ex-Ministers, etc. who

³ Bersis uses its own co-operative's machinery.

cultivate large plots and need to use machinery, because manual work (see below) costs more and takes longer too. Thus, the small farmers in most cases, are deprived of the use of machinery and if they hire private machinery it costs them twice as much (Table 10.17). Therefore, their only solution is the use of family and hired labour. However, in order to overcome this problem, the farmers ought to establish co-operative societies in each Mudirya^{*} to serve themselves and their needs, especially since the announcement of the government that it would encourage and assist every co-operative by providing long term loans, in addition to other privileges and grants.

According to the 225 farms surveyed in 1967, there were 17 windmills installed on wells for 18 farms: of these, 16 farms had one each and 2 farms had one. There were also 84 water pumps in 75 farms. Only 2 farms had 4 water pumps, one had three, one had 2 and 71 farms had one water pump each. There were only 5 farms at Benina and El Fweihat, who reported that they had electrical water pumps.

Of the 225 farms surveyed, 26 reported that they had one motor car, worth on average about £L.916,73 each (Table 10.16). There was only one farmer at El Kweifya who had an old fashioned type of olive-press, the only one in the Benghazi Plain.

The average percentage value of machinery per farmer in

* At present (1967) there are only two co-operatives, one is in Tokra and the other is in El Gwarsha.

1967 varied from one Mudirya to the other; the lowest was found in the dry and shifting farming areas and in the forest areas such as Jardina (2.8 per cent), Deriana (2.7 per cent) and Tolmeita (2.1 per cent), while the highest average percentage value per farm is found in the market orientated farming areas at Benina (20.5 per cent) and El Fweihat (21.6 per cent).

Owing to the increasing scarcity and cost of hired farm labour, mechanisation will become far cheaper than the employment of manual workers especially in the sowing and harvesting of cereals. For example, in Es-Silg area, east of Slug, Mr. M. Grighish (one of the big entrepreneurs in agriculture) declared that he had sown 7 qtls. of wheat in 1967, by using machinery from which he harvested 100 qtls. of wheat and 20 qtls. of straw, worth £L.440. The total expenditures and net income of this operation is shown in Table 10.18a. If, however, this operation had been performed by traditional methods the sowing operation for 7 qtls. of wheat would need 2 labourers with a minimum wage of £L.0.50 each per day for about 40 days, plus £L.20 each for the so-called Shahama or food allowances, so the total cost of labour for sowing would be £L.80.00. As far as harvesting is concerned, the sown area would need 2 labourers for about 4 months, with a minimum wage of £L.050 each per day, plus the Shahama of about £L.50 for both, therefore the total labour cost would be £170.0. It is worth mentioning here that the production of wheat and

straw would increase by about a third, above that harvested by machinery. Consequently, the wheat production with the traditional method would be about 130 qtls. instead of 100 qtls. and the straw 27 qtls., instead of 20 qtls.

To sum up, the total cost of sowing 7 qtls. of wheat by the traditional method would be £L.347, the gross income £L.576 and the net income £L.229 (Table 10.18b), whereas, by machinery, the sowing would cost £L.169.00, the gross income would be £L.440 and the net income £L.271 (Table 10.18a). Despite the higher gross income of about 30.9 per cent by the traditional method, yet the use of machinery is still more profitable by about £L.42 or 18.2 per cent. In addition, the time saved is more than 80 per cent.

If, however, machinery in agriculture has to be developed in the whole area under consideration, the Japanese⁽⁵⁾ walking-type garden tractor, would be the most beneficial and easy to operate in farming the local swani or gardens.

10.2.2.2 - Farm Implements

The most important farm implements found on the farms of the Benghazi Plain are ploughs, carts and dalus, and other implements which are generally worked by a draught animal or in some cases by humans such as the human-bucket for irrigation. The number of implements is usually limited and when they are worn out, they are not replaced by new ones as soon as they ought to be. As was stated earlier, almost every farm (except in the coastal sand dune areas) has one or more

wooden or iron plough. The wooden plough is usually used in the light soils, whereas the iron plough (Mihrath suri) is used in the hard clayey terra rossa. Modern disc ploughs are found only on the commercial farms and on some farms in the shifting cultivation areas, where tractors are usually found. The average cost of a wooden plough is £L.1.50, whereas the iron plough is £L.2.50 and the modern disc plough is about £L.416.70.

According to the 225 farms surveyed, ploughs represented about 48.9 per cent of the total value of farm implements or about 6.5 per cent of the total value of farm equipment (Table 10.19). Each farm of the 225 farms surveyed had about £L.30.0 worth of ploughs. If, however, the value of the 12 disc ploughs which are found at Benina is excluded from the total, the average value would be about £L.5.50 per farm, which is quite reasonable for the majority of the farms in the Benghazi Plain.

Farm fencing in the Benghazi Plain is usually constructed by piling stones in embankments around the limits of the gardens and small farms, particularly near or around the villages and settled areas. Modern fencing by means of barbed wire and iron posts was not common among farmers until it was initiated by L.A.J.A.S. in 1956. Their use did not spread until the government started selling them at subsidised prices in 1965. For instance, a quintal of barbed wire costs £L.3 in the government warehouses, while in private stores it costs

about £L.5. Pillars cost £L.0.10 each at the government stores while in private shops they cost £L.0.25 each. However, the 225 farms surveyed consumed about 1,103 qtls. of barbed wire in 1967. The average value of fencing including posts^{*} was about £L.19.60 per farm (Table 10.19). The farms or fields in the shifting cultivation areas are entirely unfenced, due to the communal or tribal ownership. In general, the average fencing value in the farms surveyed comprised about 31.8 per cent of the total value of implements or 4.2 per cent of the total value of farm equipment (Table 10.19).

Carts are considered very important farm implements in the farms around Benghazi, where they are used to carry farm products to market. Thus, about 7.29 per cent of the carts in the farms surveyed were found around Benghazi (Table 10.20).

Table 10.20 shows also that there were no carts in the farms surveyed of Sidi Khalifa, Deriana, Tokra and Tolmeita due to their remoteness from Benghazi market on one hand and the difficulty of crossing the forest land in the north and the Karst topography in El Kweifya on the other. In addition, almost all these farms are located on or near the main coastal dual-carriageway, which links them with Benghazi by a good service of truck and taxi transportation.

The value of carts per farm in the farms surveyed comprised about 19.3 per cent of the total value of implements

^{*} Each quintal of barbed wire needs 10 posts, thus the quintal of fenced barbed wire costs £L.4 plus labour.

or 2.5 per cent of the total value of the farm equipment. The average cost of a cart was £L.86.00. The value of implements, however, varied considerably; the lowest percentage value was found in the relatively poor Mudiryas of Tolmeita (0.3 per cent), Jardina (0.8 per cent) and Sidi Khalifa (1.9 per cent), whilst the highest percentage value was found in the commercial farms of Benina (39.2 per cent) and El Gwarsha (10.8 per cent).

Each farm in the coastal sand dune area and in the dalu-animal irrigation farms consumes about 2 to 3 dalus a year, because these dalus are mainly made of old rubber tyres and they are easily worn out and have to be replaced immediately because the crops cannot stand for a long time without irrigation, particularly when irrigation is done intensively during the spring and summer seasons. The average cost of a small dalu is about £L.0.60 for irrigation by human power, while the animal-dalu cost about £L.1.50 to 2.00 each.

Other minor implements such as ropes, sacks, harnesses, and nets have a small value in most of the Benghazi Plain, and most of the farmers interviewed did not know even their number or value.

10.2.2.3 - Farm Hand Tools

Since much of the work on farms is performed by manual labour, naturally all farms must have the necessary farming hand tools. Except in the well developed farms, on almost all the surveyed farms, the hand tools (i.e. sickles, shovels,

spades, axes, rakes, hoes, pails, etc.) were very simple and primitive. Most of them were worn out, and they are rarely replaced by new ones. This, of course, reduces the labourer's efficiency and increases exertion. Thanks to the L.A.J.A.S., who started distributing modern hand tools to some farmers free of charge in 1956, many farmers have realised the difference between the two types of hand tools, and thus many of them have started using modern ones in their farms. Modern hand tools are designed and shaped to fit the build of the labourers to perform the job most effectively, in order to increase significantly labour efficiency without much fatigue.

The average number of hand tools per farm in the areas surveyed was about 7.4, with a value of about £L.4.44 (Table 10.21). In general, in the shifting cultivation and dry areas and in the poor irrigated farms, hand tools are few and in bad condition. For example, in En-Nawaghia, where most of the agricultural activity is shifting cultivation, the average number of hand tools was 0.6 units per farm and worth £L.0.90, whilst in the commercial farms at Benina and El Fweihat, the average number of hand tools per farm were 73 and 19.6 respectively, worth on average £L.43.07 and £L.11.57 respectively (Table 10.21).

In conclusion, it may be said that, since mechanisation increases productivity and makes agricultural products cheaper, particularly in the Benghazi Plain where agriculture

is suffering from the high cost and scarcity of farm labour, therefore, mechanisation is necessary for agricultural development in the area under consideration in particular and Libya in general. Hence farmers must use increasingly more farm machinery, particularly since many crops such as tomatoes, carrots, onions, grapes, potatoes, etc. can be planted and harvested by machinery. The feeding and care of animals on farms can also be mechanised in the Benghazi Plain, as it has been already done in other developing countries.

Although mechanised agriculture faces the problem of a lack of well trained operators (which reduces the potential of the machinery and raises the cost of maintenance), this problem could be overcome by opening new efficient training centres for tractor and other machinery drivers. In addition more specific studies are needed in order to discover which machinery is most suitable to the local environment. This could be achieved by sending trained drivers or students abroad for higher specialisation in machinery.

PART IV

CHAPTER 11

RURAL SETTLEMENT PATTERNS

The rural population of the Benghazi Plain cannot be fully understood unless the tribal structure and distribution are analysed, because the ethnic groups and sub-groups are the major power behind the economic and cultural development of the area under consideration. Therefore a brief account of the tribal and sub-tribal divisions would be useful.

11.1 - The tribes of the Benghazi Plain

The history of the tribes of the Benghazi Plain and Cyrenaica as a whole goes back to the end of the 7th century A.D. when Arab Moslems from Arabia conquered Cyrenaica. But the most influential group of Arab invaders who affected the whole country and imprinted the area with their cultural, social and economic characteristics were the Beni Suleim who came, after the Beni Hilal, from Najd (in Arabia) to upper

Egypt and then to North Africa during the end of the 11th century.⁽¹⁾ The Beni Hilal resided mostly in Tripolitania and Tunisia, while the Beni Suleim settled in Cyrenaica. The leader of the Beni Suleim was Ed-Dib (Abu-El-Lail),* who is believed to be the founder of the Saadi (sing. Sadi) tribes, the most important and numerous tribes in Cyrenaica.

However, three main groups comprise the people of Cyrenaica today: the Saadi tribes, the Murabteen tribes and Arab El Gharb (Arabs from the west).

1. The Saadi of Cyrenaica (the so-called free tribes) are divided into two main groups: the Jibarna and the Harabi. Each one of these groups is divided into tribes and sub-tribes as shown in Fig.11.1.

The two main groups of Saadi divided Cyrenaica between themselves; the Jibarna tribes occupied western Cyrenaica (including most of the Benghazi Plain) and the Harabi occupied the eastern part. The boundary between these two big tribes runs from the mouth of Wadi Jbela on the Mediterranean coast, about 15 km. east of Tokra, in the north to Wadi Samalous in the south (see Fig.11.2). Thus, the Benghazi Plain from Wadi Jbela westward is occupied by the Jibarna tribes (Awaghir and Araibat) and eastward by the Harabi tribes (mainly Ed-Dersa).

* His descendants are not named after him, but after Saada, his wife, the daughter of the leader of the Berber tribe, Zenata, who used to dominate northern Cyrenaica before the Beni Suleim.

The growth rate of the tribes of the Benghazi Plain was not, however, equal for some tribes have increased enormously while others have increased only very slightly or remained stagnant in number.⁽²⁾ As a result of this, some tribes and sub-tribes are divided into many units while other have very limited units. Genealogically speaking, it is very difficult to classify these tribes and therefore they are arranged into a secondary order which is called Beit (Pl. Beyout = households) and into a tertiary order called Aila (Pl. Ailat = Families).

2. The Murabteen people are clients of the Saadi tribes (the free tribes). As the Saadi hold the country by right of conquest, the Murabteen use the land and water by the grace (Bil Ehsan) of the Saadi tribes.

There is much debate about the origin of the Murabteen. Ziadah⁽³⁾ believes that the Murabteen Bil Barka (Sharifs) are the remaining tribes of the first Arab conquest, while the other Murabteen (see below) are the descendants of the Berbers who lived in the area before the Moslem invasion, after which they adopted the Islamic religion and the Arabic culture. Al Ash-Hab⁽⁴⁾ claims that the Murabteen are segments of Arab tribes who came with the Beni Hilal and Beni Suleim. The first opinion, however, is more feasible.

The Murabteen tribes are divided into two main groups:

(i) Murabteen Shurfa and (ii) Murabteen Aadiyeen.

(i) The Murabteen Shurfa (sing. Sharif) are also sub-divided

into two sub-groups: the Murabteen Bil Barka (clients of goodness) and the Murabteen Sadaga (clients of charity).

These Murabteen claim that they are the descendants of the prophet Mohammed. Since they are credited with divine goodness, they are respected by the Bedu who consider them to be holy men and use them to perform religious rites. In the past, they often acted as peace makers in disputes between the tribes and sub-tribes of the Saadi, particularly when two tribes quarreled over the ownership of a piece of land or a well. In most cases the dispute was ended by the Murabteen tribes taking the land to act as a barrier between the disputing tribes (tribal problems will be discussed later in this chapter). That is why one finds a Murabteen tribe occupying a piece of land between two tribes or sub-tribes of the Saadi, such as El Msamir between El-Awaghir and El Urfa (Fig.11.2). This group of Murabteen did not use to pay fees to or perform services for the Saadi. In fact, they receive help and assistance instead. The other group of sharifs, is the Murabteen Sadaga, who used to pay Sadaga or fees to the free tribes for their protection and for the privilege of using the land and water. Although some of these Murabteen, e.g. El Fwakhir, are attached to the Saadi tribes, they live independently and have no obligations toward the Saadi, because they have their own land and water (see tribal disputes).

(ii) The Murabteen Aadiyeen (common) consist of two sub-groups

(a) the Murabteen Bil Aasa (stick servants) and (b) Murabteen

Zabbala (rubbish collectors = servants).

These two sub-groups of Murabteen have no sacred association but they once paid fees whilst some were even forced to perform services for the Saadi for their protection and the usufruct of the land and water. Some sections of these Murabteen such as El Awamma, Dinal and El Gutaan have, even today, an inferior social status. However, since independence the differences in social status between the Saadi tribes and the Murabteen have been greatly lessened and in some parts disappeared completely. At present all the Murabteen tribes are considered free, pay no fees and perform no services despite the fact that they live on Saadi land. Nonetheless, they have no right of ownership unless they have acquired it legally (according to the tribal tradition) like El Fwakhir, El Huta, El Gutaan and El Ashaibat did, by either the right of purchase or recognition by the Saadi tribes. Such recognition came after the Murabteen tribe had participated side by side with the Saadi in their wars against other tribes, such as the war of El Awaghir-El Mugharba against the invasion of the Arab El Gharb (Tripolitarians) who came to expel the Saadi tribes from Cyrenaica to Egypt in the second half of the 19th century.⁽⁵⁾

3. Arab El Gharb. These groups of the rural population originally came from Tripolitania, mostly as mercenaries to help the Saadi in their war against the Awlad Ali, in the second half of the 18th century and before their war with

El Awaghir and El Mugharba. After the war was over, these sedentary farmers resided mainly in the irrigated areas in the main villages, town and cities (about 70 per cent of the people of Benghazi City are of these groups), where they could find farm work, particularly of the mugharsa type of farming (see Chapter 10) such as is found in El Gwarsha, Gamines, El Fweihat, Tokra and Tolmeita. In addition to these sedentary people, there are some tribes of semi-nomads, who came also from Tripolitania, and are found among the Bedu tribes of the Benghazi Plain, e.g. the Furjan, Awlad Esh-Sheikh, Fwatir and Amaim (Fig.11.2).

The present-day distribution of the tribes in the Benghazi Plain resulted from the long process of tribal conflicts and unrest, after which they decided to live in peace and divide the land amongst them. This occurred about 200 years ago in the so-called Touch Year (see Chapter 9).

11.2 - Tribal Problems in relation to the land use

Disputes and conflicts between two different tribes as well as between members of the same tribe over a piece of land, well, boundary or animal trespassing over standing crops are common phenomena among the Bedu people. Minor disputes among the members of the same tribe are usually solved locally by the sheikhs of the tribe. Serious problems which cannot be settled locally are usually solved through "The Committees for Settlement of Disputes over Tribal Land." The Committees are not, however, obliged to follow the Civil Law in their

judgments, but in most cases, they have to observe the traditional rules and customs of land and water rights. It has been said that the Committee's decisions are sometimes unjust, because their members are easily influenced by various means.⁽⁶⁾

In the past (prior to the Italian occupation) disputes over ownership of land and wells led to bloodshed. For example, the area between Wadi Jbela and Sidi Abdalla, west of Tolmeita (the homeland of the Esh-Shilman sub-tribe of Ed-Dersa) was inhabited by the Urfa tribe. About 150 years ago a tribal war broke out between the Ed-Dersa and El Urfa tribes. The latter tribe was defeated and pushed out to its present territory (Fig.11.3), but the Urfa people still claim ownership of this part and at every opportunity ask for its restoration, as few of the El Urfa tribe were allowed to return to their land after the peace between these tribes was restored. During my field investigation, I was told that some of the Et-Tursh people (Urfa tribe), in order to sabotage the recent N.A.S.A. development scheme in Butraba, cracked the surface of the newly constructed coastal road which links Tolmeita with Tokra and Benghazi for about 15 km. The government authority does not know about this incident, and most people think that it was caused by the heavy rains of 1966-67, and the heavy trucks which carried the sea-sand from this area to the new town of El Marj. According to tribal tradition, the Ed-Dersa tribe cannot complain, because the

damage occurred outside their territory. Another example of an unsettled dispute causing serious concern is between the El Fwakhir and El Awaghir in the Es-Silg area (Fig.11.3). The Fwakhir acquired this land by recognition of the Awaghir as a result of assistance given to the latter in their wars, and the Fwakhir possess an official document signed by the Turkish authority confirming their claim to this land.⁽⁷⁾ Yet the El Awaghir (Ailat Ali section of Brahim) today deny this claim and instead insist that the Es-Silg is their land. This recent interest (since independence) is related to its importance as some of the best agricultural land (shifting cultivation) of Barga El Hamra (see Chapter 4). The other important disputed area is the land of Benina Airport which is argued over by the Government and the tribes (see Chapter 9).

The land on which the El Ghazalat tribe (Zuwaya) live in the south of Bersis is claimed by the surrounding tribes. No details were released to the author concerning this problem, and, in fact, the existence of the El Ghazalat tribe in this area is denied by these tribes.

However, the above-mentioned areas are but a few examples of many areas in dispute, since it is the custom of the tribes to keep their disputes secret as they do not wish any one, especially government authorities, to know about their conflicts. If, moreover, any person tries to involve himself too deeply in the tribal disputes, especially if he is an outsider, he will be suspected and probably find

himself in endless trouble.

11.3 - Rural population patterns

A comprehensive study of the rural population patterns in the Benghazi Plain is not possible at present, owing mainly to the lack of information concerning the number of villages, hamlets, farmhouses and tents, as well as the number of people dwelling in each place. The only available information is a rough estimation of the settlements in the main villages or the seat of each Mudiyya, which was conducted during the author's field survey in 1967. The settlements outside these villages were calculated from the topographic map of Libya scale 1 : 50,000, and tabulated together in Tables 11.1, 11.2, 11.3, 11.4 and Figs. 11.4, 11.5 and 11.6. The censuses and official statistics regard the Mudiyya (parish) as a pattern unit. Consequently, the rural population patterns will be treated briefly within the limits of the available information, thenceforth they will be treated according to the Mudiyya as a pattern unit.

According to the 1967 field survey, 5 main patterns of rural population were identified:

1. Large villages

- (a) Large villages in the irrigated areas
- (b) Large villages in the shifting and dry farming areas

2. Small villages

- (a) Small villages in the irrigated areas

- (b) Small villages in the shifting and dry farming areas

3. Hamlets

4. Farmhouses

- (a) Indigenous farmhouses

- (b) Italian (Ex-ENTE) farmhouses

5. Tent Camps

- (a) Spring camps

- (b) Summer camps

1. The large villages are those villages which have a population of more than 1,000 persons (Fig.11.4). These villages are usually the seats of the Mudiryas (Slug is also the seat of sub-Mutasarrifya). Two types of large village population patterns are distinguished:

(a) Large villages located in the irrigated areas, such as Tokra, Sidi Khalifa, El Kweifya, El Gwarsha and Gamines.

(b) Large villages located in the shifting and dry farming areas such as Tolmeita, Benina, Jardina and Slug.

2. The small villages are those villages with a population of less than 1,000 people and more than 100. These villages consist also of two patterns:

(a) Small villages found in the irrigated areas like Bersis, Bujarrar, El Mabni, Deriana, El Thama, Gar Yunes, El Faakat, ~~Bu-Fakhra~~ and Er-Ragta.

(b) Small villages found in the shifting and dry cultivation areas like En-Nawaghia, Ganfuda, Et-Tarria, Et-Tailamun and El Magrun.

3. Hamlets are settlements which usually have a population of less than 100 persons and more than 20. These hamlets are generally clusters of houses and shacks found in remote areas, particularly in between the villages such as Ardanu, Tansalukh, Swani Osman, Budrisa, Ed-Dweisia, Bussufon, Karkura and Shat El Bedin.

4. Farmhouses in the Benghazi Plain usually contain between 4 and 18 persons. They consist of two patterns:

(a) The ex-ENTE farmhouses which are found in Butraba, west of Tolmeita, and each contained an average of 5.5 persons in 1967.

(b) The indigenous farmhouses which are found mainly in the shifting and dry farming areas in the hinterland of the plain, notably southward of Sidi Khalifa. Some scattered houses of this pattern are found also along the coastal belt.

5. Tents are found everywhere and they are usually found either scattered or in camps.

(a) During the spring season, tents are mostly found in camps, consisting of an average of 10 to 30 tents, with a population ranging from 50 to 250 persons. Such camps are found mainly in Barga El Hamra.

(b) During the rest of the year these camps dissolve and one, two or three tents stay together near wells, cisterns, around the villages or near the main roads. Some individuals who own lands in the coastal sand dunes camp near the coast, particularly during the summer season, to collect their date,

grape and fig fruits.

The dispersed tents, huts and shacks, usually contain between 2 and 8 persons each. It is worth mentioning, however, that tents, shacks and huts in the forest areas in the northern part of the plain are usually found in one, two or three units only because the density of the forest land does not allow the establishment of big camps like those in the steppe land or Barga El Hamra.

From the above brief description of the rural population patterns, one may deduce that the present patterns of rural population and their distribution (Fig.11.4) resulted from physical features, i.e. the availability of underground water and rainfall, as well as human influence. The Bedu, for instance, as pastoralists thrive in areas outside the irrigated farming areas, whereas the sedentary farmers are concentrated in areas where underground water is fresh and the soils are relatively good.

According to the 1954 Census of Population, the rural people numbered 51,043, whilst in the 1964 Census they reached 64,841 persons. In the 1967 survey they were estimated at about 66,398 (Table 11.1).

The distribution of the rural population in the Benghazi Plain by Mudiryas, in 1954 '64 and '67, is shown in Table 11.1. The overall pattern shows that the population is adjusted to the land from which it derived its livelihood, in a subsistence economy. Thus one finds that about 57.6 per cent of

the rural people live in about 20.8 per cent of the total area of the Benghazi Plain, where underground water is available and rainfall is more abundant than in the south where the rainfall is erratic and the underground water is scarce. Here only 42.4 per cent of the people live in an area almost four times as big as the previous one. In addition to this, the distribution of the rural population varies from Mudirya to Mudirya, in accordance to the above-mentioned limiting factors. For example, El Magrun and Slug Mudiryas, with about 52.6 per cent of the total area of the Benghazi Plain contain only 27.3 per cent of the rural population or 8 per cent of the people of the Benghazi Plain; whilst Benina, with about 5.4 per cent of the total area contains about 13 per cent of the rural population.

The rural population density in the Benghazi Plain in general, is influenced by several factors of which the availability of water is the most important; in fact, it was the critical factor in determining the existence of these settlements. Although rainfall is an important physical factor in determining the distribution and density of the rural people in most of the arid and semi-arid zones in the Benghazi Plain, it controls (more or less) the movement of the Bedu people rather than their distribution and density.

The density in El Magrun and En-Nawaghia is very low being between 1 to 5 persons per square kilometre (Fig.11.5). Although El Gwarsha has greater annual average of rainfall

than Slug it has the same density of 5 to 10 persons per km^2 , because most of El Gwarsha is composed of lithosols and rock outcrops (Fig.4.1). Gamines, with numerous small gardens, but poor soil and water, has a density almost equal to that of Jardina with mainly shifting and dry farming practices, both being 10 to 15 persons per km^2 . El Kweifya and Sidi Khalifa have densities of 15 to 20 persons per km^2 . while Benina has 25-30. Despite its favourable position El Kweifya has a lower density than Benina in the south because Benina has an important function as the main airport of all Cyrenaica, in addition to the availability of a large quantity of good quality underground water. Sidi Khalifa has a density (15-20) lower than its neighbour Deriana which has a density of 20 to 30 persons per km^2 , mainly because of the prevalence of lithosols, consolidated sand dunes and rock outcrop. Tolmeita has the highest density of 45 to 50 persons per km^2 in the rural area of the Benghazi Plain, due not only to its favourable climatic conditions, but to the lack of sparsely inhabited areas.

Although Benghazi City is beyond the area under consideration it is worth mentioning, as the centre not only of Benghazi but for Cyrenaica as a whole; it has an urban density of about 5,264 persons per km^2 (Fig.11.5).

In order to cross check the density of the rural population in the area under consideration, the co-efficient of dispersion formula⁽⁸⁾ $C = \frac{E \times N}{T}$ is applied and the result

is tabulated in Table 11.3 and depicted in Fig.11.6. The patterns are much the same as those of the rural population density, but the co-efficient of dispersion gave a slightly more accurate picture of the rural population distribution.

The changes of the rural population have been tabulated in Table 11.1 and mapped in Figs.11.7 and 11.8 for the 10 years between the 1954 and 1964 Population Censuses, and the 3 years between the 1964 Census and the 1967 survey.

The rates of population increase for the Benghazi Plain in the two periods have been extremely varied. In the first period the total population of Benghazi Plain increased by about 72 per cent and in the second period by about 10.9 per cent, whilst the rural population for the same periods increased by 27 and 2.4 per cent respectively (Table 11.1). The Mudiryas of Benina, Tokra, Deriana, Sidi Khalifa and to a lesser degree, Tolmeita, Sidi Khalifa, En-Nawaghia, Slug and El Gwarsha have experienced substantial average annual increases varying from 0.6 to 12.0 per cent, whilst El Magrun and Gamines have inversely experienced a decrease of 4.8 and 0.06 per cent respectively (Fig.11.7 and Table 11.1). The rural population changes in the second period were in general slight, but they varied from Mudirya to Mudirya, with a general tendency to decrease in Barga El Hamra and increase in the Es-Sahel (Fig.11.8). Four of the 13 Mudiryas have experienced population decline: En-Nawaghia (26.4 per cent per annum), El Gwarsha (5.4 per cent), El Magrun (1.6 per

cent) and Jardina (1.7 per cent) (Table 11.1). Slug, El Kweifya, Deriana and Tokra have experienced a very slight annual increase of 0.9, 2.4, 1.8 and 1.8 per cent respectively. Benina, Gamines, Sidi Khalifa and Tolmeita have experienced a relatively higher rate of annual increase, being 7.0, 2.7, 3.3 and 3.0 per cent respectively. Although Jardina's population increased from 1965 to 1967 by about 4.4 per cent it decreased between the 1964 Census and 1967 survey, by about 4.9 per cent. This is due, however, to migration of the people on one hand and the transfer of people to En-Nawaghia Mudirya after it was separated at the beginning of 1967. En-Nawaghia with the same "push" factors, has experienced a drastic decrease of about 26.4 per cent from 1964-67. The increase of 18.7 per cent in the population of En-Nawaghia between 1966-67 was due only to the transferred registrations of the people from Jardina to En-Nawaghia. However, after the implementation of the proposed land settlement project and the development of the agricultural land in this area, the population will undoubtedly increase or at least keep pace with its natural increase.

The relatively high rate of increase in the population of Tolmeita in the second period is credited to the recent agricultural development (undertaken mainly by N.A.S.A.) in this area. The population of El Gwarsha increased by over 9.7 per cent during 1964-66 while it decreased by about 18.2 per cent from 1966-67 despite the extensive industrial

development which has taken place in recent years.

The decline in the population of El Gwarsha is accounted for by its proximity to Benghazi City, where wages are higher and more opportunities for non-agricultural work are available.

11.4 - Rural Population Movement

11.4.1.- Migration

The process of migration from rural to urban areas is a common international phenomenon. The main motivation for this phenomenon is the desire of the rural people for better earnings and consequently a better standard of living. Thus many rural people migrate either permanently or temporarily to the big cities of Benghazi and El Beida or the big towns of El Marj and Ejdabya as well as to the oil fields and petroleum terminals, where the chance of more profitable employment is available and secured. The young people of Tolmeita Mudiya before 1960 usually migrated to El Marj town for governmental jobs but in recent years the bulk of emigrants went to Benghazi and El Beida cities. The young people of El Magrun Mudiya used to go to Benghazi, but since petroleum was discovered in Ejdabya district in 1964, most of the young emigrants have gone to Ejdabya and El Brega and Ez-Zweitina petroleum terminals.

Unfortunately no information exists on a village-to-village or even Mudiya-to-Mudiya basis which will enable a reasonable account of these dynamic trends to be detailed. Complete and precise statistics, such as the registration of

births, deaths and change of residence, exist only in Benghazi City (Appendix Table 11.1). This is due to the fact that the Bedu usually do not register births and deaths or their departures or arrivals. Thus, it is very difficult if not impossible to assess accurately the amount of migration from the rural to the urban areas of the Benghazi Plain. Nevertheless, Benghazi City gained 6,159 net immigrants between 1964-1967 of which at least 60 per cent were from the rural area of the Benghazi Plain. According to the 1967 survey, the rural area lost about 1,165⁽⁹⁾ persons between 1964-67 (Table 11.4). Migration outside the Benghazi Plain is very small, affecting only very few Mudiryas (Appendix Table 11.1).

Migration from the rural areas to Benghazi City has in some places upset agricultural production and created farm labour deficiency while multiplying the shanty dwellings near Benghazi as well. The exodus from the sedentary of irrigated areas must be stopped or at least slowed, whereas an exodus from the shifting and dry farming areas to urban areas (nomads and semi-nomads) inversely ought to be encouraged. The latter trend will, undoubtedly, help to provide a labour force (at present semi-skilled labourers are mostly imported from abroad) for the urban area, on the one hand and to settle down the nomads and semi-nomads on the other.

To conclude, it may be said that, under the present circumstances, rural depopulation will continue. The present

trends cannot be reversed immediately, but if no attempt is made to introduce stability into the area under consideration, the already considerable economic and social problems will continue, in most parts, to get worse.

Despite rural depopulation agricultural production has continued to rise. This, however, is attributed mainly to the application of better farming methods and agrotechniques.

11.4.2 - Transhumance

Due to the tradition and way of life of the Bedu of Cyrenaica, which is well suited to the local environment, nomadism has retained much greater importance than transhumance. Nonetheless, transhumance, on a smaller scale, does exist in some parts of the Benghazi Plain.

A number of villagers and Bedu people* try to combine the advantage of cultivating and grazing on both the mountain and the plain areas and have acquired rights or owned lands in both areas. There is also another type of Bedu farmer who practises shifting cultivation and grazing in the plain in most of the year and irrigated farming on the coastal sand dune areas in summer (Fig.11.9).

The movement of the farmers from the mountains usually starts at the beginning of October in the southern part of the plain and at the beginning of December in the northern part. For example, the El Abadla, El Huta and some of the El Urfa who live in the mountain area descend to the plain in the Tokra area, accompanied by their families and animals, after

*No data are available to show the number of people or animals who move up and down from the plain to the mountain.

they have sown their grain. In the plain, they sow some grain and graze their animals. After finishing the harvest in the plain, which is usually ready 20 to 40 days before that of the mountains, the men ascend the mountains to harvest their homeland corn. After the harvest is completed, their families and animals join them to enjoy the fresh and healthier weather, and the animals graze on the harvested fields and grasses which last longer than on the plain. Some of the El Urfa and Ed-Dersa in the area between Tokra and Tolmeita go up the mountain to the Farzugha and El Marj areas respectively to sow their grain, and leave their families to graze the animals in the plain. In summer, after the harvest in the plain is completed, they climb the mountain with their families and animals to harvest their grain and graze their animals during most of the summer.

In the southern part of the plain or Barga El Hamra, some of the El Fsaiyat, Saati and Fwaris graze their animals on the mountain around Er-Rajma during the summer season particularly after the grass has withered on the plain. Some of the El-Fwakhir and El Ashaibat descend the mountain to the Es-Silg area east of Slug to cultivate and graze their animals from about October or November to the end of the spring. After the harvest is completed and the grass has withered they either go up the mountain or remain around their cisterns and feed their animals on hay and shrubby and perennial herbaceous plants.

The Bedu of the southern part of the plain (semi-nomads) who possess land in the coastal area, spend most of the year grazing their animals in the hinterland and at the beginning of summer they return to their swani (gardens); the El Bedin people go to Shat El Bedin, the Mshait to Karkura and Fwaris to El Murra, to grow some vegetables and pick dates, figs and grapes, mostly for their consumption and for animal fodder. Although these Bedu are closer to sedentary conditions than the other Bedu people in the surrounding area, who practise shifting cultivation and grazing in the semi-desert area, yet they are considered as semi-nomads, simply because they have no fixed residence.

Whilst the women and children remain with the animals, the men of the Zeid and El Khashmi sub-tribes (Fig.11.2) who practise shifting cultivation and grazing south-east of Deriana during the summer, move to Aseila in north-east Deriana to grow some vegetables, mainly tomatoes from which Aseila has derived its fame. Afterwards they sell their products and return to their own areas to resume their previous activities.

It is worth mentioning that some people of Benghazi City, particularly prior to independence, used to hire labourers to sow and harvest their grain and during the harvesting period in spring, they moved with their families to supervise the harvest on the one hand and to enjoy the fresh air of the country on the other. The area sown by Benghazi people is private land mostly around El Haw-Wari, El Gwarsha and in the

north of En-Nawaghia.

However, transhumance in the Benghazi Plain will retain its present trend as long as the Bedu system and way of life prevail.

11.5 - Types of Settlement

As the distribution of rural population (Fig.11.4) shows, in most parts of the Benghazi Plain people usually live in dispersed settlements consisting mainly of a single household. In other areas, notably near the coastal strip, large villages, small villages and hamlets are common. The overall distribution of villages and settlements in the region emphasises the fact that water supply is the major factor impelling settlements to concentrate largely along the coastal strip (Fig.11.10) where underground water is available and wells offer reasonable supplies.

Three factors militate against the production of an accurate and detailed map of the rural settlement distribution in the area under consideration. First there is lack of complete and accurate data; secondly, the lack of complete statistics, and, thirdly, the absence of large or even small scale maps of the land use and settlement, with which one can work. Aerial photographs of 1 : 5,000 scale are confined to the use of the N.A.S.A. offices only. Nevertheless, a tentative map of the settlement distribution has been produced. The topographic map of 1 : 50,000 scale was used as a base map for this purpose. All information and data concerning the

number of houses, tents, shacks and caves which were collected during the field work were depicted on the base map on the spot and then it was reduced to the scale of 1 : 250,000, the scale of the thesis map (Fig.11.10). The sites of the tents and tent camps are approximate and represent the years 1966-67.

According to Fig.11.10, the Benghazi Plain on the whole is an area of dispersed farms, served by a few villages and hamlets, most of which are declining even further in function. The interior of the plain represents a different settlement type with isolated shepherd tents and shacks or tent camps.

Despite the limited data on the settlement types one may distinguish the following categories:

1. Villages
2. Hamlets
3. Houses
4. Tents
5. Shacks and Huts
6. Caves

11.5.1 - Villages. The number, size and distribution of villages in the Benghazi Plain is determined largely by the availability of large quantities of good quality underground water. Other factors such as history, religion, tribal practices, regional location and the social planning and the development of modern communication appear to be of little importance. In general, the villages, with regard to their

size and function, can be classified into two main groups; (a) large villages and (b) small villages.

According to the 1967 survey there are about 6 large villages; Benina, El Gwarsha, Tokra, Tolmeita, Slug and Gamines. Until recently (before the petroleum discovery) most of the large villages were self-supporting, possessing craftsmen and others who attended to the everyday needs of the surrounding areas, and were based on agriculture which produced enough food, in normal years, to support the whole community. As communications improved, food of many varieties and agricultural equipment, imported from Benghazi at lower cost, loosened the strong link between these villages and their hinterland, and gradually the self-supporting villages and their hinterlands declined. For example, Slug, with about 120 shops for merchandise and handicrafts, served the whole community of the Mudirya and its surrounding area. At present (1967) it has lost its commercial position, more than half of the shops are closed, and most of the people depend on Benghazi market for their needs. This situation has deteriorated, particularly since the construction of the new road which links Slug with Benghazi, and because of the recent spread of truck transportation between the hinterland and Benghazi City. Benina village acquired its importance primarily as an air transport centre serving not only the Benghazi Plain, but Cyrenaica as a whole, but in addition Benina possesses huge underground reservoirs of good quality

water which provides the main supply for Benghazi City as well as the richest and most modern agricultural area in the whole of Cyrenaica.

Tolmeita and Tokra are important since they grew as compact settlements (like Slug and Benina) around ancient Roman and Greek ruins which made them, in addition to their agricultural importance, tourist attractions (Plate 11.1), while they also provided market places for the surrounding Bedu.

Gamines is almost the biggest settlement in the coastal area between Benghazi and Ejdabya. Its main importance lies in its location on both sides of the coastal highway leading from Benghazi to Tripoli and on both sides of the rural paved road which leads to Slug (Fig.11.14). In addition, there are nearby rural clusters cultivated mainly with irrigated vegetables and fruit trees. The diversion of the new coastal dual carriageway to the east of the settlement will probably affect the future growth of the settlement, and a new residential area, with shops, cafes and petrol stations, will be established near the new road.

El Gwarsha village is indebted for its fame to its location near Benghazi on the one hand and some of the best agricultural land in the Benghazi Plain. It consists of several clusters extending from north to south on both sides of the road (street village). El Gwarsha village is considered one of the oldest agricultural regions in the Benghazi

Plain and sedentary life was, and still is, its main characteristic. Thus, it is considered the only rural area of the Benghazi Plain which is not dominated by tribal people (Bedu). In recent years industry has also found its way in to El Gwarsha and consequently many factories have been established, mainly around and nearby the village.

The above-mentioned villages, in addition to their agricultural and economic position, are the seats of their Mudiryas, except Slug which is the seat of Benghazi Sub-Mutasarrifya as well.

The small villages are clustered but not compact, and appear to be more numerous (approximately 18). Most are located in areas where underground water is found in smaller quantity and is almost brackish, on which dry and partly irrigated farming is practised. Some of these villages (such as En-Nawaghia and to some degree Jardina) owe their existence to the railway development, while others (such as Sidi Khalifa, El Magrun and Jardina) were founded around shrines of Murabteen (Saints), or for religious purposes such as the Islamic School (Sanussi Zawiya) of Et-Tailamun. Moreover, some of these villages, e.g. Sidi Khalifa, Deriana, El Kweifya, En-Nawaghia, Jardina and El Magrun, are considered the seats of their Mudiryas.

The Ex-ENTE village of Jedida at Butraba was built by the Italians to serve the Arab farmers in the demographic farms of Butraba. The Mosque (in the other Italian demo-

graphic villages it is the church) is the most conspicuous structure in the settlement. This village, however, has not been functioning at all, because the Italians were not able to complete it before the outbreak of the Second World War. This settlement contains very few shacks and tents and some of the buildings are utilised as animal shelters.

11.5.2 - Hamlets. Hamlets are few and mostly consist of small clusters of stone-built houses, shacks, huts and tents, and usually contain between 4 and 10 units each. They are found mostly at about 10 to 40 km. intervals from the villages. They are located mainly in less important agricultural areas, where underground water is scarce or salty and most of the agricultural activity is carried on under the dry farming system and animal husbandry. Others are located in limited agricultural areas, i.e. areas surrounded by lithosols, rock outcrops, sand dunes, seabkh or forest. Examples of the above-mentioned hamlets are: Ardanu in the east of Tokra, Tanslukh in the north-east of Deriana, Bu-Dhisa in the north-west of Jardina, Karkura and Shat El Bedin.

11.5.3 - Houses. Most of the permanent settlements outside the villages and hamlets are dispersed and found mainly near wells and cisterns. Owing to the scarcity of water resources, rural houses are very rare in the hinterland of the Benghazi Plain. According to the 1967 survey they accounted for only 8.8 per cent of all settlement types (Table 11.5).

In general, however, there are three types of houses in

the rural area of the Benghazi Plain: (i) The arab rural house (Housh), (ii) The Popular houses (Shaabiya) and (iii) the Ex-ENTE farmhouses.

(i) Hoosh - The traditional rural house is designed in general to offer shelter for both humans and livestock, house implements, and provide storage for produce. Many houses, particularly outside the villages, are in a bad condition and offer the minimum of shelter and comfort.

The rural house is generally square or rectangular, with two or more rooms opening onto an uncovered courtyard which is exposed to the weather (Fig.11.11). Relatively large, covering an area of about 400 m^2 , it has a flat roof usually covered with palm tree pillars and tree branches with a layer of clay or cement to make it waterproof. The floor is not paved or tiled and is simply beaten earth. Nearly every housh contains a well in the yard, as well as a kitchen, oven and W.C. The latter two, in some cases, are found outside the house. In general, however, there is very little comfort in a rural home; lack of water and drainage systems make sanitation difficult. Cooking and laundering often take place in the open air. Moreover, animals turn the courtyard into heaps of manure, dirt and slush, causing many diseases.

(ii) Popular Houses - The popular houses (Shaabiya) in the rural area are found in almost every large and important village in the Benghazi Plain (Table 11.1). They form groups of 25 or 50 houses, each unit including 5 detached houses

(Plate 11.2). They are designed to give a combination of both the traditional type of house with an open courtyard in the back, and the modern villa type with covered rooms and corridors and windows opening outside the house (Fig.11.12 and Plate 11.2). Each house consists of three bedrooms, kitchen, bathroom, W.C., corridor and backyard, and is provided with electricity and water taps, even in areas where these public utilities have not been installed yet. Although these houses are comfortable and efficient, most of their inhabitants are dissatisfied because they are built in adjoining blocks which deprive the people of their privacy and give them no space for raising animals or even poultry. Secondly, they are located near the main roads which is dangerous for the children at play, in addition to the creation of many social problems.

(iii) The ex-ENTE Farmhouse - The Ente Per La Colonizzazione organisation built 50 farmhouses in the Butraba area to be a Demographic Settlement for the Libyans of the surrounding areas, like those of the Italian Demographic Villages in the neighbourhood areas of El Marj, Batta, Farzugha and El Hemda. The ENTE house is designed according to the Arab way of life and tradition. Generally it is an enclosed building with 2 rooms and an open corridor and courtyard (Fig.11.13), occupying an area of 100m^2 (10 x 10 m). This type of house contains a well but no running water, electricity or drainage system, as in the case of those houses which were built for the

Italian settlers. Owing to the bad condition of most of these houses, most of them are uninhabited and used as stores, shops or animal shelters. The people of this area live in tents or shacks beside or near these houses. N.A.S.A. in 1964 undertook the responsibility of repairing these houses and developing the agricultural potential of this area but, unfortunately, up till 1967 nothing planned had been carried out.

According to the 1967 survey the rural area of the Benghazi Plain (including all types of houses) contained about 9,775 houses or 36.1 per cent of the total settlement units: 22.8 per cent were houses in compact clusters, 4.5 per cent popular houses and 8.8 per cent dispersed houses (Table 11.5 and Fig.11.10).

11.5.4 - Tent. The tent (Ar. Khima) is associated with the nomadic way of life, and since all the inhabitants of the interior (outside of the villages) and southern part of the plain are nomads and semi-nomads, the tent is the predominant type of settlement in these areas. According to the 1967 survey, tents accounted for about 52.5 per cent of the total rural settlement units, and about 82.3 per cent of the total rural settlements outside the villages (Table 11.5).

The traditional tent consists of a single large-to-medium square or oblong piece of cloth, made of goat and camel hairs, or old rags of cotton and wool cloths, stretched upon a number of wooden poles, of which the central pole is the

longest and strongest (the Sheikh's tent usually contains two large poles in order to distinguish him) and held by long outstretched ropes pegged to the ground (Plate 11.3).

Generally there are two types of tents. The winter tent (Beit-Shta) is composed of a cloth made of coarse wool and goat and camel hair, and when new cost between £L.80 and £L.100 in 1967 (while the summer tent was between £L.15 and £L.30). In the southern part of the plain they are usually set up from October until the end of May, whereas in the northern part they are used from the beginning of November until the first of April. The summer tent (Beit-Seif) is, however, lighter than the winter one and is usually composed of two pieces of cloth; the upper part, or the roof, consists of white cloth in order to reflect the sunshine, and the lower part, or the ceiling, is made of strips (like mosaic) of coloured old cloth to add decoration to the tent.

Tents in the Benghazi Plain are found either dispersed or in camps, the so-called Naja (Bedu-camp) in the open range of the steppe region in the southern part of the plain. The Bedu Camp is usually pitched in depressions and on the slopes of the wadis and their tributaries for shelter from the rain in winter, whilst in the north they are hidden in the bushes. The Bedu people get together in small or large clusters during the spring season for grazing, and co-operate in shearing, harvesting and threshing, particularly in large and fertile areas such as Es-Silg, east of Slug, and Wadi El

Arka, east of Deriana (Fig.11.10). If, however, the rainfall is not sufficient and the harvest is poor, tents are usually found dispersed. The size of the Bedu Camp depends entirely on rainfall and water supply, but generally it ranges between 10 to 30 tents. In summer the Bedu Camps dissolve or break up and each family goes to live near its well, cistern, or in the saniya in the coastal sand dune.

11.5.5 - Shacks and Huts.

(i) The Shack (Barraka) is a new type of settlement in the rural area (outside of the villages) of the Benghazi Plain. It was introduced, together with cotton and canvas tents, after the El Marj earthquake in 1963, when every Bedu, particularly in the northern part of the plain, rushed to the disaster area and obtained a relief tent or zinc metal boards (Zingu) and wood to build shacks or tents outside the destroyed area. Since then, shacks have become fashionable with the Bedu people and have, in fact, produced some sort of settlement for many Bedu in the area under consideration (Plate 11.3). Moreover, shack settlement has developed, and a semi-detached type of shack^{*} has been introduced (Plate 11.4). Shacks have been found with the villages and hamlets since the Second World War; such shacks are usually built of flattened petrol tins or barrels or packing cases.

(ii) Huts (Zeriba) are usually constructed of palm tree fronds and trunks. This type of settlement is common in the coastal area where palm trees are grown. It is normally used as a

^{*}The construction of a new shack cost about £L.50 in 1967.

summer residence or shelter for the farmer or his animals.

According to the 1967 survey, the rural area contained about 1,097 shacks and huts, or 8.6 per cent of the total settlement units (Table 11.5 and Fig. 11.10).

11.5.6 - Caves. The cave type of settlement is not numerous in the Benghazi Plain. It is found mainly in Tolmeita, Tokra, Deriana, Benina and El Gwarsha. Most of the inhabitants of these caves are poor Bedu or immigrants from other areas, who cannot afford to live even in a tent. These caves are usually the sites of ancient Roman or Greek burial grounds (Plate 11.5) or natural caves, found in the Karst area or on the escarpment (Plate 11.5). According to the 1967 survey they numbered about 0.3 per cent of the rural settlement units (Table 11.5 and Fig. 11.10).

It can be concluded that in the rural area of the Benghazi Plain the dependence of the settlements on water supply is critical. Outside the main villages the petroleum industry does not appear (1967) to have modified the patterns of settlement at all, despite the fact that it has a considerable social and economic effect on the urban area of Benghazi City.

11.6 - Rural Services

11.6.1 - Communications

11.6.1.1 - Roads

The existing system of communication in the Benghazi Plain combined modern and traditional means. In general, it is adequate only in connecting Benghazi with Jabal El Akhdar and

Tripolitania, whereas the hinterland, except between Slug-Benghazi and Benina-Benghazi completely lacks road connection with Benghazi or other parts of the plain.

The most important road in the Benghazi Plain is the newly constructed (1967) four lane coastal dual-carriageway (Plate 11.6) which links the coastal area with the rest of the country. This road runs for about 150 km. from El Bakur, at the escarpment east of Tokra to Sidi Abdul Ati on the southern border of the plain (Fig.11.14).

In addition to the coastal carriageway, some roads link some of the important areas of the hinterland with Benghazi. In the north-east of the plain there is the Tokra-Tolmeita new road which was started in 1963 and completed only in 1967. It is about 38 km. long and 4 m. wide. Although this road is very important to the agricultural and tourist development of that area, unfortunately it was mostly damaged (see Chapter 11). A secondary asphalted road links Tolmeita with El Marj town (about 20 km.) leaving the coastal road about 3 km. west of Tolmeita and ascending the first escarpment through Wadi Esh-Shaaba. A secondary and yet very important road links Benghazi with its only Airport at Benina, and continues toward Jabal El Akhdar through El Abiyar (Fig.11.14). At the time of the field investigation in May 1967 the western part of this road, about 20 km. between the Airport and Benghazi, was under reconstruction (Plate 11.7) and it is now transformed from a single lane to a four lane dual-carriageway, running

straight from Benghazi to the Airport, avoiding Benina village. The Airport is also linked by another asphalted road (20 km. long) running from Benina to the coastal dual-carriageway just to the north of Sidi Khalifa. This road was completed in 1967, and it was constructed mainly to facilitate transportation from the Airport to Jabal El Akhdar without crossing Benghazi.

One of the most recently constructed regional roads links Slug with Benghazi and passes through Jardina and En-Nawaghia. It is about 52 km. long and 7 m. wide. The opening of this road (May 1967) brought life and some prosperity to this isolated and neglected agricultural area on the one hand, and has reduced the distance between Benghazi and Slug from 72 km. to only 52. km.

Finally, there is a regional asphalted road, with a length of about 18 km. and a width of 3 m. linking Slug with Gamines. Until recently it was the only link between Benghazi and the hinterland of Barga El Hamra. At present the function of this road has declined considerably and its future remains as a link road between Gamines and Slug.

Apart from the above-mentioned primary and secondary roads, there are many truck roads running eastward, northward and westward, from the main coastal roads to various villages and settled clusters in most parts of the plain. In addition to these truck roads, there are also numerous sand and silt tracks, connecting the rural settlements with each other and

with other parts of Cyrenaica (Fig.11.14).

In a land of great distances and rare villages or settlement clusters, communications are the first essential for an organised economy or settlement, therefore a new agricultural road network is vital for the development of the agricultural potential of the hinterland of the Benghazi Plain, and for the social and cultural development for its rural people. Consequently, the following agricultural asphalted roads are suggested, in order to link all parts of the plain with the focal point, Benghazi City, on which all settlement clusters depend for their food and agricultural products and for their marketing.

1. A road linking Esh-Sheleidhima with Slug (about 40 km. long). Although plans for the construction of this road were included in the last Five-Year Plan (1963-68), until May 1967 nothing was done about it. However, the construction of this road is vital and about half of the inhabitants of Slug Mudirya will benefit from it.

2. A road linking Slug with Antelat (about 140 km. long), the gate to the desert in the south of the plain.

3. A road linking Slug with Et-Teilmun and El Magrun in the south (about 30 km. long).

4. Several short roads connecting the proposed El Gattara village (see Conclusion) with the main road between En-Nawaghia and Benghazi, and from El Gattara to En-Nawaghia and from El Gattara village to El Bazm castle at the escarpment (an

attractive ancient Roman Castle and Caves) in the south of Wadi Enghar (Fig.11.15). The total length of these regional feeder roads is about 55 km.

5. Spur roads off the main coastal road

- (a) to Shat El Bedin ($\frac{1}{2}$ km.)
- (b) to Er Ragta ($\frac{1}{2}$ km.)
- (c) to Karkura (2 km.)
- (d) to Et-Tarriya (2 km.)
- (e) to Bu Fakhra (2 km.)
- (f) to Ganfuda and Gar Yunes ($\frac{1}{2}$ km.)
- (g) from Dar El Araibat, east of Sidi Khalifa to Gasr Et-Tawil (6 km.) in the south (an attractive touristic site)
- (h) from east side of Sidi Sweiter to the beach ($\frac{1}{2}$ km.)
- (i) from Deriana to Wadi Ejweibya (about 9 km.) at the escarpment
- (j) from Bersis on the coast to El Hemda on the first escarpment (12 km.)

6. A ring-road around Benghazi (which is planned by the Government) which commences from the dual carriageway near El Gwarsha to the dual-carriageway near El Thama.

The width of all the above-mentioned feeder roads would be 4 m.

11.3.1.2 - Railways

The Benghazi Plain, or Cyrenaica as a whole, until 1966

had in operation a single track of narrow-gauge (95 cms.)⁽¹⁰⁾ railway connecting Benghazi with El Marj (108 km.) via Benina, Er-Rajma and El Abiyar in one direction, and connecting Benghazi with Slug via En-Nawaghia and Jardina in the other (Fig.11.14). There was only one diesel train for passengers operating three journeys per week from Benghazi to El Marj and two a week from Benghazi to Slug.

Although the railway was abandoned in the summer of 1966 because it was running at a rather heavy loss, there is no doubt that it contributed greatly to the social and economic development of the interior (Jardina and En-Nawaghia). For instance, the present settlement patterns are indebted to the construction of the railway and stations, during the Italian period. Yet in a semi-desert area like the Benghazi Plain, where the population is dispersed, villages are very small, loads are light, and inter-urban mobility is small, rail transport cannot hope to compete commercially with road transport. Nonetheless, most of the people of Cyrenaica feel that the railway still has a role to play in the hinterland. Thus they believe that the Government must revise its plan to completely abandon the rail services. However, in view of the present spread of motor transport and the development of the existing road network by the construction of more agricultural feeder roads, there is no further need for the railway services and the money allocated for railway lines and rolling stock would be more profitably invested in

agricultural development schemes and the expansion of the rural road network in the area under consideration.

11.6.1.3 - Telecommunications and Postal Services

Telecommunications are not widespread in the rural area of the Benghazi Plain and the existing insufficient services were constructed by the Italians with no change or development having taken place since then.

The telephone service is inefficient and is found only in Government offices and police stations. Most of the telephone communications are not direct but have to go through the police station or central switchboard which linkssome Mudiryas with Benghazi. For example, Slug, Gamines and El Magrun contact Benghazi through a trunk at El Magrun Mudirya. Benina makes its calls through the Airport's trunk.(see Fig.11.18)

There are no post offices in the rural area. The mail is carried through the Mudiryas, either by passing buses or Government mail cars which come from Benghazi every day bringing the mail to be distributed through the Mudirs and collecting the mail sent from each Mudirya. Benina, however, is exceptional because the postal service is run through the post office at the Airport. There is a new post office, just completed (1967), located in the centre of the settlement.

There are no telegraph services in the rural area, simply because there are no post office operators.

The development and modernisation of telecommunication in the area under consideration is essential for the economic and social development of the rural people.

11.6.2 - Markets and Marketing

The main and almost only market for agricultural products is Benghazi market (Funduk). In the rural area, although hamlets and villages may be regarded as the first link in the chain of marketing, in the sense of being collecting and clearing centres, yet transactions do not normally take place there. Moreover, some products may be shipped straight from the fields to Benghazi market and probably never pass through the village or the hamlet. From Benghazi market, the agricultural products are despatched to retail shops and mobile traders for sale to individual consumers. It often happens that the supplies flowing in to the market do not meet the consumers' demand. Thus, the marketing system, in the Benghazi Plain is both inefficient and insufficient. Consequently it has to depend on imported agricultural produce, mainly from Tripolitania and abroad.

The village markets of the hinterland play a small part in collecting and distributing agricultural output. Their main function, however, is to provide food and other rural needs. The village markets in the Benghazi Plain are unlike those of the other parts of Cyrenaica, in fact of all northern Libya, where each large village has its own weekly market-day so that farmers can sell their produce and buy simple consumer goods from shops and mobile traders. The lack of market-days in the villages of the Benghazi Plain, despite the surprisingly extensive hinterland area, is due mainly to the fact that most

of the farming, except in the Benghazi and Benina areas, is of a subsistence type with but a very small surplus, if any, to sell. Secondly, almost all the hinterland people practise shifting cultivation of cereals and grazing of animals. Their surplus grain is usually sold to the Ministry of Agriculture at a fixed subsidised price. As for the animal products and by-products (i.e. small lambs, kids, wool, hair, hides and samn), middle-men come and buy, of course very cheaply, everything on the spot.

With the recently developed road services, many private entrepreneurs have bought lorries and small buses and started transport services connecting the main villages and the important agricultural area (scattered clusters) of the hinterland, almost every day, with large settlement centres and Benghazi City (Figs. 11.15 and 11.16).

The rates for goods and passenger fares vary from place to place according to the distance between the fields and Benghazi City on the one hand, and the condition of the roads (asphalted or dirt roads) on the other. For example, a farmer from Tokra (67 km. from Benghazi) pays 10 piastres (2/-) for his fare and 15 piastres (3/-) for each lot of goods (usual weight 50 kgs.) he takes to the market, whereas a farmer from El Magrun (about 100 km. south of Benghazi) has to pay 20 piastres for his fare and 30 piastres for each lot of goods. A farmer from Es-Silg area, about 40 km. south-east of Slug, pays first 10 piastres for his fare and 20 piastres

for his goods to Slug and then from Slug to Benghazi (52 km.) he pays 20 piastres for his fare and 30 piastres for his goods. The total cost from Es-Silg to Benghazi is 30 piastres for the fare and 50 piastres for the goods. Thus a farmer who comes to Benghazi from a distance of 100 km. by an asphalted road pays about 50 piastres for his trip, whilst another farmer coming about 92 km. from the hinterland, mainly by a track road, pays about 80 piastres.

The frequency of the farmers' visits to Benghazi market is determined mainly by the distance, easy accessibility and economic necessity. From the vegetable producing areas near Benghazi, i.e. El Fweihat, El Kweifya, El Thama, El Gwarsha (village) and Benina, where the production requires frequent marketing, farmers visit the market almost every day. The other relatively distant vegetable farmers from Sidi Khalifa, Deriana, Ganfuda and El Faakat (south of El Gwarsha), visit the market twice or three times per week. From Tokra, Gamines and Slug, which are still more distant, and the irrigated crops are of subsistence level, the visit to the market occurs only once every week or every other week. In the interior of the plain, where the shifting cultivation of cereals predominates, the production, which mostly is not sold, does not require frequent visits to the market, and therefore farmers usually visit Benghazi only three to five times a year. The visits of the fruit farmers (particularly those of the coastal sand dunes, i.e. Shat El Bedin and Er-

Ragta) to the market in Benghazi are seasonal, and they occur during the summer season when the fruits ripen (Fig. 11.17).

However, in spite of the focal point of Benghazi market and its almost complete monopoly of the marketing system, the village markets do contribute in collecting and distributing some of the agricultural products, particularly to the non-farming inhabitants. Moreover, some farmers of the Benghazi Plain buy and sell their goods in markets outside the Benghazi Plain, in El Marj, El Abiyar and Er-Rajma, mainly owing to the proximity of these market places and tribal links.

In general, however, the markets and marketing system in the Benghazi Plain are relatively traditional, and their improvement and development are badly needed in order to keep pace with the present social and economic development of the area. Therefore, a new system with new market places in the main villages must be planned. Market days in, at least, Tolmeita, Tokra, El Gattara (the proposed village in the land settlement project), Slug and El Magrun, must be established (Fig.11.16) as soon as possible, in order to facilitate the marketing of the agricultural products, create commercial life in these areas, and eliminate the monopoly and avarice of the middle-men.

11.6.3 - Public Utilities

11.6.3.1 - Water Supply

The rural population in the villages and some hamlets in the Benghazi Plain obtain their water, for domestic and human purposes, mainly from shallow wells whose water is mostly brackish and subject to pollution. In the hinterland, apart from a few tribal wells, the only source of water is the rainwater collected and stored in cisterns. Only 4 out of the 13 Mudiaryas of the Benghazi Plain have a network of tap water: El Magrun, El Gwarsha, Benina and Tolmeita (Fig. 11.18).

El Magrun settlement is provided with water from a steel elevated water tank (in 1967 it was worn out and most of its water was leaking away) which has a capacity of 64 m^3 . The water is brought in from a water pumping station lying about 1 km. to the north-west of the village. This water is of relatively good quality and quantity. There are 5 public taps inside the settlement for domestic purposes, and another 2 for animal watering; one lies just to the west of the village, and the other is at the pumping station.

El Gwarsha, in addition to its local wells, has about 3 public taps serving the main settlement. The Government building and the recently established manufacturing plants are provided with water through two pipelines which supply water from Benghazi.

Benina's water is provided from one well, supplemented by

the main reservoir which supplies Benghazi City. It has 4 public taps, one of which is utilised for animal watering. The total consumption of the settlement was about 954 m^3 per day in June 1967, of which only 36 m^3 were extracted from the well of the settlement.

Tolmeita settlement is provided by water from a well at Sidi Abdalla, 3 km. west of the village. A windmill is installed on this well and also a stand-by diesel engine in case operation by the windmill is stopped for any reason. The total daily consumption of the settlement was about 37 m^3 in May 1967, of which about 5 m^3 goes to irrigation of the backyard gardens. The water is supplied from a tank with a capacity of 109 m^3 , sited at the western side of the settlement. However, the amount of water extracted from the well, due to the expansion of the water network, no longer serves the settlement's needs, particularly during summer.

Owing to the petroleum impact on all aspects of life, and the planning schemes for the development of the rural areas, the Benghazi Plain has just started to benefit from the construction of electricity power stations and elevated water towers for domestic water supply. Such new water towers were erected in El Magrun, Gamines, Slug, El Gwarsha and Tokra, with a capacity of 180 m^3 each. In 1968 water supply networks to houses were completed in Slug, Gamines and Tokra, and people are enjoying good drinking water probably for the first time. The less fortunate Mudiryas, where drinking water is

scarce and salty, i.e. Deriana, En-Nawaghia and Jardina, have no hope of good drinking water because no plans for water supply to these areas have been thought about. The re-utilisation of the ancient Roman spring (which used to supply water for Hadrianapolis city, the present Deriana village) in Wadi Ejweibya at the escarpment east of Deriana, might bring life again to this area. Underground water exploitation is another hope for water supply to these unlucky areas.

11.6.3.2 - Electricity

There are only 4 Mudiryas, i.e. Benina, El Gwarsha, El Kweifya and Slug, which have electricity (Fig.11.18). The first three Mudiryas obtain their electricity through high tension from Benghazi City. Although El Kweifya has electricity, it is provided for Governmental buildings only, and no private citizen has enjoyed it yet. Slug is the only Mudirya which depends on its own local power-station which provides electricity to the settlement daily from 7 p.m. to 1 a.m. The total consumption of the settlement in 1967 was about 460 kw. per day. The streets of Slug are also lighted.

Benina is supplied with electrical power by two 3-phase lines⁽¹¹⁾ (one is 6,000 v. and the other is 11,000 v.). There is a transformer with a capacity of 300 kWh. located in the settlement and it is connected to the 6,000 v. line. The daily consumption of the settlement in June 1967 was about 600 kw., and half of the electrical power is supplied by Benina Airport.

In El Gwarsha, despite its proximity to Benghazi, electricity is not widespread. It is found only in those buildings which are supplied with water, the newly established industrial plants and in the streets.

Although new electrical power-stations were constructed in El Magrun, Gamines, Tokra and Tolmeita in 1966, electricity has not been introduced yet. Gamines was the only Mudirya in April 1967 with an installed generator, which has a total capacity of 125 kw./day. At the time of my last visit the experts were testing the electricity, but there was no service outside the power-station, and even the electricity lines were not even constructed to supply electricity to houses and offices. According to the newspaper El Hakika of Cyrenaica, up till February 1969 no electricity service was in operation in the above-mentioned Mudiryas.

11.6.3.3 - Sewage Disposal and Refuse Collection

Owing to the unfavourable climatic conditions, dryness and abundance of sunshine, water-borne diseases do not exist in the area under consideration. Moreover, the general appearance of the villages is relatively clean due to the reasonably adequate (in most villages) cleaning services.

Sewage disposal services do not exist in the rural area of the Benghazi Plain. Nevertheless, improperly built cesspit systems do exist in some houses. These cesspits are emptied periodically by farmers and used as organic manure for their farming.

Refuse collection is carried out by usually 1 to 3 workers in each Mudirya, depending on the size and importance of the settlement. The refuse is usually dumped outside the villages where it is burnt or sometimes it is accumulated and probably sold to farmers. Despite the availability of a great number of labourers in each Mudirya, there were only 8 Mudiryas with well-organised refuse collection; 3 Mudiryas did not have organised refuse collection, and 2 Mudiryas, i.e. Jardina and En-Nwaghia had no garbage collection at all (Fig.11.18).

In general, the rural area of the Benghazi Plain has very poor public utility services. Even the few existing services or those which are still under construction are not sufficient and do not cater for the country's present economic and social development. Therefore, more adequate public utilities ought to be introduced in the area under consideration.

Before concluding this chapter, it is worth mentioning that educational institutions are fairly evenly spread in the Benghazi Plain, particularly in the coastal area (Fig.11.18). In the interior, the only area which needs a school urgently is the area of El Fwakhir homeland where no school or any public building exists at all. Another important suggestion for the development of the educational system in the rural area of the Benghazi Plain is the introduction of mobile classrooms in order to follow the children who are obliged to leave school and accompany their families during the

harvesting season. Another alternative solution to this problem would be to start and finish the academic schooling year earlier to suit the harvesting season.

The health services are also well-organised. Dispensaries and clinics are found in almost every big village (Fig.11.18), doctors visit each Mudirya once a week, and the ambulance service, though not sufficient, is efficient and satisfactory.

PART V

CONCLUSION

CHAPTER 12

LAND SETTLEMENT PROJECT

The foregoing analysis of the agricultural potential and the settlement situation in the Benghazi Plain indicates that there are only small areas such as Butraba, El Gwarsha and El Gattara, suitable for agricultural development and settlement. Apart from the above-mentioned areas the remainder of the plain, particularly outside the present irrigated area, will depend upon winter rains for its agricultural production.

Since the Butraban resettlement and El Gwarsha settlement schemes have been studied by N.A.S.A. and FAO experts with the result that their proposed projects have been already planned, El Gattara land settlement project is the only scheme which will be treated in this context.

In order to carry out a modern plan for a land settlement project, well trained farmers with sound theoretical and practical professional knowledge who are able to cope

with the many tasks modern farming presents are needed, but farmers with such qualifications are not available in the Benghazi Plain or in Cyrenaica as a whole, to take over newly established farms. Since voluntary assistance and group co-operation are the main characteristics of the Bedu's agricultural practices and are of primary importance in tribal organisation, a similar, but modernised type of co-operative land settlement project is worth trying. The chief reason for the suggestion of the co-operative system of land settlement in this area is the strong tribal tradition and influence, unlike the El Gwarsha area, where the land is mostly state and privately owned and the tribal influence is absent, and where N.A.S.A. has undertaken a modern type of land settlement scheme (Fig. 5.2). Thus the El Gattara land settlement will be designed according to the co-operative type of farming, where the tribal members of the area work together and benefit together. The farmers here must work two probationary years during which they are paid a monthly wage of £L.30 per household and they receive a small share of the produce they grow. Thereafter, they should work on a half-share basis; the Government receiving half of the produce as payment for a portion of the expenses including the cost of water pipe channelling, livestock and farm equipment, which will be acquired through a credit loan from the Agricultural Bank. This project would probably be better if undertaken by the Ministry of Agriculture in order to create competition with

the N.A.S.A. which at present is undertaking all land settlement and resettlement projects in Libya. After the success of the project is secured, presumably after eight or ten years, the Government could divide this area into individual farm units and transfer them to the settlers permanently.

The chief objective of this land settlement planning is to settle the Bedu of En-Nawaghia Mudirya and the surrounding areas and improve their social and economic status, because at present, they are very poor and have the lowest average annual income (about £L.40.66) in the Benghazi Plain. In addition to this it is hoped to exploit the agricultural potential of the deep and fertile terra rossa of this area by using the water for irrigation from Wadi El Gattara Dam, in order to supply Benghazi with its vegetables, fruits, milk and eggs, which at present are imported from other parts of Cyrenaica and Tripolitania as well as from abroad.

However, before executing this scheme there are several steps which must be planned and studied carefully for the success of this project. These steps are briefly analysed as follows:-

1. Selection of settlers
2. Acquisition of the land
3. Reclamation of the land
4. Layout of the plan
5. Settlement buildings
6. Supply of agricultural requisites
7. Credit arrangement

8. Patterns of farming and labour force

9. Output and future outlook

12.1 - Selection of Settlers

Since "forced migration"^{*} to this area is unlikely, because of the tribal structure and influence therefore, "voluntary migration" is most likely. The prospective settlers will be settled on a large stretch of irrigated agricultural land about 4200 hectares in area located between Wadi El Gattara and Wadi Enghar east of En-Nawaghia (Fig.12.1').

The criteria on which the prospective settlers will be selected are based on the tribal system and economically productive age groups, with a preference for those with previous agricultural experience and who are in good health. Preference, of course, will be given to farmers who are actually engaged in farming and those who live in the area and are practising good livestock husbandry. Besides the tribal people who live in the area, in the selection of the rest of the farmers, priority must be given to fellow tribesmen who have already settled in irrigated farms in other parts of the plain and who wish to join them. The reason for this is to encourage the Bedu to learn from and co-operate easily with their own tribesmen rather than any foreign group. However, the social stability resulting from a well-balanced population structure is as important as any other factor in agricultural development and consequently in the success of the scheme.

^{*} Forced migration often applies to the entire population in a given area, while voluntary migration usually applies to individuals, taken from among a wider group (1).

After the prospective settlers have been selected they must be orientated toward the understanding of the purpose and aim of this land settlement project. This will be better if it is conducted through the Sheikhs, Mudirs and the Mustashar of the area.

The most efficient means of informing the farmers are as follows:-

- (a) Since most, if not all, of the prospective settlers cannot read and write, the best and most feasible way to instruct them is through the Friday's preaching in the Mosque.
- (b) The mobile cinema could display some successful settlement projects in Cyrenaica (Beida and Massa) and Tripolitania (Ain Ka'am and Ez-Zahra).
- (c) The radio and newly established television could also provide detailed information about the land settlement project and its benefits.

Since most of the prospective settlers are unfamiliar with modern agricultural techniques, regular training for some of the settlers must be arranged at the nearby Government Experimental Farm at El Fweihat, well before the execution of this project.

Tractor driving training must also commence before the start of the scheme. Young farmers of 25-35 years old, must be chosen and trained at the Tractor Station in El Marj, for a course of at least six months. When fully developed the project can absorb about 500 families (which are impossible

to find at present) with an average family number of eight persons. But at the initial stage about 250 families are sufficient and they can be found among the people of the En-Nawaghia and the surrounding areas as well.

12.2 - Acquisition of the land

Although the land, which is allocated for the project, theoretically is invested in the State, the tribal right in the land must be observed and confined to its people and no outsider (except for some governmental farm labourers) can be allowed to join this project in order to avoid tribal conflict. The land which will be assigned to the proposed village settlement is State property, because it is located on the ridge area (rock outcrops and lithosols area) and it is well recognised by the Bedu (see Chapter 9) so that no one can claim its ownership.

12.3 - Reclamation of the land

The area assigned for the project is ideal from all aspects of reclamation. The soil mantle is very good, consisting of relatively deep terra rossa and needing only a little fertilizer to increase its productivity to the required level. The existing lithosols and shallow soils in the edges of the area will mostly be planted with trees as wind breaks and sown with barley in winter. In addition, this area does not need much vegetation clearing, because it contains only a few small Zyziphus plants and some dwarf plants in the small depressions. The minor clearing will be the collection of some stones and

pebbles carried by Wadi El Gattara and deposited during its periodic floodings. The area needs only a slight levelling of small depressions because most of the area is almost level, with an average slope of about 3 per thousand (see Figs.2 and 12.1). Levelling is mostly required in the area which will be utilised in the initial stage of the scheme for vegetable and fodder cultivation. Contour bunding is needed near the Wadi El Gattara levees and the small wadi ravines in the south-west and west of the El Gattara proposed village. The prospective settlers, as paid farmers in the initial stage of the project, should supplement the work of the machinery and not, of course, replace it, so small hand equipment is indispensable. For example, in digging canals, holes to plant trees, foundations for buildings and other purposes, crowbars, hoes, axes and shovels are necessary equipment which must be provided by the government. But if the work has to be done against time, a mechanised earth digger becomes necessary to supplement the workers' efforts.

The irrigation system must be planned and designed according to the effluent system of irrigation, which will flow from the Dam. The irrigation of the fields will be better if sprinkler irrigation is practised. This, however, will require an extensive network of underground water pipes of approximately 25,000 metres with a diameter of 10 cms. The main pipeline, which will be about 8,000 metres long with a diameter of 15 cms. from the Dam to the village, will supply the

domestic and animal needs. An elevated water-tower with a capacity of 200 m³ will be erected in the north-east of the village. The purpose of this water tank is to facilitate the treatment of the water with chemical components for purification purposes. Several public taps and small pools for animal drinking must be planned outside the cultivated area. In addition a large public tap for domestic and animal use must be planned in the other side of the wadi near the escarpment (Fig.12.2).

The amount of water available (ref. Chapter 5) for irrigation, from the dam will be sufficient to irrigate 1,780 hectares, of which 445 hectares will be irrigated full-time and 1,335 hectares will be irrigated part-time. However, for the security of the project and to test the annual amount of the water collected by the dam, it would be advisable to start with 200 hectares of full-time irrigated land and 600 hectares of part-time irrigated land, as an initial stage of the whole project. This proposed irrigated area can be divided into plots of 50 ha. each, in order to facilitate farming practice on the one hand and to permit a proper application of the rotation system. As the project goes on successfully and more Bedu become interested in it, the irrigated area can be expanded.

It is very important to make efficient use of the water for irrigation and any misuse of it will cause technical difficulties. Therefore, an expert at the initial stage and

later on an experienced person to control the water distribution with regard to the timing and amount of water applied should be provided. Half of the available water ought to be utilised to irrigate the tree plantations for the first 3-5 years.

The remainder of the area allocated for the land settlement project, which is about 2,330 hectares (Fig.12.2) will be left for the shifting cultivation of cereals (mainly barley and wheat) and for free grazing grounds for animals.

Soil conservation will be of great importance in this area, because the land is almost level, and sprinkler irrigation must be used to prevent any water erosion. Nevertheless, trees must be planted as wind breaks and at the same time as a soil conservation measure against wind and rain erosion.

12.4 - Layout of the plan

Since the whole project area is designed for co-operative or joint work, the land must be divided according to this arrangement. The cultivated area under irrigation must be divided into 40 plots, each with an area of 5 ha. These plots at the initial stage of the project ought to be separated from each other, preferably not too far from each other, and from the village. This arrangement will, undoubtedly, allow more space for fallow areas and tree planting. The full-time irrigated area will be planted with vegetables and fodder only; fruit trees will not be planted in this area for the first few years in order to allow the full use of machinery. Fruit

trees, mainly citrus, will be planted in the rest of the irrigated area.

Rows of trees surrounding the project area, particularly around the proposed village, and in between the cultivated areas as wind breaks must be planned. The east-west orientation of the trees is aimed at protecting the vegetable and tree crops from the southern winds (Ghibli) and the northern winds. Whereas, the north-south orientation of the fruit trees is aimed at avoiding these winds by protecting each other from the south as well as from the north.

The fencing of the whole proposed cultivated area, by barbed wires, is most essential to protect the agriculture from human and animal trespass.

The part-time irrigated area, which will be utilised mainly during the cooler part of the year where there is less evaporation and the agriculture needs less winter water will be divided into three plots, each plot of about 200 hectares. One plot will be devoted to winter vegetable cultivation and two plots for wheat cultivation (Fig.12.2).

The area which will be put under shifting cultivation will be classified into three categories:

- (1) Where there is deep terra rossa e.g. El Magzah, wheat will be cultivated and, of course, mechanisation will be applied.
- (2) Where there is a shallow soil mantle and lithosols, barley is better suited.
- (3) The area of rock outcrops, lithosols, wadi bunds and

fallow lands will be left for animal grazing. Outside the project area, the prospective settlers will also be allowed to sow and graze in other tribal land.

12.5 - Settlement buildings

The farmhouses, shacks, mobile houses (which are well suited to this project) or tents will remain dispersed and scattered all over the area. In some cases, three or more shelters (houses, shacks or tents) are grouped together in one cluster for family or kinship purposes. However, the farm family shelters will be better if they are located in the edges of the farming land, rock outcrop and lithosols areas, preferably not too far from the proposed village (Fig. 12.2). Although the dispersed system costs more, in providing each shelter with separate drinking water, electricity, internal roads and medical services, it is necessary for the desires of the settlers to be taken into consideration in this type of land settlement. In this project, the prospective settlers are expected to build their own houses instead of being provided with ready-built stone, brick and tile houses, as has been done in ex-Ente farmhouses in Butraba and Jabal El Akhdar, and so the newcomers will be allowed to set up improvised shacks and tents. Then they may proceed to build, if and when they wish, their more permanent houses out of stone or brick and tiles with or without modern public utilities.

The buildings of public services such as: a Mosque, a

police station, a dispensary, a veterinary office, schools (for boys and girls), a market place, shops, an agricultural extension office, a tractor station, a general store, administrative buildings and residential houses for the employees will be grouped in one unit in a centre site within the settlement scheme and will be called the "El Gattara village" (Fig.12.2). The proposed village will be constructed on a rock outcrop and lithosol area near Jabbanet (cemetery) Sisi Bu-Hofra, about 500 metres south of Wadi El Gattara. It will occupy about 100 ha. in the initial stage and another 100 ha. for future expansion and development. This village occurs about 22 km. to the south-east of Benghazi, 8 km. west of the dam site at the escarpment and about 9 km. to the north-east of En-Nawaghia village.

The electricity power supply to the main village could be obtained from either the new commercial farming area about 8 km. west of El Gattara village or from Benina village about 13 km. in the north.

The cost of land reclamation, the water irrigation network and the construction of the settlement cannot yet be known, because they depend upon government tenders.

12.6 - The supply of agricultural requisites

The land settlement project area needs at least 4 tractors, tractor implements, 2 power sprayers, 2 combines, 2 trucks and 2 motor cars. In addition, farm equipment such as axes, cutting knives, hoes, saws, spades, rakes etc. must be provi-

ded and put under the supervision of the extension officer. The cost of the farm machinery and equipment must be borne by the Ministry of Agriculture on the basis of long-term loans through the Agricultural Bank, as in the case with all other agricultural co-operative societies.

The tractor station, in addition to the project area, is entrusted to provide tractor hire and other agricultural machinery services to the neighbourhood areas, as well as repair services for the private tractors and other farm machinery at reasonable charges.

Agricultural requisites like improved seeds, seedlings, fertilizers, pesticides, some improved livestock (mainly dairy cattle) and poultry raised for egg production, must also be provided as necessary by the Ministry of Agriculture from their experimental farms at El Fweihat, and Ez-Zorda in El Marj and Tripolitania. This must be done free of charge as a part of the government's general policy to develop agriculture in the country. Moreover, the government must bear the cost of the construction of the settlement buildings (village) and farmhouses as a part of the Idris Housing Scheme, which has allocated money to build about 70,000 houses in the rural areas of Libya.

12.7 - Credit Arrangement

Adequate credit facilities for the purchase of the above-mentioned farm machinery and equipment and other farm requisites must be provided by the Agricultural Bank, both in cash

and in kind, to the project settlers to enable them to meet their short, medium or long term loans. The use or investment of these loans must be well supervised by the project authority. The money borrowed from the Bank must be guaranteed by the Ministry of Agriculture.

At first, farm requisites must be paid for through the credit facilities after having been substantially subsidised by the Government.

12.8 - Patterns of farming and labour force

This section of the project plan is probably the most important one, because it reveals the agricultural potential of the area under consideration and consequently the potential of the area for the future supply of Benghazi City's needs of agricultural products.

The type of farming in this scheme is intended to be mixed; a combination of winter grains (mainly wheat), forage (mixed clover and alfalfa), legumes, summer and winter vegetables, as well as fruit plants and livestock enterprises.

The farming methods must follow modern agrotechniques supported by a scientific rotation system (see Table 12.1). The agricultural production will be mostly concentrated on limited cash crops (mainly vegetables). Vegetables will receive farmyard manure and chemical fertilizers as a supplement, the kind and quality of fertilizers varying from one crop to another. The farmers of Benina (commercial farming) generally use about 5 qtls. per hectare, and since the project

area will use better quality water for irrigation and has deeper terra rossa soils, 4 qtls. per hectare seems reasonable. The part-time irrigated wheat will need about 2 qtls. per hectare of superphosphate (Mono) and 1 qtl. per hectare of Ammonium Sulphate at the sowing time and 1 qtl. with the first irrigation.⁽²⁾

Under the co-operative farming plan, most of the crops will be planted and harvested with tractors, manual labour will, therefore, be used for vegetable growing and looking after fruit trees and livestock. Irrigation will be carried out by the sprinkler method and labour will be needed only in moving and arranging the pipes from one place to another. According to the project plan there will be about 250 farm families in the initial stage of the scheme, which will provide on average 2 permanent workers; the total labour force, therefore, will be 500 labourers. When the project is fully developed there will be available, from the planned 500 families about 1,000 workers.

The planning problem in this settlement project is how to reorganise the existing type of shifting cultivation of mainly wheat and barley to the market orientated irrigated farming of vegetables, forage and fruit trees. Thus, a complete change of farm activity will be introduced to suit the area proposed.

Livestock enterprises will be maintained, but dairy cattle will predominate and will be kept and fed in stalls. About 200

well-bred cows will be enough at first. Thereafter, 800-1,000 head could be raised in the project area. Other animals such as sheep and goats, can be kept according to the traditional system. These animals will live on grazing land outside the project area (Fig.12.2) during winter and spring, and they will be fed on dry forage (straw and hay) and green fodder (alfalfa and mixed vetch) during summer, or in case of failure or delay of rains. However, stall or farm feeding will be decided according to the rainfall conditions. About 2,000 sheep and 500 goats (10 head per farmhouse) could reasonably be raised by the prospective settlers.

Since there are enough chickens produced for meat at present (Chapter 8), chickens for egg production must be raised in this area. The poultry enterprise ought to be undertaken by the Ministry of Agriculture at first so that modern equipment and outside workers can be provided (probably immigrants from Tripolitania) because the Bedu as was mentioned before, look down on those who raise poultry. Consequently, about 2,000 chickens will be enough to start with, and about 10,000 chickens could be raised in the project area later on.

12.9 - The output and future outlook

It is very difficult, however, to forecast the future success of this project, particularly with regard to the agricultural output and the economic benefits, but it is certain that the project will result in settling the Bedu of

the area and will find jobs for idle people. It will also provide a reasonable standard of living much higher than the present one. Nevertheless, the agricultural potential and the economic benefits have been tentatively estimated and are displayed in Table 12.2.

Table 12.2 contains also estimates of the agricultural production and benefits of El Gwarsha settlement and Butraba resettlement projects. The El Gattara project will produce about 475,729 qtls. of vegetables, cereals and forage. Most of the cereals, particularly wheat, will be consumed by the farmers, forage will be fed to livestock and vegetables will be marketed. It will provide also 765,000 litres of milk of which about 720,000 litres of cow's milk will be sold at Benghazi market. The rest of the milk (sheep and goats' milk) will be consumed by the farmers as fresh milk, Laban (skimmed milk) and samn (purified butter). About 45,334 qtls. of meat, 62,500 dozen eggs, 60 qtls. of wool and 2.5 qtls. of hair will also be available.

The total gross income per household in the El Gattara land settlement project, from crop and livestock production, will be about £L.2,100 per annum. The total farm expenses per household, on the other hand, will be about £L.630 per annum. Thus the net income per household will be about £L.1,470 per annum whereas the net income per household in El Gwarsha and Butraba projects will be about £L.1,275⁽³⁾ and £L.460⁽⁴⁾ per annum respectively.

As far as the total potential of the agricultural produc-

tion from all the settlement projects is concerned, there should be available for the Benghazi Plain about 520,284 qtls. of vegetables, grains and forage, 1,110,600 litres of milk, 65,000 qtls. of meat, 86.5 qtls. of wool and hair and about 105,000 dozen eggs per year.

It is not easy to estimate fruit production, because the fruit trees will not produce before 5-9 years, but in general, fruit produced (mainly citrus) by these projects should undoubtedly contribute not less than 40 per cent of Benghazi's needs.

The striking fact that has emerged from this study is the efficiency of the rural area of the Benghazi Plain, if all the schemes go well, in producing most of the agricultural resources which will be needed to support the population of the Benghazi Plain. For example, the project area of El Gattara will produce about 49.9 per cent of the total grain produced in 1967, or about 30.8 per cent of the consumption of that year. About 592.6 per cent of the 1967 vegetables production or about 284 per cent of the total consumption and about 3.9 per cent of the meat production or 1.0 per cent of the total consumption will be produced there. In addition to the above-mentioned agricultural products, there will be about 183 per cent more milk and 77.4 per cent more eggs than were produced in 1959 (Table 12.3).

To sum up, in the light of the above-mentioned results, the proposed land settlement project, if everything goes as

planned, will provide Benghazi City with sufficient food, particularly with vegetables, grain, fruits, milk and eggs. Meat as well as some grain are the only agricultural products which Benghazi will find it necessary to import mostly from abroad for many years to come.

If this project failed because of the inability or refusal of the settlers to adopt modern methods and techniques of farming, or through their unwillingness to accept a new way of life, then the Ministry of Agriculture could use the project area for experimental fields instead of at El Fweihat Experimental Farm in Benghazi which, at present, is strangled by the construction of new buildings, due to the rapid expansion of Benghazi City. The Government also ought to keep the good and desirable farmers to work in the area as paid farm labour. The rest, however, would return to their previous way of life.

REFERENCES

Chapter 1

1. Cited in: Thornbury, W.D., Principles of Geomorphology.
Eight Print, New York and London
1964, p.448.
2. Cited in: Ibid p.455
3. McBurney, C.B.N. & Hey, R.W., Prehistory and Pleistocene
Geology in Cyrenaica-Libya.
Cambridge, 1955, p.43.
4. Ibid. p.51.
5. Ibid. p.39
6. Ibid. p.57.
7. Torayah Sharaf, A., The Geography of Libya (in
Arabic)
Alexandria, 1963, p.100.
8. Desio, A., Studi Morfologici Sulla Libia
Orientale.
Miss. Scie. della Real Acc.
D'Italia, A. Cufra (1931:39).
Vol.II Roma, 1939, pp.42-43.
9. Marchetti, M., Note Illustrative per Un
Abbozzo di Carta Geologica
Della Cirenaica.
Boll. della Soc. Geol. Ita.,
Vol. L III, 1934, pp.322-323.
10. Meliczek, H., Socio-Economic Condition of a
Libyan Village and Proposals
for Future Development.
Inst. of Foreign Agri.,
Berlin, 1964, p.12.
11. Gregory, J.W. and others, Contributions to the Geology
of Cyrenaica.
Quat. Geol. Soc. Vol. XLVII,
No.2681.
London, 1911, p.590.
12. McBurney, C.B.N. & Hey, R.W., op. cit., p.40.

13. Desio, A., op.cit., pp.46-47.
14. Ibid. p.46.
15. Little, O. H., Geology of Cyrenaica Handbook of Cyrenaica Part I B.M.A., 1944, p.19.
16. McBurney, C.B.N. & Hey, R.W., op.cit., p.19.
17. Torayah Sharaf., A., op.cit., p.46.
18. McBurney, C.B.N. & Hey, R.W., op.cit., p.45.
19. Desio, A., op.cit., p.65.
20. Spratt, P.N., Travels and Researches in Crete Vol.II. London, 1865, pp.376-378.
21. Gregory, J.W., op.cit., pp.583-92.
22. Marinelli, O.H., Sulla Morfologia della Cirenaica Rev. Geol. Ita., Annata XXVII, Fase 4-7 Florence Apr.1920-Aug.1920, pp.69-86.
23. Ahlmann, H.W., La Libye Septentrional, Geografiska Annaler, H. 1-2 Stockholm 1928.
24. Stefanini, C., I Terrazzi Fluviale e Marine della Africa. Italiana, Inter. Geog. Un., II Rep. of the Comm. on Pliocene and Pleistocene terraces. 1930, pp.23-24.
25. Marchetti., M., op.cit., p.324.
26. Desio, A., op.cit., pp.63-64.
27. McBurney, C.B.N. & Hey, R.W., op.cit., pp.65-67.
28. Cited in Thornbury, W.D., op.cit., pp.246-248.

29. Conant, L.C. &
Gaudarzi, C.H.,

Geologic Map of the Kingdom of
Libya. Scale 1:2,000,000 and
A.I.D., U.S.A.,
Map No.1-350 A., 1964.

30. McBurney, C.B.N., &
Hey, R.W.,

op.cit., p.46.

Chapter 2

1. Torayah-Sharaf, A.,

The Geography of Libya
op.cit., p.712.

2. Ibid.

p.188.

3. Air Ministry (U.K.),,

Meteorological Office, Weather
in the Mediterranean.
Vol.I, London, 1937, p.48.

4. Desio, A.,

op.cit., p.13.

5. Government of Libya,,

Housing in Libya.
Doxiados Assoc.
Athens, 1964, p.20.

6. Air Ministry (U.K.),,

op.cit., p.153.

7. Wheatley, O.J.,

Agriculture of Libya.
F.A.O. Report No.21.
Rome, 1951, p.24.

8. Torayah-Sharaf, A.,

op.cit. p.174.

9. Leuenberger, R.,

Irrigation Requirements and
Irrigation Intervals of various
crops grown in the coastal
region of Cyrenaica and
Tripolitania. (Mimeo.)
F.A.O. Benghazi, 1965,
p.3. X

10. Torayah-Sharaf, A.

The Problems of Rainfall of
Libya.
Bulletin of Faculty of Arts and
Education University of Libya.
Vol.I.
Benghazi, 1958, pp.305-306.

11. $i = \frac{P}{t-9}$
 i = aridity index
 P = average annual rainfall in millimetres
 t = average annual temperature in $^{\circ}\text{C}$.

12. Fantoli, A., Le Pioggie Della Libya.
 Roma, 1952, pp.16-19.

Chapter 3

1. Desio, A., op.cit., p.77.
2. Fletch, H.C. and Tileston, F.M., Watershed Management Flood Protection for the Wadi Gattara - Libya.
 Ministry of Agriculture. Report No.3e.
 Tripoli, 1964, p.2.
3. Little, O.H., Geology of Cyrenaica.
 op.cit. p.25.
4. Cited in Little, O.H., op.cit., p.25.
5. Doyel, W.W. and Maguire, F.J., Ground-Water Resources of Benghazi Area, United Kingdom of Libya, U.N., U.S.A. and Libya,
 Washington, 1964, p.B 8.
6. Torayah-Sharaf, A., The Geography of Libya,
 op.cit., p.331.
7. Cited in Doyel, W.W. and Maguire, F.J., op.cit., 1959, p.27.
8. Jones, J.R., Water for Municipal Use at Agedabia, Libya.
 Libyan Government and U.S.A.I.D.
 Tripoli, 1963, pp.11-12.
9. Pioger, R., Water Resources and Development in Libya.
 U.N. FAO.,
 Libya, 1952, p.40.
10. Doyel, W.W. and Maguire, F.J., op.cit., p. B 10
11. Little, O.H., op.cit., p.26.

12. Pioger, R., op.cit., p.41.
13. Marchetti, M., op.cit., pp.238-240.
14. Doyel, W.W. and Maguire, F.J., op.cit., p. B11
15. Jones, J.R., op.cit., p.15.
16. Torayah-Sharaf, A., *The Geography of Libya*, op.cit., p.324.
17. Doyel, W.W. and Maguire, F.J., op.cit., p.B 12
18. Torayah-Sharaf, A., *The Geography of Libya* op.cit., p.325.
19. Doyel, W.W. and Maguire, F.J., op.cit., p. B 12
20. Pioger, R., op.cit., p.63.

Chapter 4

1. Micheli, A., Contributo in Umidita della "Terra Rossa" della Pianura Bengasina e sui Variazioni. Rapporto Alla Lavorazioni Della Terreno. Firenzi, 1936.
2. U.S. Army, Corps of Engineers., Topographic map of Libya, Scale 1 : 50,000. Washington D.C., 1964.
3. Wheatley, O.J., op.cit.,pp.59-61.
4. Refenberg, A., The soils of Palestine. Translated by Whittles, C.L., London, 1947, pp.74-77.
5. Little, O.H., op.cit., p.18.
6. Hubert, P., Report dealing with the soil conditions of the Ente Farm Settlement Area of Tolmeita, Cyrenaica (Mimeo).
FAO - Libya, Benghazi, 1963, p.2. ^x

7. Little, O.H., op.cit., p.16.
 8. McBurney, C.B.N., and Hey, R.W., op.cit., p.82.
 9. Hubert, P., Report dealing with the Soil Conditions of the Agedabia Area, Cyrenaica (Mimeo).^x
FAO - Libya, Benghazi, 1963, p.4.
 10. Hubert, P., The Soils of Northern Cyrenaica A Soil Survey Report. (Mimeo)^x
FAO - Libya, Benghazi, 1964, p.10.
- This study concerns only a pilot project in the
Jabal El Akhdar, between Massa and Beida.
11. Desio, A., op.cit., (Footnote) p.43.
 12. McBurney, C.N.B. & Hey, R.W., op.cit., p.80.
 13. Hubert, P., Agedabia, op.cit., p.4.
 14. McBurney, C.N.B. & Hey, R.W., op.cit., pp.84-86.
 15. Desio, A., op.cit., p.87-89.
 16. Marchetti, M., op.cit., pp.321-322.
 17. Torayah-Sharaf, A., The Geography of Libya.
op.cit., pp.227-232.
 18. Ibid. pp.232-234.
 19. Hubert, P., op.cit., 1964, p.56.
 20. Hubert, P., The Soils of Tolmeita (Cyrenaica)
op.cit., p.6.
 21. Hubert, P., op.cit., 1964, p.56.
 22. Kligebiel, A.A. & Montgomery, P.H., Capability Classifications
Agriculture Handbook No.210.
U.S. Department of Agriculture,
Washington D.C., 1961.
 23. Ibid. p.8
 24. Fisher, W. B., The Middle East,
London, 1961, pp.79-89.

25. Keith, H.G., A selected list of the more common indigenous plants of Libya.
FAO - Libya, Tripoli, 1957, p.4.
26. Messines, P.du S.J., Forestry in Libya.
Report to the Government of Libya.
FAO Report No.22,
Rome, 1952 p.109.
27. These figures are provided by the Extension Advisor at Deriana.
28. Messines, P.du S.J., op.cit., p.109.
29. These figures are calculated from map on 1 : 250,000 scale.
30. Fantoli, A., op.cit., p.22.
31. Fletcher, H.C. & Tileston, F.M., op.cit. in Appendix II
32. Ghisleri, A., Tripolitania E Cirenaica
(Dal Mediterraneo al Sahara).
Milano, 1912, p.12.
33. Maugini, A., "Contributo Alla Conoscenza Del
Pascoli E Prati Naturali,
Della Cirenaica Settentrionale"
In Pampanini, R., "Prodromo
Della Flora Cirenaica."
Forli. Min. delle Colon.
1931, part E, p.588.
34. Messines, P.du S.J., op.cit., p.107.
35. These figures are roughly estimated through observation
in several localities.

Chapter 5

1. Della Cella, P., Narrative of an expedition from Tripoli in Barbary to Western Frontier of Egypt.
London, 1822, pp.193-198.
2. Hamilton, J., Wanderings in North Africa.
London, 1856, pp.145-146.

3. U.S.A.,
Topographic Map of the Kingdom of Libya.
Washington, 1962.
4. Karaman, Y.,
Land Use Survey in the Mediterranean Countries.
In "Land Use in semi-arid Mediterranean Climate" UNESCO, Paris, 1964, pp.159-162.
5. Leuenberger, R.,
Water Resources and Water Utilisation in Northern Cyrenaica - Libya. (Mimeo.)
FAO, Libya, 1965, pp.33-34.
6. Leuenberger, R.,
Possibilities and Limitations in Developing New Lands for Settled Farming in Cyrenaica (Mimeo.)
FAO, Benghazi - Libya, 1964, p.6.
7. _____.,
Summary of Conditions and Problems related to water utilisation and agriculture development in Cyrenaica. (Mimeo.)
Benghazi - Libya, 1964, p.2.
8. Della Cella, P.,
op.cit., p.93.
9. Wheatley, O.J.,
op.cit., p.174.
10. Tilestone, F.M.,
Concrete Canal Lining on small farms in Libya.
USAID, Agriculture Division, Libya - Tripoli, 1964, pp.16-18.
11. Leuenberger, R.,
Summary of Conditions....., 1964, op.cit., p.2.
12. Leuenberger, R.,
Possibilities and Limitations.... op.cit., p.2.
13. Leuenberger, R.,
Irrigation Requirements....., 1965, op.cit., p.1.
14. Mishra and others.,
Irrigation Guide for Field Crops. The Journal of International Agriculture.
World Crops, December, 1967. pp.24-25.

15. Leuenberger, R., Irrigation Requirements, 1965, op.cit., pp.5-7.
16. Personal Interview - with the Chief Engineer of the Constructing Company, Othman Ahmed Othman on the 26th April, 1967.
17. Leuenberger, R., Basic Considerations in Planning and Operating an Irrigation Scheme, receiving its water supply from the Benghazi Sewage Disposal Plant. (Mimeo), FAO Benghazi - Libya, year ?, p.1
18. Howard Humphreys & Sons., Benghazi Sewage and Sewage Purification (Project Report). London, 1961, p.17.
19. Leuenberger, R., Basic Considerations, op.cit., pp.3-4.
20. Redha Abdul Nabi, K., A Study in the Land Tenure System in Guarsha Mudirya - Mutassarifiah Benghazi. FAO Benghazi - Libya, 1965, p.12.
21. Leuenberger, R., Basic Considerations, op.cit., pp.3-6.

Chapter 6

1. Abu Sharr, I., Crop Agronomy and Improvement in Cyrenaica. FAO Report No.1577. FAO Rome, 1962, p.4.
2. Al-Jibouri, H.A., Wheat Growing in Libya. The Journal of International Agriculture. World Crops, June, 1967. p.26.
3. Abu Sharr, I., op.cit., p.5.
4. Al-Jibouri, H.A., op.cit., p.3.
5. Abu-Sharr, I., op.cit., p.9.
6. Soghair, A.A., Crop Improvement in Cyrenaica. FAO Report No.1111 (in Arabic) FAO Rome, 1959, pp.19-59.

7. Abu Sharr, I., op.cit., pp.10 and 38.
8. Soghair, A.A., op.cit., p.20.
9. Al-Jibouri, H.A., op.cit., p.28 and
Abu Sharr, I., op.cit., p.8
10. Abu Sharr, I., op.cit., p.14.
11. Ibid. p.15
12. Ibid. p.16.
13. Calculations based on printed statistics of Benghazi Municipality, 1967.
14. Ibid.
15. Ibid.
16. Lalevic, D., Agriculture in Libya and a
plan for its development.
Tripoli, 1967, pp.112.
17. Calculations based on printed statistics of Benghazi Municipality, 1966-1967.
18. Personal interview with Mr. Rafaa Zeew on May 24th, 1967
at Benina.
19. Lalevic, D., op.cit., p.116.
20. Mazzochi, G.B., The Production of Fruit and
Vegetables
FAO Report No.2134.
FAO Rome, 1966, p.12.
21. Nuttonson, M.Y., The Physical Environment and
Agriculture of Libya and
Egypt with special reference
to their regions containing
areas climatically and latitu-
dinally analogous to Israel.
Washington D.C., 1961, p.177.
22. Mazzochi, G.B., op.cit., p.12.
23. Ibid. p.11.
24. Ibid. p.11.
25. United Kingdom of Libya, 1960 Census of Agriculture
Tripoli - Libya, 1962, p.237.

Chapter 7

1. 1960 Census of Agriculture, op.cit., p.92.
2. Torayah-Sharaf, A., op.cit., 1963, p.228.
3. Messines, P. du S.J., op.cit., p.116.
4. Ibid. p.123.
5. Willimott, S.G. & others., Conservation Survey of the Southern Highlands of Jordan. University of Durham, Geography Department. Durham, 1964. p.54.
6. Messines, P. du S.J., op.cit., p.39.
7. Ibid. pp.125-126.
8. Ibid. p.128.
9. Ibid. p.129.
10. Abu-Sharr, I., op.cit., p.22.
11. Nuttonson, M.Y., op.cit., p.142.
12. Park, B.C., Range Management, Handbook for Libya, Tripoli - Libya, 1963, p.16.

Chapter 8

1. Evans-Pritchard, E.E., The Sanussi of Cyrenaica London, 1954, p.37.
2. Torayah-Sharaf, A., op.cit., 1963, pp.288 and 372-74.
3. Wheatley, O.J., op.cit., pp.76-77.
4. Ibid. p.78.
5. Lalevic, D., op.cit., p.265.
6. Wheatley, O.J., op.cit., pp.78-79.
7. Ibid. p.81.
8. Ibid., p.82.

9. Ibid. p.82.
10. Lalevic, D., op.cit., p.165.
11. Calculations based on printed statistics of Benghazi Municipality, 1966.
12. 1960 Census of Agriculture, op.cit., p.460.

Chapter 9

1. Wheatley, O.J., op.cit., pp.201-203.
2. Hajjaji, S., The New Libya.
Ministry of Information and Culture.
Tripoli - Libya, 1967, pp.92-95.
3. Caponera, D.A., Water Legislation - Libya.
FAO Report No.1550.
Rome, 1962, p.10.
4. Ibid. p.11 (footnote)
5. Ibid. p.11
6. Ibid. p.9.
7. Redha Abdul Nabi, K., A report on the Land Tenure
System of Bu-Traba Settlement
Project of the Coastal Plain,
Cyrenaica. (Mimeo.)
FAO Benghazi - Libya, 1966, p.5.
8. Abu-Sharr, M., op.cit., p.6.
9. Ibid. p.11.
10. Symons, L., Agricultural Geography.
G. Bell & Sons Ltd.,
London, 1968, pp.170-175.
11. Ibid. pp.102-103.

Chapter 10

1. Lasserre, M., Draft Outline for Country Mono-
graphs for Seminar on Housing
Statistics and Programme (Mimeo).
Ministry of Housing and State
Property
Tripoli, Libya, 1966, p.5.

2. Er-Rayed Newspaper, January 8th, 1969.
Tripoli - Libya, p.9.
3. Lalevic, D., op.cit., p.264.
4. Theodorou, N.T., Indigenous and Italian Farm
Enterprises in Zavia Area.
FAO Report No.259
Rome 1954, p.61.
5. Lalevic, D., op.cit., p.80.

Chapter 11

1. Al Ash-Hab, T.M., Cyrenaica between Yesterday and
Today (in Arabic)
Alexandria, 1945 p.26.
2. No data are available (except for 1954) to make comparison.
3. Ziadah, N., Cyrenaica The 8th Arab Country.
(In Arabic)
American University in Beirut.
Beirut - Lebanon, 1950, p.23.
4. Al Ash-Hab., T.M., op.cit., pp.70-72.
5. Ibid., pp.115-122.
6. Abdul Sahib Alwan., A Field Study of the Customary
system of Land Tenure and
Related Problems in the
Mutasarrifiya of Agedabia.
FAO Benghazi, 1965, p.10.
7. Sheikh Mohammed El Abd Mustashar of El Fwakhir showed me
this document on May 13th, 1967.
8. $C = \frac{E \times N}{T}$
 E = The population outside of the villages
 N = The Number of Settlements
 T = The total population of the settlement
9. This figure is much less than the real number of emigrants.
This is due to the incomplete statistics.

10. Doxiadis, Assoc.,
Transport in Libya.
Ministry of Planning and Deve-
lopment.
Tripoli, 1963, p.172.
11. Doxiadis, Assoc. in Libya
Eastern Muhafadat Inventory, A6
Muhafadah Benghazi
Mutassarriyiah Benghazi
Athens, 1966, p.54.

Chapter 12

1. U.N.,
The community development
approach to Land Settlement
U.N. New York, 1966, p.13.
2. Singh, H.,
Farm Plan for a 4-hectare farm
in Gwarsha Project Area -
Benghazi (Mimeo).
Benghazi, 1965, p.13.
3. Ibid.
p.16.
4. Singh, H.,
Butraba
op.cit., p.16.