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Cornell University

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

Jack W. King II

Terence R. Forbes

Abdul Elah Abu Ghanem

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Armand Van Wambeke

Co-Principal Investigator

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MINISTRY OF AGRICULTURE

Dr. Ahmed Al-Hamdani	Minister
Mughbil A. Mughbil	Deputy Secretary
Dr. Ali Noman	General Director
Amin Al Masyabi	Director of Employees
Mohamet Sharif Aldin	Co-Manager for American Project
Ahmed El Darwish	Irrigation Adviser
Mohamet Yehya	Co-Manager, Gerabal Livestock Farm
Abdullah Atirk	Extension Supervisor in Kalaiba
Abdul Daim Sharaf	Chief of Horticulture Section
Abdul Samat Attiah	Horticulture Expert
Saleh A. Alkuhali	

CENTRAL AGRICULTURAL RESEARCH SERVICE

Dr. Jamal Fuad	Project Manager
Ali Al Aghbari	Co-Manager
Abdul Rehman Sallam	Research Director
Dr. Ali Al-Thoor	Head, Soils Dept.
Prof. Ismael Gewaifel	Soil Survey Expert
Abdul Alim Khaled Saif	Soil Survey Counterpart
Dr. Salah Elgawhary	Soil Chemist
R. K. Sharma	U.N. Volunteer
A. K. Mabrouk	U.N. Volunteer
Dhuruba Shrestha	U.N. Volunteer

TIHAMA DEVELOPMENT AUTHORITY

Ahmet Ali Hummad	Chairman
Ibrahim Al-Doomi	Director General
Abdul M. Hazza	Research Director
A.L. Hakimy	Manager, Surdud Farm
Abdul Rhahim Rudman	Soil Fertility Research
Mohamet Arashad	Resident Engineer, Zabid
Mohamet Anwar	Senior Hydrologist, Zabid

SOUTHERN UPLANDS RURAL DEVELOPMENT PROJECT

Ghazi Nasser	Director General
Mohamed Abdullah	Chief, extension section
Mahmoud Zaim	Extension Expert
Mohamoud Aljadah	Asst. Extension Expert
Mohamed Nabil	Asst. Extension Expert

UNITED STATES EMBASSY

George M. Lane	Ambassador
David E. Zweifel	Ambassador
Ronald Neuman	Deputy Chief of Messian

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

Charles Ward	Mission Director
Robert Beckman	Deputy Director
Harry Johnson	Program Officer
David Frederick	Program Officer
Dr. H. (Pat) Peterson	Ag. Dev. Officer
Dwane Hammer	Project Manager
Tracy Atwood	Assistant Ag. Dev. Officer
Jeffrey Lee	Ag. Dev. Officer (Washington)
Timothy Bertotti	Admin. Officer
Campbell McCluskey	Project Manager

CONSORTIUM FOR INTERNATIONAL DEVELOPMENT

Prof. Hugh Henderson	Chief of Party
Prof. Robert Witters	Chief of Party
Tom LaQuey	Administrator
Clinton Orean	Mechanic

OTHERS

Ahmed H. Abu Ghanem	Sana
Collin Beardsley	BKS Surveys Ltd.
Dr. Ing. Reiner Bonhage	Electrowatt Corp.
Wherner Dubach	Swiss Technical Aid
Helmut Eger	University of Tubingen
Erwin Egli	Swiss Technical Aid
Dr. John Farnworth	Overseas Development Authority
John Keast	BKS Surveys Ltd.
Peter Mansell	BKS Surveys Ltd.
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Johann Stocker	Furlanis Construction Co.
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John R. I. Wood	British Council
Dr. Matthew Drosdoff	Professor Emeritus, Cornell University
Dr. Robert Lucey	Chairman, Dept. of Agronomy, Cornell University
Dr. Joseph Metz	Head, International Agriculture, Cornell University
Rudolph Straub	University of Tubingen
Jan Leunk	Hydrologist, DHV
J.J. McNally	Flight Operations Dir., BKS Surveys Ltd.
George Rohaley	Cartographer
Sheila Oltz	Editorial Assistant
Ela M. Bullon	Illustrator
Eleanor Huxley	Illustrator

CORNELL STAFF

Dr. A. R. Van Wambeke	Principal Investigator
Dr. Jack W. King II	Soil Survey Project Leader
Dr. Terence R. Forbes	Project Coordinator
Ralph Stuart	Technical Assistant
John Lottey	Technical Assistant
Melanie Nesheim	Technical Assistant
Merrily Dethier	Administrative Aide
Cynthia Ryan	Student Assistant
Tatyanna Seredin	Student Assistant

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Armand R. Van Wambeke, Ph.D.	Principal Investigator
Jack W. King II, Ph.D.	Project Leader
Terence R. Forbes, Ph.D.	Project Coordinator

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Ralph Stuart — Technical Assistant

Provided substantial contributions in laboratory analyses, estimation of soil moisture regimes, and computerized typesetting.

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Computer programming and typesetting.

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FOREWORD

Until present, only limited information was available on the soils of the Yemen Arab Republic. The few soil surveys that had been conducted previously were not sufficient or adequately correlated in a national or international system to serve development needs. They varied in degree of detail, and required complementary studies to respond to an increasing demand for soil resource information. This reduced their usefulness and restricted the transfer of technical knowledge from other areas with similar ecological conditions.

This project involved the mapping of soils and land resources of the Yemen Arab Republic. The study will be an important part of the data base for planning the development of agriculture and urban infrastructures.

The objective of the soil survey was to produce a generalized 1:500,000 scale soil map based on field observations, which were also extrapolated by interpretations of satellite and air-photo imagery. The map shows associations of subgroups as recognized by Soil Taxonomy (USDA, 1975).

For eighteen months, one soil surveyor with support equipment and personnel was stationed in Yemen with operations based in Taizz. Field work included soil profile examination and mapping. Soil analyses were required to place the soils into Soil Taxonomy classification. Representative soil profiles were sampled, tested, and described throughout Yemen as part of this effort. The surveyor was assisted by Yemeni personnel, both professional and nonprofessional. Soil samples were analyzed by the FAO-assisted Agricultural Research Service at Aussefeire; some special, texture, and mineralogical analyses were performed at Ithaca.

The information provided by this project will be useful in the planning of development activities in Yemen. The survey will assist in locating areas of high potential where more detailed soil information would facilitate the introduction of new technology for agricultural production.

The project mapped those areas of Yemen west of longitude 45 degrees, 30 minutes. The survey area does not include islands in the Red Sea.

Chapter 1

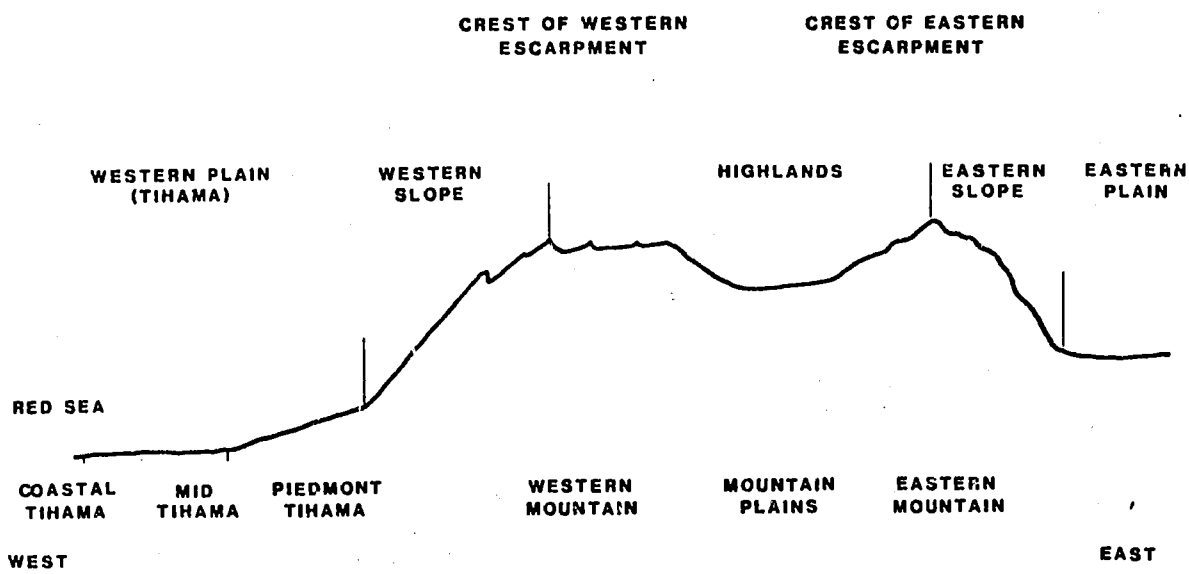
SOIL GEOGRAPHY OF THE YEMEN ARAB REPUBLIC

REGIONS OF NORTH YEMEN

North Yemen can be divided into five major regions: the Western Plain (Tihama), the Western Slope, the Highlands, the Eastern Slope, and the Eastern Plain (including Wadi Jawf). (See Figure 1.1.)

FIGURE 1.1

THE REGIONS OF NORTH YEMEN



THE TIHAMA

The Tihama is an alluvial/coastal plain which averages approximately 40km in width and separates the mountains of Yemen from the Red Sea for the entire length of the country. Where the Tihama meets the mountains the elevation is about 250m. Atmospheric humidity on the Tihama is high due to the influence of the Red Sea but rainfall is low varying from a trace at the coast to approximately 400mm in some places near the mountains. There is an increase of precipitation as one moves north on the Tihama. The elevation of the mountains immediately adjacent to the plain apparently also has an influence on the amount of rain which falls in a given area. Lower adjacent elevations have less rainfall. Air temperatures are uniformly high with only small seasonal and diurnal variations.

The eastern third of the Tihama forms a gently sloping piedmont which merges on the west with the nearly flat mid-Tihama. This piedmont, especially in the central and northern parts of the Tihama, is a good agricultural region. Spate irrigation results in high productivity near the wadis. In many places on the central and northern piedmont rainfall is sufficient for the production of drought tolerant crops such as sorghum and millet. There is a gradation from coarse to fine materials from the piedmont to the Red Sea. Areas on the piedmont which have been routinely spate irrigated are loams texturally and are free of gravel and stones. Old alluvial terraces, however, whose surfaces have not been influenced by spate irrigation, are common on the piedmont and these are gravelly and stony.

The mid-Tihama is used primarily as range and is bordered on the west either by the Red Sea or by the coastal Tihama, a band of poorly drained and/or salt-affected soils which seldom extends more than one kilometer inland.

The most common soil order on the Tihama is the Fluvent. There is some variation, primarily in a north-south relationship, in the soil characteristics of the piedmont and mid-Tihama.

The southern Tihama extends from the border with the Peoples Democratic Republic of Yemen north to Wadi Nakhalah (near the town of Hays) and is the driest region of the Tihama. Torrifluvents are the most common soils of this region but it is also the area in North Yemen with the most extensive Calciorthids. These are found most commonly in the coarse alluvial materials of the piedmont. Also, Psamments are very rare in the southern Tihama but are common in the central and northern Tihama.

The Central Tihama encompasses the area between Wadi Nakhalah and Wadi Mawr. Ustifluvents and Ustipsamments are the most common soils of the piedmont here and Torrifluvents and Torripsamments are the most common soils of the mid-Tihama in this region. Unique to the central Tihama are the extensive Ustipsamments in the form of stabilized dunes on the piedmont.

Psamments are the most common soils of the Northern Tihama because of the influence of sandstone parent rocks. There are two other unique characteristics of this region. Firstly, there are coarse alluvial terraces starting at the piedmont extending into the midTihama. These are normally confined to the piedmont or found only in the central and southern Tihama. Secondly, this is the only area in North Yemen where extensive areas of noncalcareous soils were observed.

Numerous wadis dissect the old alluvium of the Tihama with seven of them being designated as major. These wadis along with the approximate areas of their catchment basins are listed below in sequence from south to north.

Wadi	Approximate Area of Catchment (km^2)
1. Wadi Mawza	1537
2. Wadi Rasyan	2080
3. Wadi Zabid	4910
4. Wadi Rima	2887
5. Wadi Siham	5137
6. Wadi Surdud	2506
7. Wadi Mawr	9262

These wadis are fed primarily by rainfall in the mountains. Consequently the quantity and timing of this flow is not necessarily related to climatic conditions on the Tihama but rather to the size of the catchment area and the timing and quantity of rainfall within the catchment. Only at the highest flood stage of the major wadis does the water of the Tihama wadis reach the Red Sea. However, their flood plains do account for the presence of Ustifluvents in the climatically arid mid-Tihama.

THE WESTERN SLOPE

The Western Slope is bounded on the west by the Tihama and on the east by the crest of the western escarpment of the Yemeni highlands. Lithic Torriorthents dominate nonterraced slopes and are common on terraced slopes where Typic Ustorthents are common or dominate. The soils of the wadis are Typic Ustifluvents. The northern part of this region was the only area observed where Gypsiorthids were present to any significant extent.

THE HIGHLANDS

The highlands are bounded on the west by the crest of the escarpment of the Western Slope and on the east by the crest of the escarpment of the Eastern Slope. North of the Sumara pass the highlands are discontinuously separated by a series of highland plains. These plains are all dominated by Fluvents but there are differences in parent materials with those of the Dhamar-Yerim and Amran regions being characterized by calcareous silt and those of the Sana and Sadah plains being characterized by coarser alluvial materials. Where parent materials are fine, soils with vertic characteristics and Mollisols are sometimes found in low-lying areas. Although not dominant, buried Mollisols are found on these plains and are most common in the Amran and Sadah regions.

Most of the area south of the highland mountains are similar to those of the western slope but there are exceptions to this in the Hajjah, Ibb, and Taizz regions where the high mountains do have some Mollisols.

In the northern and eastern highlands there are extensive areas where there are not any soils, only exposed bedrock.

The southern highlands, south of the Sumara pass, are a unique area with valleys, plateaus, and massive mountains. The wadis in the eastern part of this region are rich agriculturally; they drain into the Indian Ocean and have Ustifluvent soils characteristic of the wadis of the Western slope. Most of the mountain soils of this region are similar to those of the Western Slope. The most important characteristic of this region is the very strong influence of calcareous loess on the soils. The loessal soils of Ibb and Turbah are strongly expressed examples of this phenomenon.

THE EASTERN SLOPE

The Eastern Slope is bounded on the west by the crest of the eastern escarpment of the Yemeni Highlands and on the east by the Eastern Plains and Wadi Jawf. The mountains of the Eastern Slope are not generally terraced because of insufficient rainfall to support this type of agriculture. The wadis, because of excessive variability between drought and extremely rapid runoff from the barren mountains, are not often farmed. The soils of the mountains of this region are primarily Torriorthents and both Torrifluvents and Torriorthents are present in the wadis. Although they are exceptional, there are rich agricultural wadis in this region, such as Wadi Khaab in the northeast. Here the soils are Ustifluvents and the climate is ideal for a wide variety of crops.

THE EASTERN PLAINS

The Eastern Plains, including Wadi Jawf, is generally a gently sloping dry region which supports only a small population of herders and merges into the Rub Al Khali desert. However, there are exceptions to this general rule--Harib, Marib, and Wadi Jawf being the major ones--all of which owe their existence to runoff from the highlands rather than to any variation in climatic patterns of the Eastern Plain. Fluvents, Orthents, Psamments, and Calciorthids are all amply represented on the Eastern Plain. The unique characteristic of the Eastern Plain relative to the rest of North Yemen is the wide range of agricultural production potential in this region. There are more problem soils in the Eastern Plains than in any other area of the country. Poorly drained, salic, stony, and hummocky soils are all found to a significant extent in this region. In contrast, where the soil and water resources are good, the excellent climate and suitability of the land for mechanizied agriculture make such locations some of the highest agricultural yield potential regions of North Yemen.

Chapter 2

SOIL-FORMING FACTORS AND THE GENESIS AND CLASSIFICATION OF SOILS IN YEMEN

CLIMATE

The climate of the Yemen Arab Republic is characteristic of arid and semi-arid tropical areas. Rainfall is seasonal and variable, and its quantity is primarily controlled by the effects of the mountains. Weather and climate data are very scarce.

RAINFALL

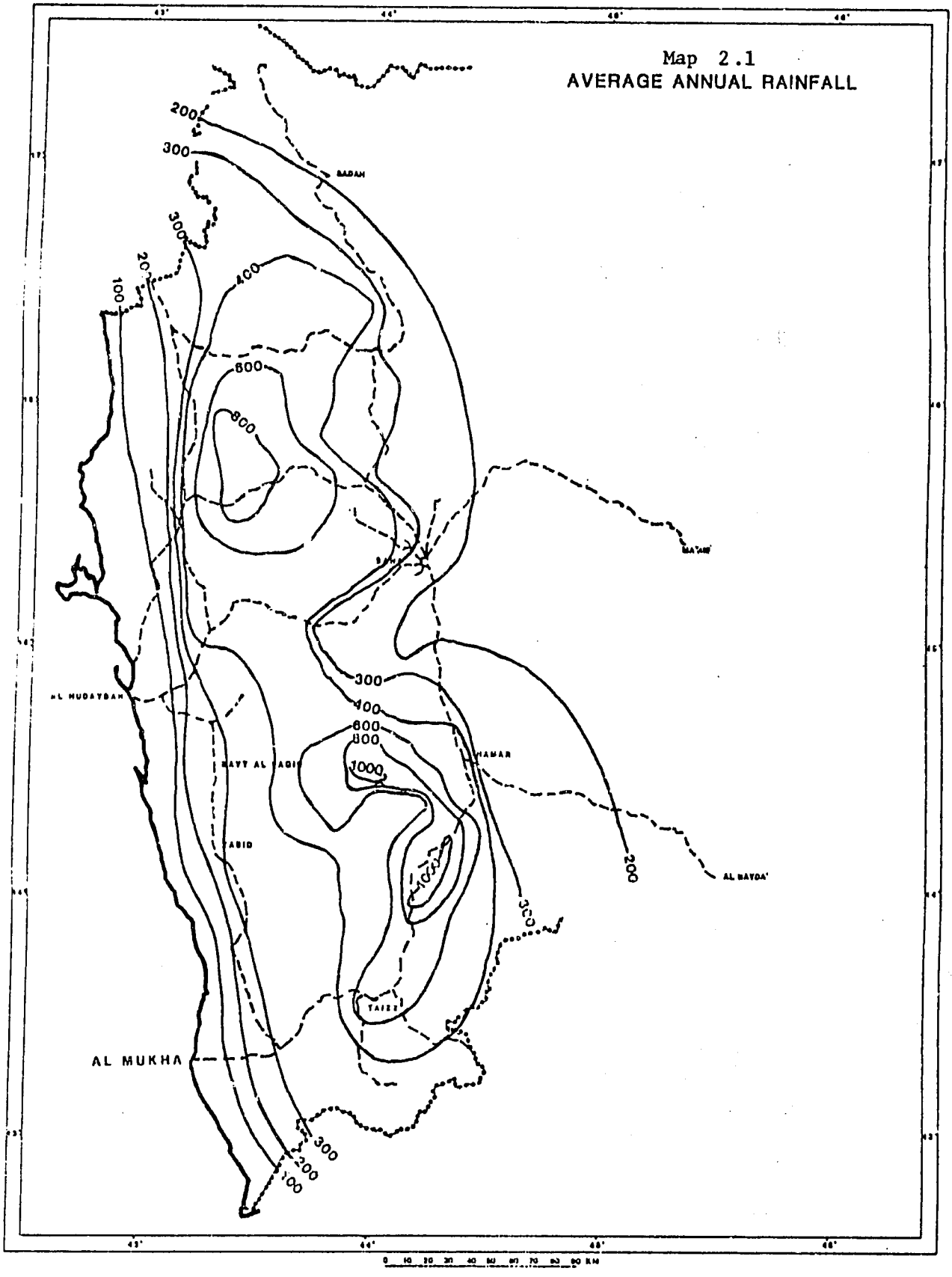
Rainfall varies from approximately 1000mm/yr in the Ibb area to near 0mm/yr along the Tihama and in the Rub Al Khali. An average annual rainfall map is shown in Map 2.1. The largest amounts of rainfall are associated with the western and central highlands as humid winds from the Indian Ocean and Red Sea are forced to rise and cool. Once past the highest mountains, the winds have lost most of their moisture and rainfall decreases rapidly to the east.

TEMPERATURE

Temperature in Yemen is strongly influenced by elevation. The yearly average ranges from approximately 11^{0}C at Rabat to 26^0 at Al Hudaydah on the coast.

High potential evapotranspiration rates, resulting from high temperatures (Figure 2.1), are somewhat moderated on the Tihama by the high relative humidity. Extremely dry conditions with dessicating winds, as found in Sahelian Africa, are not common.

Freezing weather seldom occurs in the lowlands. However, nighttime freezing weather is common in some of the highland areas. For example, at the Kitab dairy on the Dhamar Plain one hundred consecutive nights of freezing temperatures were recorded. The lowest recorded temperature at Kitab is -9^{0}C.


Map 2.1
AVERAGE ANNUAL RAINFALL
SADAH
MA'RIB
AL HUDAYDAH
BAYT AL FAQIH
ZABID
HAMAR
AL BAYDA'
TAIZZ
AL MUKHA
100
200
300
400
600
800
1000

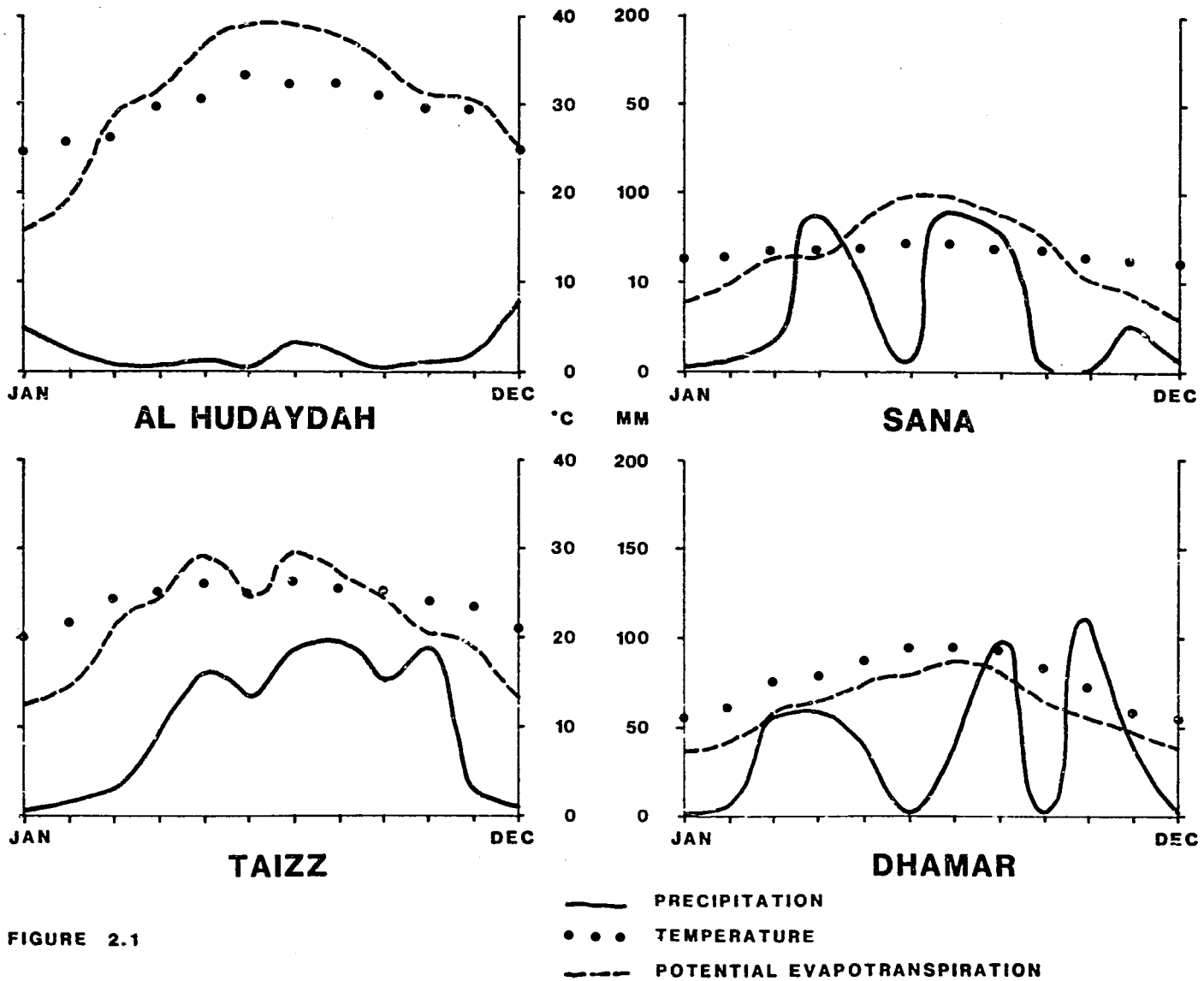


FIGURE 2.1

Climatic Data for Yemen

GEOLOGY

This information is adapted from reports by Geukens (1966) and Grolier and Overstreet (1978).

The Yemen Arab Republic includes four major geologic provinces: 1) the Precambrian shield areas, 2) sedimentary rocks of Paleozoic and Mesozoic ages, 3) Tertiary and Quaternary volcanics, and 4) Quaternary alluvial deposits. A generalized geologic map is given in Map 2.2.

PRECAMBRIAN SHIELD

The Precambrian shield, composed of igneous and metamorphic rocks, is the basement of the Arabian peninsula. The igneous rocks include pink orthoclase granites, diorite, gabbro, and mafic volcanics. Metamorphic rocks include mica, chlorite and garnet schists, gneiss, quartzite, marble, slate, and amphibolite. The structure of the shield is very complex, because the rocks have been folded and faulted several times.

SEDIMENTARY ROCKS

There are three sets of sedimentary rocks in Yemen: the Wajid sandstone, the Kohlan and Amran groups, and the Taliwah and Medj-Zir groups, going from oldest to youngest.

All of the sedimentary rock groups are approximately horizontal. The Wajid sandstone rests directly on the Precambrian shield. The Kohlan group is also in contact with basement rocks. The Kohlan and Amran groups and the Taliwah and Medj-Zir groups are conformable. The Amran and Taliwah groups are unconformable.

Wajid Sandstone

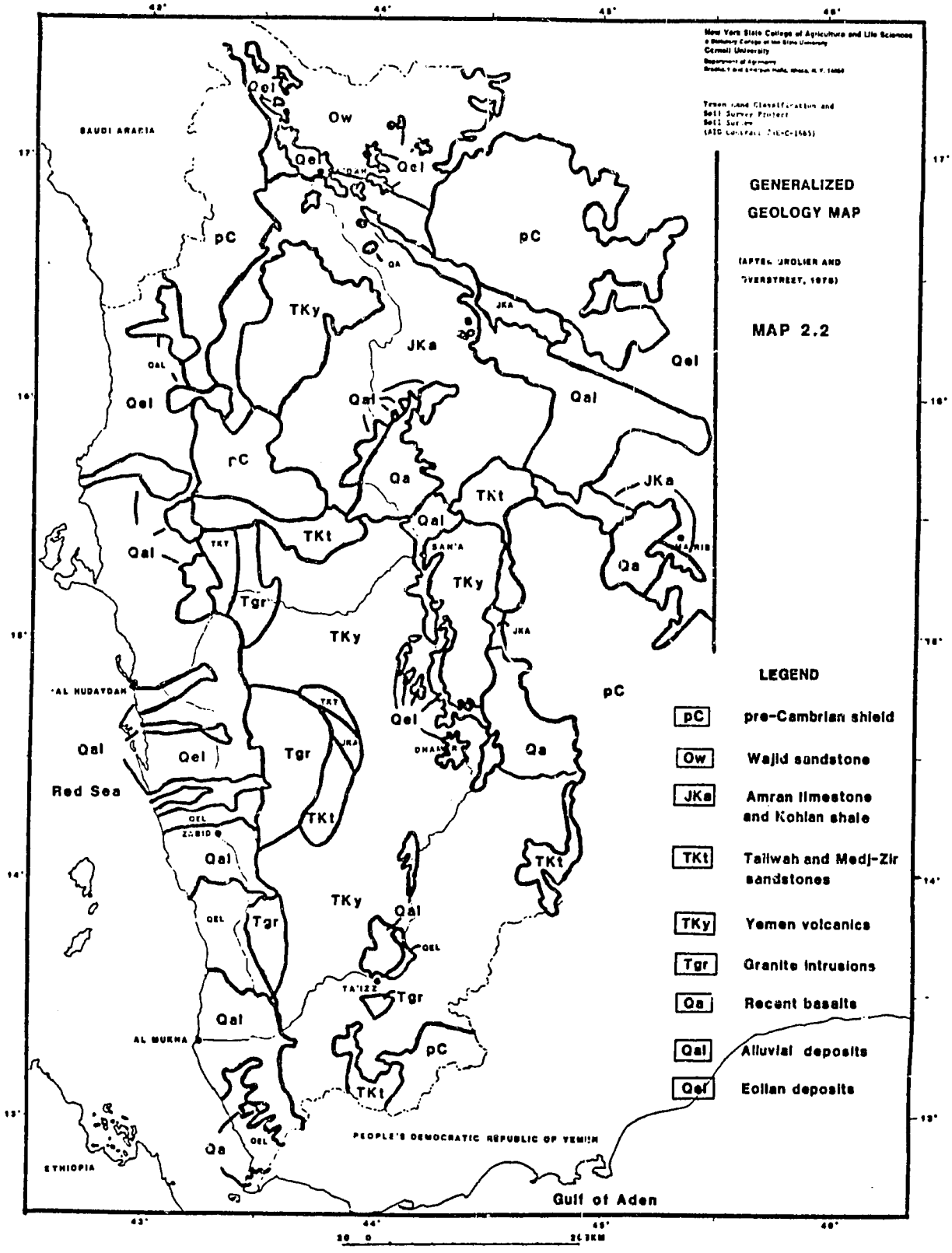
The Ordivician Wajid sandstone is a cross-bedded, coarse-grained, well-rounded, quartz sandstone. It includes frequent conglomeratic gravel lenses. The grain size decreases to the north. It contains no fossils.

Kohlan and Amran Groups

The Jurassic Kohlan group consists of green silty shale and arenaceous sandstone which includes conglomerate lenses. The sandstone is interbedded with and overlies the shale. The sandstone becomes purer in quartz to the north. The Kohlan series is generally unfossiliferous.

The Kohlan group grades into the overlying Jurassic Amran group. The Amran group contains fossiliferous blue and light gray limestone, marl, and calcareous shale and sandstone. The Amran group varies in lithology from place to place.

YEMEN ARAB REPUBLIC



Tawilah and Medj-Zir Groups

The third group of sedimentary rocks includes the Cretaceous Tawilah and Tertiary Medj-Zir groups. They are cross-bedded, coarse-grained quartz sandstones. They generally contain hematite nodules where they are in contact with volcanic materials. The lower Tawilah group includes conglomerate layers interbedded with red and green shale layers. The Medj-Zir group contains locally fossiliferous layers of calcareous shales.

TERTIARY AND QUATERNARY VOLCANICS

Volcanic rocks which formed in Cenozoic Era are divided into two groups. Igneous rocks of the Tertiary Period are known as the Yemen Volcanics, while any younger volcanic rocks are grouped as Quaternary Volcanics.

Yemen Volcanics

The Yemen Volcanics formation, as defined in Grolier and Overstreet (1978), includes Tertiary volcanic rocks (the Trap Series) and contemperaneous granite laccoliths. The Trap Series (Geukens, 1966) is made up of alternating layers of lava flows, basalts, porphyries and various tuffs. The original volcanic craters are rare. The Trap Series includes sedimentary deposits, which were laid down during volcanically quiet times. These deposits include fossils.

The granite laccoliths included in the Yemen Volcanics are exposed both within and adjacent to the Trap Series, and are also found in the sedimentary rocks north of Sana. They are heavily dissected.

Quaternary Volcanics

Granites which are younger than the Yemen Volcanics, and volcanoes whose cones are still intact, are present throughout Yemen. The granites contain tourmaline and amphibole crystals. The volcanoes are basaltic and are often enclosed in layers of tuff. The most recent volcanism is located in the Dhamar-Rada area.

QUATERNARY ALLUVIAL DEPOSITS

Quaternary alluvial deposits are divided on the basis of their mode of transportation into wind-laid (aeolian) and water-laid (fluvial) deposits.

Aeolian Deposits

Loess: Loess deposits are found in areas where mountains present a barrier to the wind, causing it to slow down and drop its sediment load. The loess of Yemen probably originated in the Rub Al Khali to the northeast, the direction of the prevailing winds. Many of the

loess deposits, particularly in the intermountain plains, have been reworked by alluvial processes.

Dunes: In the survey area, sand dunes are found primarily on the Tihama, where the ground is level. Barchans and some longitudinal dunes are found, indicating that sand supply is the limiting factor of dune formation. The source of the sand is probably the wadi beds and alluvial fans, which receive sand from wadis coming out of the mountains. The great sand seas of the Rub Al Khali are outside of the survey area.

Fluvial Deposits

Alluvial Fans: Alluvial fans are deposited where a quick decrease in slope (as at the bottom of a mountain) causes flowing water to slow down and drop its sediment load. Fans are found on the Tihama and on the Wadi Al Jawf, along the mountain fronts.

The fans are made up of coarse-grained material, because the dryness and lack of vegetation allow wind and water to carry away finer particles. Reworked loess material is commonly mixed with the alluvium.

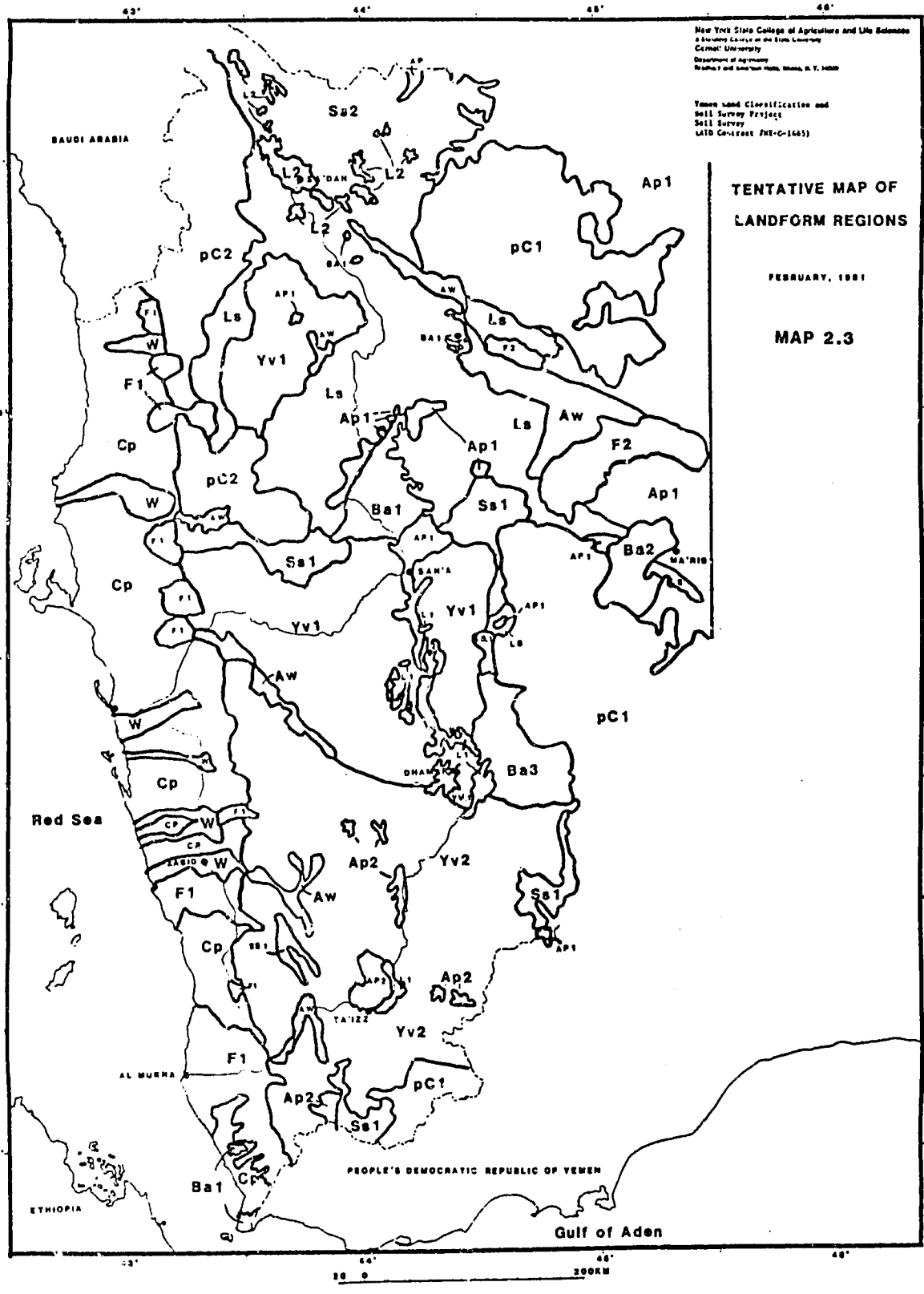
Alluvial Plains: Alluvial plains form in broad, flat areas of low relief on the Tihama and in mountain valleys. The processes of sediment deposition which form alluvial plains are similar to those which form wadis. The sediments, however, are generally finer in texture than those in the active wadi beds and are spread over a much larger area. The source of the sediments is the weathering debris from the highlands mixed with reworked alluvial loess.

LANDFORM REGIONS

A map of the landform regions of the Yemen Arab Republic is given in Map 2.3. The map divides the country into areas in which similar soils occur as associations in a generally uniform pattern. The landform regions were recognized on the basis of topography, bedrock geology, and climate. The topographic relationships between the landform regions are shown in Figure 2.2.

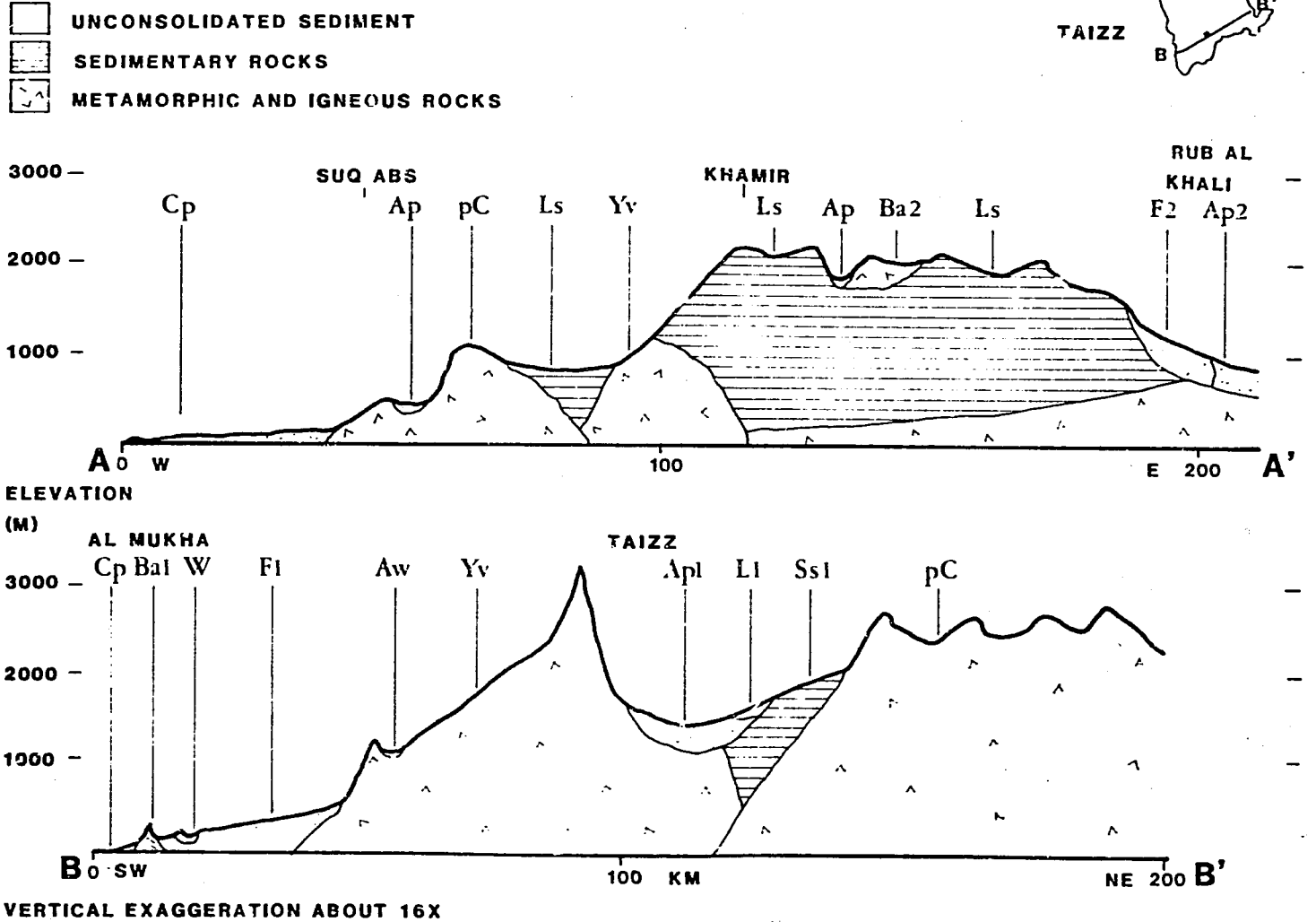
The sources used for the preparation of this map were the USGS 1:500,000 geologic and geographic maps (Grolier and Overstreet, 1978), which used Landsat imagery as their base. Selected areas were also examined with airphotos at 1:60,000 scale, obtained from the Resource Information Laboratory at Cornell University. Because of the scale (1:500,000) of the information used, only general landform regions were outlined.

YEMEN ARAB REPUBLIC



Topographic Cross-Section of Landform Regions

FIGURE 2.2



The country was divided into seven areas, with as many subdivisions as necessary. These are: Precambrian shield areas, sedimentary rock areas, the Yemen volcanics area, recent basalt flows, loess deposits, the coastal area, and inland alluvium.

DESCRIPTIONS OF LANDFORM REGIONS

Basalt Flows

Basalt flows are areas covered by basaltic lava flows which are too young to have been weathered extensively. These landscapes consist of basaltic cones and lava flows surrounded by colluvium grading into alluvial fans. These recent basalt flows occur throughout the country. The area covered by each flow varies widely. Two groups of basalt flows were distinguished.

The first set of flows (labelled Ba1 on the landforms map) is unweathered, due to the lack of rainfall and their youth. Because of this, there is little soil formation and these flows do not appear to support agriculture. However, in nearby alluvial areas, soil has been able to form on a combination of the basalt material and reworked loess. These areas receive irrigation and are heavily cultivated.

The second basalt flow group (labelled Ba2) consists of the major flow about 80km east of Dhamar, and receives more rainfall than the other group. Airphotos were unavailable for this area, but the satellite imagery seems to indicate that the basaltic rocks are more weathered than in the Ba1 group. The surrounding basalt alluvium is densely cultivated.

Coastal Area

This area is usually referred to as the Tihama. Three kinds of landforms were distinguished: wadis, alluvial fans, and coastal plain.

Coastal Alluvial Fans: The coastal alluvial fans are labelled Cf. The material making up the fans comes from the highlands: the Yemen volcanics in the south and the Precambrian shield in the north. These alluvial fans receive very little rainfall (200 - 300mm/year), but are used for agriculture when wadi water is available, often using bund farming.

Coastal Wadis: Wadis on the coastal plain (labelled Cw) receive water from the mountains to the east. There is little or no rainfall on the Tihama to supply wadis directly. Most of the water in the wadis seeps into the underlying sediments before reaching the Red Sea.

Wadi alluvium, which is carried by water from the mountains and adjacent fans, forms flat plains. The alluvium contains both volcanic-derived sediment and reworked loess. The alluvial deposits become finer away from the mountains. There is little relief associated with wadi beds.

Wadis are used extensively for agriculture, with most of the activity near the mountains, where water is most plentiful. Blowing sand often threatens cultivated fields on coastal wadis.

Coastal Plain: The coastal plain (labelled Cp) is the alluvial plain on the Tihama outside the wadi and alluvial fan areas. It is extremely dry, and wind is the primary landform shaping force. Longitudinal dunes and barchans are prevalent. There is little relief besides the dunes on the coastal plains and little agriculture.

Inland Alluvium

The areas of inland alluvium were divided into three categories; alluvial plains, wadi alluvium, and inland alluvial fans. Alluvial plains and inland alluvial fans were probably formed during an earlier, wetter period.

Alluvial Plains: Alluvial plains (labelled Ap) are broad plains of alluvium covering bedrock between mountains. Some plains show protruding volcanic cones. The alluvium is a mixture of products of the weathering of the surrounding rock outcrops (volcanic and sandstone formations) and materials deposited by the wind.

Two major classes of alluvial plains were separated on the basis of rainfall. Six hundred millimeters per year was chosen as an arbitrary break point because it is near the boundary between the ustic and aridic soil moisture regimes. Those with higher rainfall (close to 1000mm/year) support extensive agriculture (labelled Ap2). Those in drier areas (rainfall around 300mm/year) support less agriculture (labelled Ap1).

Wadi Alluvium: In the mountains, wadis are entrenched in steep valleys between mountain ridges. The areas (labelled Aw) along the major wadis in the mountains generally have a reliable supply of water and can support agriculture in the floodplain. The moisture conditions of any individual wadi vary depending on the amount of rainfall and the type of alluvial material deposited.

Inland Alluvial Fans: This unit (labelled Af) includes two fans along the Wadi Al Jawf. These inland alluvial fans receive almost no rainfall (0 - 100mm/year) and cannot support agriculture. There is almost no weathering of the alluvial material and thus little soil formation.

Loessal Plains

Loessal plains are areas of extensive loess deposited in broad mountain valleys. These were divided into two groups, depending on the material found underneath them. Loessal plains deposited on bedrock are labelled Lp, while loessal plains deposited on lake deposits from an earlier, wetter time are labelled Ll. Both landforms are broad, level valleys, but the soils formed on them are significantly different. The Ll group tends to be used for

agriculture more extensively than the pure loessal plains, because they generally receive more rain and the soil formed is more productive. Both loess areas are intensively terraced and/or ridged for agricultural purposes.

Precambrian Shield Areas

The Precambrian shield is made up of erosion-resistant igneous and metamorphic bedrock. Consequently, the terrain is very jagged and mountainous. Mountain ridges are separated by wadis or linear areas of alluvium. There appears to be little deposition of alluvial material in wadi beds, which are braided stream channels.

The Precambrian shield areas are divided on the basis of rainfall. The unit labelled pC1 is located in very dry areas (rainfall <100mm/year), and is unable to support agriculture, except in isolated areas along major wadis. The wetter areas (rainfall of around 600mm/year) make up the area labelled pC2. Agriculture is found both in the stream floodplains and on terraces up the sides of the ridges in these areas.

Sedimentary Rock Areas

Limestone and sandstone are the two major kinds of sedimentary rocks deposited in Yemen. There are several different formations of each kind, but they appear to result in similar landforms.

Limestone Areas: Limestone areas (labelled Ls) are located in the drier areas of Yemen and are consequently very resistant to erosion. The area is dissected, generally along structural features.

Agriculture is extensive where the water supply permits, but where rainfall is limited, little or no agriculture takes place. In the drier areas, there is little soil formation, due to lack of weathering of the rocks.

Sandstone Areas: There are two major sandstone formations: the Taliwah group (labelled Ss1) and the Wajid sandstone (labelled Ss2).

The Taliwah group is located in areas of relatively high rainfall and is highly dissected, with entrenched wadis between high mountain ridges. There appears to be little soil formation on the mountain sides or in the stream channels. There is little agriculture in these areas.

The Wajid sandstone outcrops in the dry northern area. They are less rugged than the Taliwah areas, with broader plains between mountains. Some agriculture is found on these plains, where rainfall or groundwater supplies permit.

Yemen Volcanics

The Yemen Volcanics formation occurs extensively over southwestern Yemen. The area is a rugged igneous plateau, which has been strongly dissected. Mountainsides are rocky, with some soil formation in protected areas. Agriculture is concentrated in valley bottoms, with some terracing on less steep slopes.

The Yemen Volcanics area was divided into two areas on the basis of rainfall. The area with less than 600mm of rain per year (labelled Yv1) is more dissected and rugged. Farming in these areas is limited to wadi valleys, with a few terraces. The area receiving more than 600mm/year is labelled Yv2. In these areas, agriculture is more extensive, with a large amount of terracing.

GENESIS AND CLASSIFICATION OF SOILS

GENETIC PROCESSES AFFECTING SOIL RELATIONSHIPS IN YEMEN

The genesis of the soils of Yemen is influenced primarily by six natural processes and two man-induced processes. These processes result in the accumulation of soil parent material and in the formation of the soil itself. The natural processes which result in the accumulation of soil parent material are: aeolian deposition, desert sedimentation, colluvial deposition, and combinations of these three processes. The natural processes which affect soil formation in Yemen are: intermittent, low levels of soil leaching and the low level of organic matter accumulation. The man-induced process affecting parent material formation is the accumulation of sediment through terracing and irrigation. The man-induced soil-forming processes are the leaching of soil parent material by irrigation and the accumulation of organic material by cropping.

Natural Processes

Parent Material Formation: Parent material formation is the accumulation of inorganic sediments which have the potential to form soils by geologic processes.

Aeolian Deposition: Aeolian transport and deposition of soil parent materials has been and still is an important factor of soil genesis in Yemen. The wind has deposited soil parent material in two forms: as loess and as dunes. Large and widespread deposits of loess are observed throughout Yemen. Recent and ancient dunes are a predominant feature of the Tihama coastal area.

Loess: In the mountains most of the aeolian material is silt and clay-size calcareous loess. This loess orginates either locally or from the Rub Al Khali and Sahara deserts.

Field and airphoto observations show that deep loess deposits have accumulated in broad areas of low relief. In steep mountain areas, loess is deposited in valleys at least 2km wide. Larger loess deposits such as the Al Ganed plain (40km northwest of Taizz) appear to be graben areas filled with thick wind-blown sediments (Figure 2.3). On steep slopes and in wadi flats, the loess is reworked and transported by water. Aeolian-deposited loess layers are not observed on steep topography or in wadi bottoms.

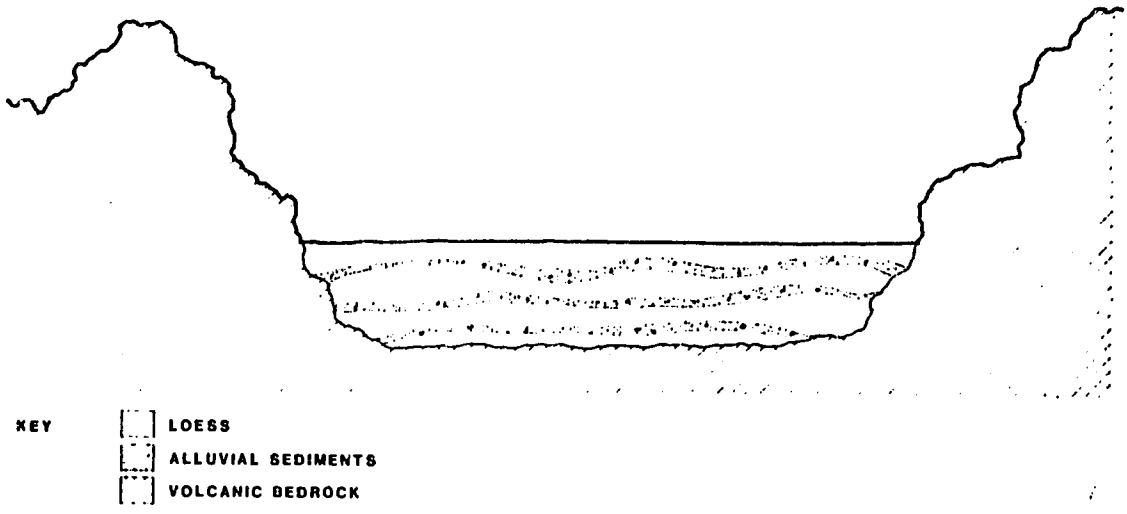


FIGURE 2.3

Deposition of Loess in Broad Valleys Between Steeper Topography in the Yemen Volcanics

Dunes: On the Tihama, sand and loess from the wadi beds are moved by the wind. Barchan and longitudinal dunes are frequently observed in the areas between wadis. Dunes grow, driven by prevailing winds from the Red Sea. Soil profile development is slow in these areas of shifting sand and loess.

Sand and silt dunes are presently encroaching on many cultivated areas in the wadis on the Tihama (Figure 2.4). This sediment transport has no doubt been important in the past also. Much arable

land is lost each year by this encroachment, and local farmers must create new farmland in stabilized areas.

Fluvial Sedimentation: Sedimentation by water is important both along wadis and on intermountain plains.

Wadis: Sedimentary processes are particularly active along wadis. Sedimentation accounts for the layering and thin-bedding of many wadi soils. This is observed at the wadis on the Tihama and in large inland basins, such as Qa'Jahran (the area north of Dhamar). Large areas of soils in the inland plains also appear to have deep caps of more recent wind- and v er-deposited material. In all of these areas, the most striking differentiation of the soil profiles is produced by fluvial sedimentation.

In a transect across Wadi Zabid (Figure 2.5) several levels of natural alluvial terraces, each with distinct textural compositions, are observed. The older, more extensive terraces contain less sorted, coarser materials (gravel and small boulders) while younger, less extensive terraces are typically better sorted and finer in texture. Textures of soils near the border of dune fields and wadis are coarse. Textures become finer towards the interior of the wadi (Figure 2.4).

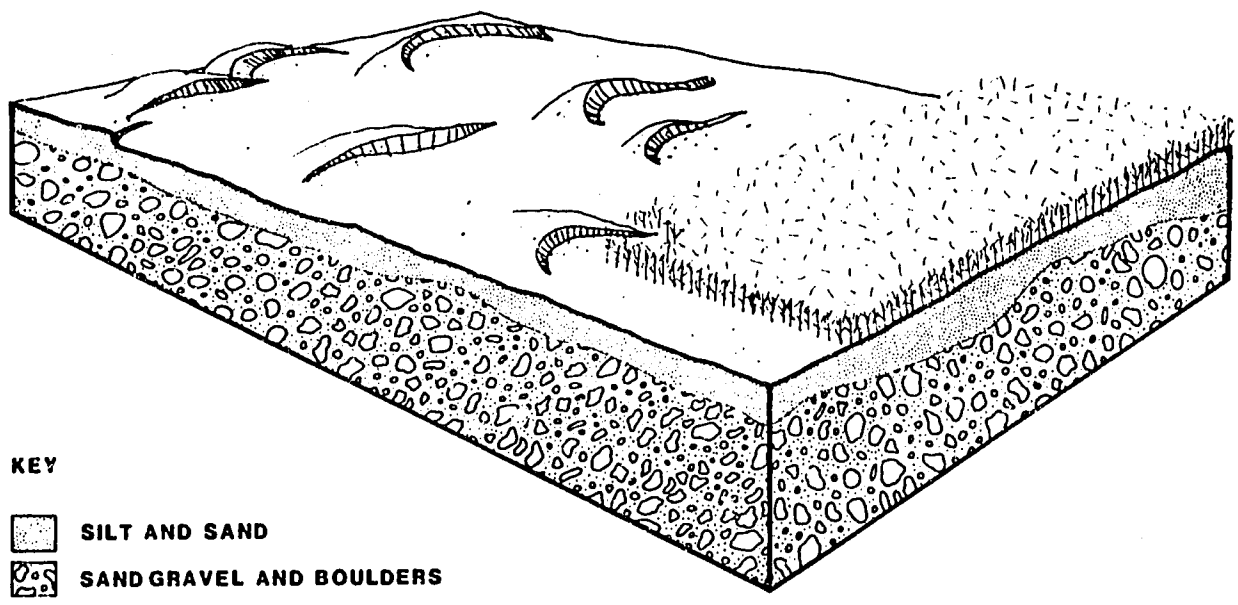


FIGURE 2.4

The Encroachment of Dune Fields on Cultivated Wadi Soils

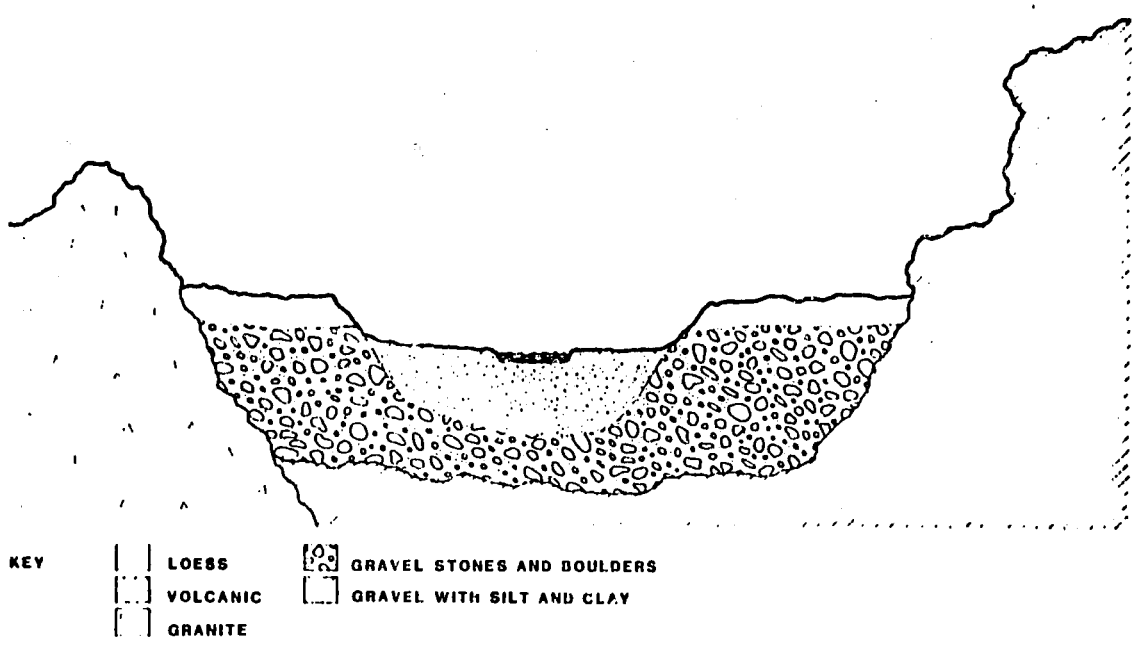


FIGURE 2.6

A N-S Transect Showing the Location of Major Alluvial Terraces Across Wadi Zabid Near the Volcanic Foothills

In an east-west transect along the Wadi Zabid from the volcanic mountains to the Red Sea, another sequence of sediments is observed (Figure 2.6). In general, materials become finer eastward from the mountains until a zone of recent sedimentary marine deposits is reached near the Red Sea. This sequence of soil parent materials appears typical for the Tihama as a whole.

Intermountain Plains: In Qa'Jahran (the Dhamar Plain) extensive lacustrine deposits (Acres, 1980) are observed. These deposits suggest a previous wetter climate and/or restricted drainage in the horst and graben landscape. The lacustrine sediments are typically covered with a thin, more recently deposited loess cap (Figure 2.7).

Colluvial Deposition: The extensive colluvial deposits in the Yemen volcanic zone are distinct from the aeolian and alluvial deposits. Characteristically, they occur as moderately sloping pediments at the base of steep volcanic walls or mountainsides (Figure 2.8). The volcanic stones, gravel and boulders in the colluvium are usually sharp and rough-edged. Colluvial pediments in the higher rainfall areas of Ibb are deeper (reach closer to volcanic outcrop summits) and less steep than those in lower rainfall areas, e.g. near Sana.

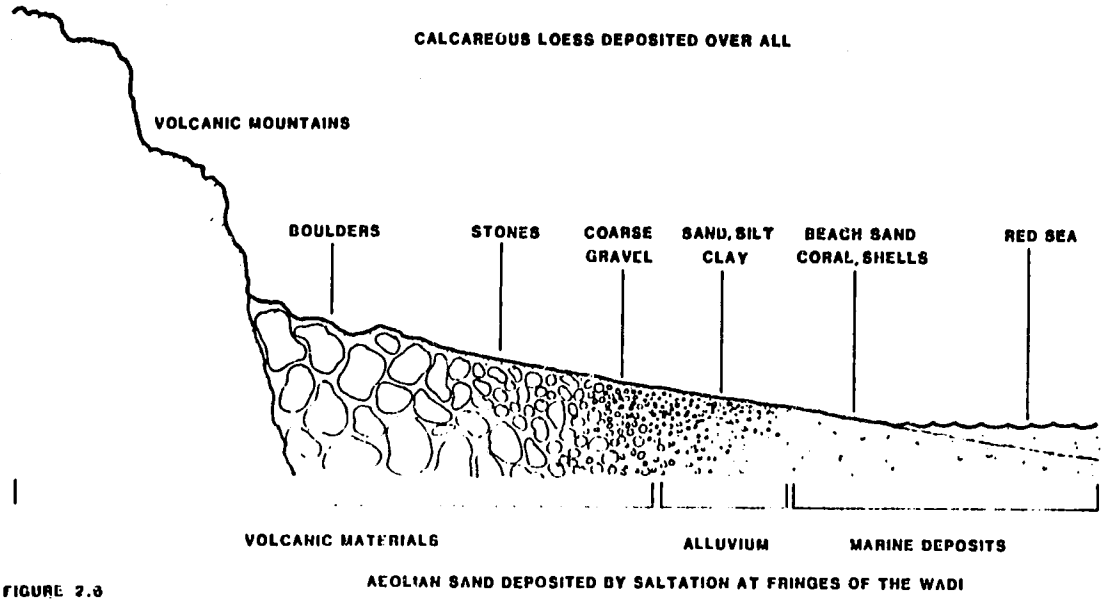


FIGURE 2.6

Parent Materials on an E-W Transect Along Wadi Zabid

Combinations of Fluvial, Colluvial, and Aeolian Deposits: Most soil parent material in Yemen accumulates as a result of all three processes of soil parent material formation. Alternating layers of colluvium, alluvium, and loess in any sequence or combination are common. Colluvium mixed with loess is characteristic of many soils of the volcanic highlands.

This form of accumulation of parent material often results in a buried soil horizon. On flat to gently rolling broad landscapes, buried soils characterized by dark A1 horizons covered by more recently deposited materials are common (Figure 2.7). These buried soils can be covered by aeolian, colluvial or alluvial materials. For example, at Ibb roadcuts often show alluvial sediments overlain by loess. In these cases, a very abrupt boundary is observed.

Soil-forming Processes: Soil-forming processes are those which act on soil parent material to produce soil horizonation.

Intermittent and Low Levels of Soil Leaching: Large regions of Yemen are in the aridic soil moisture regime. The highest rainfall in the country (near Ibb) may be marginally udic. Leaching of carbonates and other salts is not advanced. As a result of the low level of

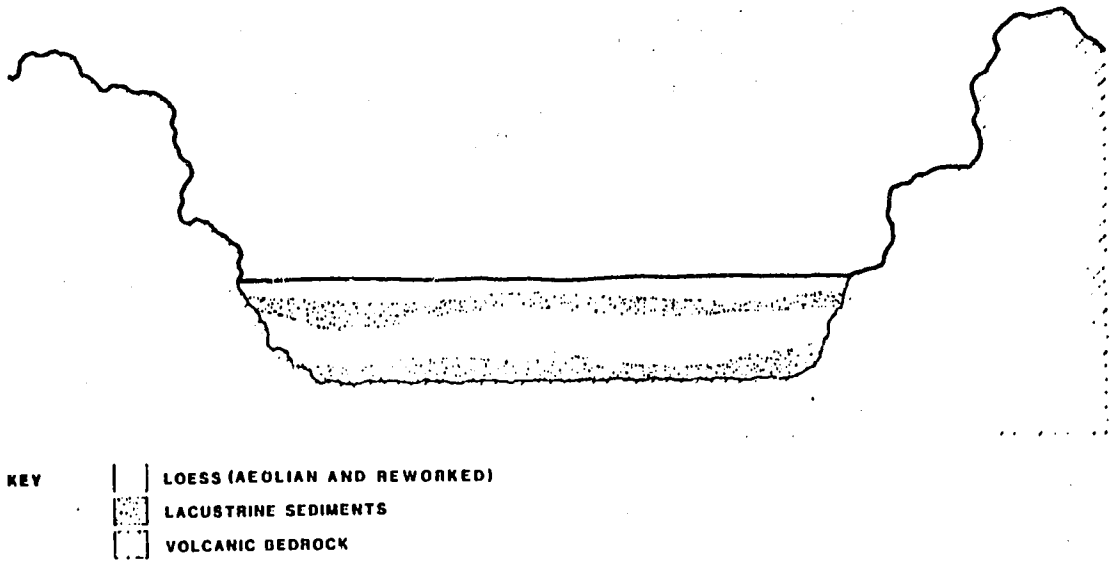


FIGURE 2.7

Lacustrine Sediments Overlain by Aeolian Loess at Qa'Jahran

leaching, soil mineralogy is characterized by a young weathering stage.

The intermittent and low levels of leaching control the location of carbonates and carbonate morphology in the profile. All profiles examined in the field were at least slightly calcareous. Typically, some leaching of carbonates has occurred, so calcareous concretions were formed in B-horizons of some soils. In some areas, where significant water may episodically collect, e.g. plateaus at the bases of steep volcanic mountains, distinct zones of high accumulation of carbonates are present (Figure 2.9).

Low Levels of Organic Matter Accumulation: In Yemen, as in most arid regions, there is little accumulation of organic matter in soil horizons. Only in areas of higher rainfall (as in the Ibb area), or at water collecting positions in the landscape (lower-slope concave positions) does organic matter accumulate to any great extent in the surface horizons. Mollic epipedons can be found in such positions.

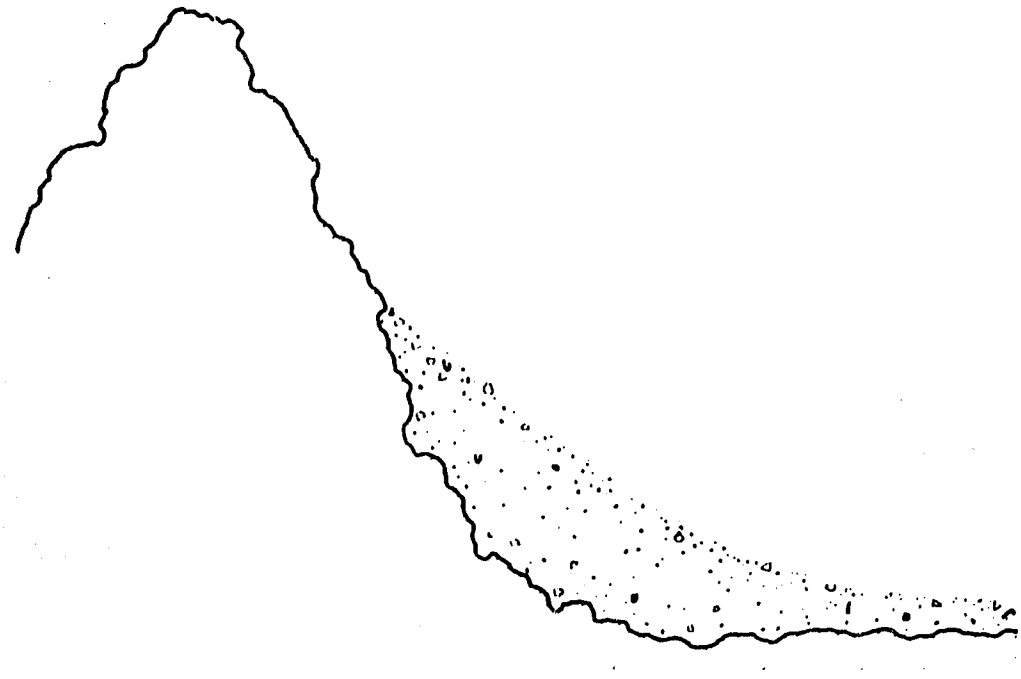


FIGURE 2.8

Colluvial Pediment Near The Base of a Volcanic Rock Outcrop Near Al Ganed

Man-induced Processes

Parent Material Formation: Man affects soil parent material formation by terracing and irrigation. It has been suggested that men have been constructing terraces in Yemen for at least 2000 years. In the mountainous areas, soil horizonation has been altered significantly by this human influence. Similarly, sedimentary processes have been controlled and modified by farmers building bunds and other barriers along wadis on the Tihama and inland.

Terracing: Terraces retain and collect soil parent material along the mountain slope. The natural process of erosion and movement of soil materials downslope is greatly slowed, and soil is able to form on the accumulated parent material. Terracing also results in the sorting of the parent materials because stones are removed from the colluvium and used to build terrace walls.

Two kinds of terraces are recognized in the Yemen volcanic zone: colluvial terraces and loess terraces. All the terraces observed could be classified into one of these two groups.

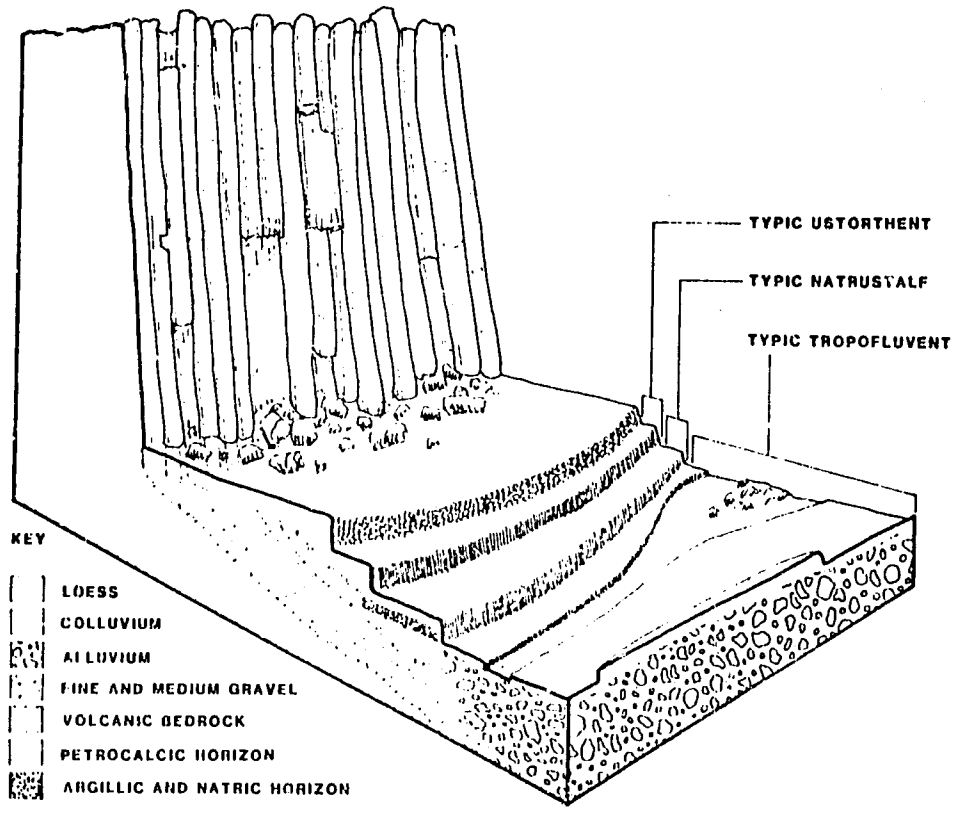


FIGURE 2.9

Soil Relationships on Plateaus Beneath Steep Volcanic Mountains

Colluvial Terraces: Colluvial terraces consist of colluvium from volcanic rocks mixed with some loess. The soil material in colluvial terraces is quite erodable as seen in terraces with broken-down walls. The colluvium itself is gravelly and/or stony and has a lower water-holding capacity than the loess material.

Loess Terraces: Loess terraces have no constructed retaining wall, because loess erodes less easily than colluvial soil parent materials. Loess material is heaped up and a vertical free-standing wall is constructed.

Irrigation: Long periods of irrigation and water control have also affected the deposition of soil parent materials. Spate irrigation on the Tihama has increased sedimentation on the lower, flatter areas. This sedimentation results in formation of terraces often differing in height by several meters.

Soil-forming Processes:

Leaching of Soil Parent Materials by Irrigation: Irrigation of some form has been going on perhaps as long as the construction of terraces.

Highland Irrigation: In the highlands, rainwater collection on concave fields by bunds and ridges is the most important form of irrigation. These methods make the small amount of precipitation more effective by reducing runoff. Terracing has the same effect because it also reduces runoff. These processes result in a small increase in leaching of the soil parent materials and soil formation occurs more quickly than it would naturally.

Tihama Irrigation: Along the Tihama spate and well irrigation have been practiced. The leaching and reprecipitation of salts must have resulted from this. However, this was not immediately apparent in any of the areas visited, and will need to be confirmed by analytical lab results.

Increased Accumulation of Organic Matter: Soils which have been intensively irrigated for cropping for long periods of time have higher amounts of organic matter in their surface horizons. However, organic matter does not generally accumulate sufficiently in this manner to form mollic epipedons.

TAXONOMIC SOIL CLASSIFICATION OF THE SOILS OF NORTH YEMEN

The mapping units are associations of subgroups (USDA-SCS, 1975). In the legend (Chapter 5), associations are named by the predominant soil order. Each of these predominant soil orders is described below.

Entisols (approximately 59.5% of total area)

Most soils in North Yemen are either subject to constant erosion processes or are the product of recent deposition with the result that strongly expressed profile development is rare and the dominant soil order is the Entisol. Orthents dominate in the most arid regions of the country where organic matter decreases uniformly with depth and in mountainous regions where most soils are situated on slopes steeper than 25%.

Fluvents dominate most plains and wadis both because of the irregular distribution of organic matter in the profile and because significant amounts of organic carbon are found at a depth of 1.25m in the profile.

Soil moisture regimes are wet enough in limited areas for some Entisols to be classified as Aquents.

Most Entisols in North Yemen are strongly influenced by alluvial or loessal calcareous silt parent materials but where the parent rocks are sandstone or on the plains where sand has accumulated in dunes, psamments are common.

Aridisols (approximately 8.7% of total area)

In arid regions characterized by a stable surface calcic, and in some instances, gypsic horizons have developed so the soils are classified as Calciorthids or Gypsiorthids. Salic horizons were observed and the soils classified as Salorthids in limited areas where groundwater was both near the surface and saline.

Mollisols (approximately 2.6% of total area)

Mollisols are present in the most cool and moist areas of North Yemen. The most extensive Mollisols have a calcic horizon and are classified as Calciustolls. Other Mollisols developing on calcareous parent materials are Petrocalcic Haplustolls, Udic Haplustolls, Vertic Haplustolls (where surface water accumulates), and Typic Haplustolls (with a cambic horizon on the basis of color). Mollisols which develop where the parent rocks are noncalcareous tend to be Typic Hapludolls.

Most Mollisols on the mountain plains of North Yemen are buried soils. Many Mollisols in the mountains have a shallow lithic contact and are used only for grazing.

Inceptisols (approximately 4.3% of total area)

Inceptisols are very limited in extent but do occur where soils with a calcic or cambic (on the basis of color) horizon exist in a region where the moisture regime is not aridic.

Vertisols (approximately .4% of total area)

Vertisols are the most limited in extent of the major soil orders found in North Yemen. They occur isolated in only a few intermountain basins. They are typically buried under a thin calcareous loess cap.

The rest of the area is predominantly rock outcrop.

Chapter 3

AN OUTLINE OF THE VEGETATION OF THE YEMEN ARAB REPUBLIC

John R. I. Wood

Currently working for the British Council in Colombia, John R. I. Wood holds MA degrees from Cambridge and Reading Universities and has published a number of articles on the botany of Arabia and northeast Africa. He visited North Yemen regularly from 1972 - 1982 and lived there from 1974 - 1980. Recently he published A Handbook of the Yemen Flora.

The present paper sets out to describe the vegetation of the Yemen Arab Republic in two parts. The first part gives a narrative description of the vegetation. In the second part nineteen plant species are selected as indicative of certain ecological conditions. A very brief description of each species is given together with information on its ecology. A distribution map of each species is provided and this shows the actual recorded distribution of each species.

VEGETATION DESCRIPTION

Yemen lies in the extreme southwest of the Arabian peninsula and is separated from Africa by the Red Sea, a narrow barrier of relatively recent formation. As its geographical position would suggest, its lowland vegetation is a mixture of that found on the African plains (Sudanian) and that found in the Afro-Asian desert regions (Sahara-Sindian), the Sudanian element being predominant in areas with an annual rainfall above about 250mm and the Sahara-Sindian elements in areas with a rainfall less than this. Yemen is also remarkable for its mountain ranges which rise in several places to well over 3000m. The mountain vegetation is predominantly Afromontane but there are small Mediterranean, Irano-Turanian and Boreal elements. The main vegetation types and their geographical affinities are discussed under the following general headings:

Maritime Vegetation (The Red Sea coast)

Desert (i.e. the Sahara-Sindian element)
0 - 1100m

Savannah Bushland (i.e. the Sudanian element)
100 - c 1900m

Mountain Vegetation (principally the Afromontane element)
1900 - 3666m

Wadi Vegetation

MARITIME VEGETATION

The coastal vegetation is highly specialized. Virtually all the species present are unknown elsewhere in Yemen and all share the capacity to tolerate very high salt levels.

Mangrove Swamp

The most conspicuous species is the white mangrove, *Avicennia marina*, which provides an almost continuous fringe along the beach from the Wadi Siham northwards. Locally in the shallow muddy inlets and creeks around Luhayyah and Midi it forms extensive stands of several acres in extent. No other species is associated with it.

Sabkhah

This is the local term for the land lying within about one kilometer of the coast which has been saturated with salt spray driven inland by onshore winds. Much of it is salt encrusted and bare of all vegetation but on hummocks and in slightly drier areas *Suaeda fruticosa* is dominant. It is often associated with *Aeluropus lagopoides* and sometimes with *Cressa cretica*, *Limonium axillare* and *L. cylindrifolia*, all three of which are uncommon but restricted to this habitat. Sabkhah communities can be found all along the Red Sea coast.

Shingle Beaches

In a few places, notably around Khawkhah and Midi, there is a raised beach above the high tide mark. This supports a quite different maritime vegetation characterized by the presence of *Atriplex farinosa*, *Zygophyllum album*, *Z. coccineum* and *Halopyrum mucronatum*.

DESERT VEGETATION

These types of vegetation occur in areas which receive a rainfall below about 200mm per annum lie in the western half of the Tihama and in the extreme east of Yemen around and to the east of Khabb, Ma'rib

and Harib. Besides the low rainfall both areas are composed almost entirely of alluvial soils, principally mobile or semi-mobile sands, and have a sparse but characteristically Sahara-Sindian vegetation.

Coastal Sand Dunes in the Tihama (Alt. 0 - 150m)

Running the whole length of the Tihama and extending eastwards for a distance of between 20 and 25km is an area of sand dunes. Apart from plantations of the date palm *Phoenix dactylifera* and *Hyphaene thebaica* near villages and along wadis where ground water is close to the surface, the area is almost entirely treeless and this is probably a natural phenomenon. Rainfall in the area is very low and trees would never have thrived, though two indigenous and undescribed species of the palm genus *Hyphaene* occur. It seems probable, however, that the present vegetation is somewhat impoverished because of grazing.

The characteristic dominant species in this area are the salt bushes, *Suaeda monoica* and *Salsola spinescens*, which occur mostly near the sea, and *Jatropha pelargoniifolia*, *Leptodenia pyrotechnica* and *Odyssea mucronata* which occur more frequently inland. Although they appear to have slightly different ecological requirements as one species is rarely codominant with another, they all tend to form the same type of community. They are undershrubs, 0.5 - 2m high, which can form relatively dense bushland with plants only about 2m apart or can occur as scattered individuals in open duneland with extensive bare areas between them. Whatever the dominant species, the associated plants are almost always *Aerva javanica*, *Dipterygium glaucum*, *Fagonia indica*, *Heliotropium pterocarpum*, *Panicum turgidum* and *Tephrosia purpurea*.

Many of the plants occurring here are widespread throughout the Sahara-Sindian region, notably *Aerva javanica*, *Leptodenia pyrotechnica* and *Panicum turgidum* which all occur in the eastern deserts discussed in "Aeolian Sands in the East of Yemen." Some species, though, of which *Heliotropium pterocarpum* and *Odyssea mucronata* are the only common ones, are strictly limited to the Red Sea basin which is treated by some authors (e.g. Zohary) as a division of the Sahara-Sindian region.

Silt Deposits in the Western and Central Tihama (Alt. 50 - 300m)

Extensive deposits of fine silt are found along wadi lines in the central Tihama, apparently marking the point where floods dried up and deposited their silt load. In the western Tihama the silt deposits have been much eroded and are usually found as scattered mounds amid sand dunes.

Whether the deposits are extensive or small, they tend to carry the same vegetation. The dominant species are the three shrubs, *Salvadora persica*, *Cadaba rotundifolia* and *Capparis decidua*, all of which can form extensive dense scrub about 2m in height. Good examples can be seen at Husayniyah (*Capparis decidua*), Khalifah (*Salvadora persica*), and Mawza' (*Cadaba rotundifolia*). Although climbers like *Cyphostemma*

ternatum and Pentatropis nivalis are often found in the protection of the dominant shrubs, the ground flora is exceedingly sparse, the ground between the bushes often being completely bare. Cassia senna and Jatropha glauca are among the few common species, though Trianthema triquetra and Zygophyllum simplex occur not infrequently suggesting a relatively high level of salt in the silt deposits.

Aeolian Sands in the East of Yemen (Alt. 900 - 1100m)

Although this region covers a considerable portion of Yemen, very little is known of its vegetation. It is quite probable that parts towards the center of the Empty Quarter are almost entirely devoid of all vegetation but more accessible areas are covered by a sparse vegetation consisting of Calligonum crinitum, Rhazya stricta, Salvadora persica and, more rarely, Leptodenia pyrotechnica, all of which grow on hummocks. Associated species are few but include hardy perennials like Pennisetum divisum, Heliotropium dygynum, Dipterygium glaucum and Aerva javanica, the last two also being characteristic plants of the Tihama sand dunes. Ephemeral species occur but appear to be rare, Tribulus omanensis being the most typical.

SAVANNAH BUSHLAND

With the exception of the desert regions discussed in the previous section, the natural vegetation of almost all Yemen below about 1800m would have been dense bushland or open woodland of the type found throughout the Sudanian savannah regions of Africa. Much of this bushland has been cleared for agriculture while in other areas it is much degenerated through overgrazing. In remote and more favored areas there are considerable stands which must resemble the primeval vegetation and in a few areas some fragments of woodland survive. Nearly everywhere the dominant plants are species of Acacia or Commiphora usually about 2 - 4m in height. The type of scrubland in which they are dominant is referred to as Acacia-Commiphora bushland. In a few areas however, a different species is dominant, either Dobera glabra, Combretum molle or one of the succulent Euphorbias, and these distinct communities are also discussed. The survey begins with the eastern Tihama and then goes on to discuss the various communities in the mountains. There are certain features common to the Tihama vegetation described in the next three sections, notably the abundance of Acacia ehrenbergiana, A. hamulosa and A. oerfota, which separate these communities from the mountain vegetation where Acacia mellifera and A. asak are abundant. Very few species, except Aerva javanica and Blepharis ciliaris, are common both on sand and rock but the bushland in the southern Tihama is to some extent intermediate between that found on the Tihama sands and that found on the mountains.

Sand Dunes in the Eastern Tihama (Alt. 100 - 400m)

Sand dunes extend into the eastern part of the Tihama, particularly between the Wadi Rima' and the Wadi Mawr. This area clearly enjoys a higher rainfall than the northern and southern extremities of the

Tihama, is evidenced by the extensive plantations of Pennisetum Millet found on the dunes around Qutay, Zaydiyah and Qanawis. At first sight, this region would appear to belong most naturally to the desert regions (Section 2) and indeed many of the characteristic Sahara-Sindian species noted earlier, like Dipterygium glaucum and Panicum turgidum, are common here. The duneland, however, is much richer in vegetation, with a considerable number of ephemeral annuals like Aristida mutabilis and Indigofera arrecta and it is really only man's activity that has rendered the area treeless.

The natural vegetation was almost certainly open woodland dominated by Acacia ehrenbergiana some vestiges can be found, notably between Dahi and Zaydiyah. Often associated with Acacia ehrenbergiana is A. tortilis, but no other tree, except the rare Commiphora quadricincta, is known to occur in this sort of woodland. The acacias provide a continuous, if rather thin canopy and no shrubs or herbs flourish under them with the exception of Tephrosia purpurea which is abundant. Cocculus pendulus and Pentatropis nivalis are common climbers.

Dobera Parkland on Silt Lands in the Extreme East of the Tihama (Alt. 300 - 500m)

Lying immediately to the west of the first mountains of the escarpment from the Wadi Zabid north to the Wadi Mawr is a belt of country about 10km from east to west. This area possesses a rich alluvial soil probably built up from silt washed down from the escarpment. The characteristic tree is Dobera glabra which gives the area an open park-like aspect. It seems probable that this tree was dominant in open woodland in prehistoric times in association with Acacia ehrenbergiana and A. oerfota, both of which occur in abundance today though no vestiges of this woodland remain. As with the woodland outlined in "Sand Dunes in the Eastern Tihama", it seems that there would have been little ground cover and few, if any, shrubs in this woodland since the vegetation under the isolated Dobera trees is extremely sparse.

Today most of this area is cultivated and the vegetation is limited mainly to plants of grassy banks around fields where Cynodon dactylon and Dactyloctenium scindicum are the most characteristic species and to the field weeds themselves. Several of these like Sesbania leptocarpa and Schoenefeldia gracilis are restricted to this area but others such as Gynandropsis gynandra, Echinochloa colona, Brachiaria reptans and Cyperus rotundus extend far inland on the rich alluvial soils of the irrigated valleys.

In areas which have avoided cultivation, a secondary scrub has developed. This is 1 - 2m in height and is dominated either by Indigofera oblongifolia or Abutilon pannosum. The scrub is sometimes so dense that other species cannot survive but in open areas Cassia occidentalis, Dactyloctenium scindicum, Jatropha glauca and Ocimum forskolei are frequent.

Gravel Plain in the Southern Tihama (Alt. 100 - 500m)

South of the Wadi Zabid the eastern Tihama has a quite different appearance. The area appears to receive a relatively low rainfall and the soil is mostly composed of gravels fanning out along the numerous small watercourses.

The vegetation is of the Acacia-Commiphora bushland type with small trees 2 - 4m in height variously spaced. In some areas the bushland is quite dense and probably resembles that found before the arrival of man but in most places a good deal of scrub has been cleared for firewood and regeneration has been made difficult by the abundance of grazing animals.

The dominant tree species are four species of Acacia (A. edgeworthii, A. ehrenbergiana, A. hamulosa and A. tortilis), two species of Commiphora (C. gileadensis and C. myrrha), two species that mimic the Commiphoras in their vegetative appearance (Euphorbia cuneata and Rhigazom somaliense) and Saltia papposa, a shrub of extremely arid bushland. Climbers like Cissus quadrangularis are frequent but most characteristic are the tough, wiry, often succulent or spiny plants that make up the ground flora. The grasses Cymbopogon schoenanthus and Lasiurus scindicus, the succulents Aloe niebuhriana and Euphorbia triaculeata, the undershrubs Blyttia spiralis, Campylanthus yemenensis, Chascanum marrubifolium and Indigofera spinosa are all typical.

Acacia-Commiphora Bushland on Steep Slopes on the Escarpment (Alt. 400 - 1600m)

All the lower regions of the escarpment are characterized by steep slopes subject to very rapid run-off during the rains. Consequently there is little soil and the ground is predominantly rocky. Agriculture is mainly limited to the valleys; the hillsides are covered in bushland. There is considerable variation in the density of the bushland; in some areas it is almost impenetrable but in most places grazing and clearance for firewood have ensured that the bushes are quite far apart; in a few cases the hills are almost denuded, particularly near main roads.

The most characteristic shrub of this bushland is Acacia mellifera. It is commonly associated with Acacia asak and Commiphora sp. A sensu Wood (1983). Underneath these main bushes is a shrub layer 1 - 2m in height, consisting of Acalypha fruticosa, Adenium obesum, Anisotes trisulcus, Cadaba farinosa, Grewia tembensis and Ormocarpum yemenense. Succulent species are also prominent and Cissus quadrangularis, C. rotundifolius, Aloe spp., Caralluma penicillata, Euphorbia cactus, E. inarticulata, Kleinia odora and Sansevieria ehrenbergii are all common. The ground flora is quite rich and consists mostly of tough perennials, notably Aerva javanica, Aristida adscensionis, Blepharis ciliaris, Boerhavia diffusa, Commicarpus helenae, Indigofera spinosa, Ruellia patula and Tetrapogon villosus.

Acacia-Commiphora Bushland in the Foothills (Alt. 400 - 600m)

All species present on steep slopes on the escarpment are also common at low altitudes, but the foothills of the escarpment are rather distinct. This area is characterized by an abundance of Grewia tenax, a species unknown above 1000m. Other characteristic plants of the foothills are Acacia ehrenbergiana, Aloe vera, Commiphora gileadensis, Cordia sinensis, Delonix elata, Endostemon tenuiflorus, Indigofera tinctoria and Pavonia arabica.

Acacia-Commiphora Bushland at Middle Altitudes (Alt. 1600 - 1900m)

In some areas Acacia-Commiphora bushland extends almost to 2000m. Such bushland, found for example around Maghrabah on the Sana-Hudaydah road, has a rather different appearance from that at lower altitudes. The only Commiphora present is likely to be C. schimperi which rarely occurs in abundance. Acacia etbaica replaces the other species of Acacia. Most of the characteristic shrubs at lower altitudes disappear and only Adenium obesum and Grewia tembensis remain frequent. Instead, the common shrubs are Barleria bispinosa, Cadia purpurea, Pavetta longiflora, Psiadia punctulata, Rhamnus staddo and Segeretia thea. Succulents are less numerous but Aloe vacillans, Euphorbia cactus and Kleinia odora are amongst the most abundant species present. The ground flora is rather species-poor though many plants common at low altitudes are still present. Particularly characteristic, however, are Leucas alba, Seddera arabica and Tragia pungens.

Acacia-Commiphora Bushland in Dry Areas (Alt. 500 - 1600m)

There is some difference in the nature of the Acacia-Commiphora bushland in dry areas which can often be identified by the abundance of Aerva javanica. This type of bushland is comparatively species-poor but is usually marked by the relative frequency of Commiphora myrrha, Euphorbia cuneata and Salvadora persica. Other species found only in drier conditions are Cadaba heterotricha, C. rotundifolia, Seddera latifolia, Fagonia indica and Farsetia longisiliqua.

Acacia-Commiphora in Areas of Good Rainfall (Alt. 500 - 1600m)

In contrast to the bushland outlined in the previous section, that found in areas of good rainfall is relatively rich in species. The characteristic plants of drier bushland are rare or absent but they are replaced by the much more numerous species restricted to areas of good rainfall. The great variety of shrubs, and particularly the genus Grewia, is especially marked. Grewia schweinfurthii, G. velutina and G. villosa are frequent, as are Abrus bottae, Cordia ovalis, Ehretia obtusifolia and Ochna inermis. There is also a much richer herb flora with species like Commelina albescens, Leptothrium senegalense, Justicia flava and Polygala senensis occurring in some abundance.

Valley Forest (Alt. 500 - 1000m)

This is the richest Sudanian type of vegetation found in Yemen, but is very local and only present in the deep valleys penetrating the western slopes of mountains rising sheer out of the Tihama, notably J. Raymah, J. Bura' and J. Milhan. Such areas enjoy a relatively high rainfall with reduced hours of sunshine owing to the buildup of mist and low cloud along the escarpment.

Bushland in these areas is sometimes transformed into genuine forest with a tree canopy six or more meters in height above the Acacia-Commiphora bushes. The most common tree is Combretum molle which is locally dominant. Other very characteristic trees are Breonadia salicina, Celtis toka, Mimusops laurifolia

and Trichelia emetica, all of which are commonly riparian, and Berchemia discolor, Ficus glumosa, Tamarindus indica, Zizyphus mucronata and Z. spina-christi, which are usually found on the higher slopes. There is a great variety of shrubs about 2m in height, of which the most abundant are Carissa edulis, Oncoba spinosa and Phoenix caespitosa. Climbers such as Clitoria ternatea, Jasminum fluminense and Commicarpus plumbagineus are abundant. The ground flora is also comparatively rich. The valley forest is remarkable for the large numbers of Sudanian species which are otherwise unknown in Asia.

Euphorbia Scrub (Alt. 1000 - 2000m)

In parts of southeast Yemen, particularly in the Taizz-Qa'idah area, the Rujariyah and the lower Wadi Bana, a remarkable derivative of the Acacia-Commiphora bushland is found. In this the succulent element outlined in "Acacia-Commiphora Bushland on Steep Slopes on the Escarpment" has replaced the Acacia-Commiphora bushes as the dominant species. The most prominent succulents are Euphorbia cactus, E. inarticulata and E. schimperi, but above 1500m these are often joined by Euphorbia ammak and E. parciramulosa. Other commonly associated succulents include Adenia venenata, Eulophia petersii, Sansevieria forskaliana and Sarcostemma viminale. The ground flora is essentially the same as that found in the various types of Acacia-Commiphora bushland, particularly on steep slopes on the escarpment, but the spiny Euphorbia bushes provide protection for a number of species like Hibiscus deflersii, H. vitifolius and the grasses Hyparrhenia hirta and Themeda triandra, which are particularly abundant here.

Although the Euphorbia scrub seems to be best developed in areas of slight or moderate gradients, this does not seem to be a complete explanation for its replacement of the Acacia-Commiphora bushland as it is often well developed on very steep slopes in surrounding areas.

Acacia-Commiphora Bushland in Eastern Yemen (Alt. 1100 - 1900m)

Both the steeper slopes and the more level stony plains of eastern Yemen are covered in Acacia-Commiphora bushland. The eastern bushland is never as dense as that found on the escarpment and becomes sparser

towards the east. It is usually best developed on the steep slopes of rather narrow valleys. Although Commiphora myrrha is the only common Commiphora, several species of Acacia are abundant including A. campoptila, A. hamulosa, A. mellifera and A. oerfota, while A. ehrenbergiana is mostly restricted to valley bottoms. Other species that are at least locally frequent are Euphorbia cuneata, Jatropha spinosa, Maerua crassifolia and Salvadora persica. Succulents and climbers are both relatively uncommon while the ground flora is species-poor and mostly represented by tough Sahara-Sindian species like Aerva javanica, Blepharis ciliaris, Cymbopogon schoenanthus and Pergularia tomentosa.

MOUNTAIN VEGETATION

The 1900m contour marks the division between the lowland Sudanian vegetation and the highland (true mountain) vegetation. Almost everywhere in Yemen there is a significant break at about this point. In terms of natural vegetation, the mountain region is probably divisible into five regions, though the first of these has been so much modified by man that the primeval vegetation is virtually nonexistent.

The West-facing Slopes (Altitude 1900 - 3000m)

This area receives the highest rainfall in Yemen and enjoys reduced hours of sunshine particularly at altitudes above 2600m where low cloud is common. Frost is very rare.

The whole area is intensively cultivated except on the steepest slopes; terraces have been carved out of the hillsides wherever possible. Except on cliffs, the natural vegetation has been destroyed but a few relicts allow one to speculate as to its nature before the advent of man.

All the best land was probably covered in Acacia origena woodland; considerable numbers of this tree survive. Associated with it were Cordia africana (still frequent around villages), Dombeya schimperiana (now rare), Euphorbia ammak (still common), Olea europaea (now very local), Pittosporum viridifolium (now rare) and a number of uncommon species. Undershrubs were probably frequent including Acanthus arboreus, Myrsine africana, Rhoicissus tridentata, Rosa abyssinica, Rhus retinorrhea and Vernonia leopoldii. The ground flora was mainly composed of grasses such as Andropogon greenwayi, Hyperrhenia hirta, Pennisetum villosum and Themeda triandra.

Today this woodland is replaced by terraced cultivation. The retaining walls provide a home for many cliff plants like Campanula edulis, Cheilanthes pteridioides, Minuartia filifolia and Pentas lanceolata, while the fields themselves are often filled with weeds like Anagallis arvensis, Chenopodium schraderianum, Erucastrum arabicum and Solanum villosum. The grassy banks around the fields and grassy slopes preserved for fodder are often very species-rich,

providing a refuge for plants unusual in Arabia like orchids and everlasting flowers. Species like Habenaria macrantha, Helichrysum forskahlii, Crepis ruepellii, Swertia polynectaria, Plectranthus barbathus and the little clover, Trifolium semipilosum are common in these situations.

The most abundant secondary vegetation is found on steep, eroded slopes where cultivation is not possible. Such slopes are covered principally in large herbs and undershrubs. Typical plants include Acanthus arboreus, which renders the slopes unpleasantly prickly, Achyranthes aspera, Annarhinum forskahlii, Bidens biternata, Clutia spp., Commicarpus arabicus, Conyza pyrrhopappa, Euphorbia schimperiana, Hypoestes forskalii, Nepeta deflersiana, Pennisetum setaceum, Rumex nervosus, Solanum incanum and Vernonia leopoldii.

Mountains Lying in Rainshadow (Alt. 1900 - 3300m)

As the description suggests, this type of vegetation lies to the east of that found on the west-facing slopes. It is best developed in the Hujariyah and in Khawlan Ash Sham but can also be found on J. Lawz and on the Yisloh pass. Rainfall is much lower than on west-facing slopes but mists appear to be frequent. The vegetation is much less clearly Afromontane in its character and shows many similarities with that found in Oman (Mandaville) and Afghanistan (Freitag). Everywhere the slopes are steep and very little soil is retained. Terraced cultivation is unusual and most fields are found in the valleys.

The most characteristic tree is the juniper, Juniperus procera, but though juniper woodland still survives in Saudi Arabia (Wissmann) there is no woodland left in Yemen except for little colonies in mountain gullies. Instead, the hills are scattered with occasional juniper trees which give the hills a park-like aspect. In some cases, as on the Yisloh pass, the juniper has completely disappeared. Associated with the juniper are Olea europaea and Acacia origena which are joined below about 2300m by Acacia etbaica and Ficus salicifolia.

Today all these trees are comparatively uncommon and the hills are generally covered with a secondary bushland of varying density. Typical undershrubs are Aerva lanata, A. javanica, Cadia purpurea, Clutia lanceolata, Dodonaea viscosa (sometimes very abundant), Kleinia odora, Otostegia fruticosa, Psiadia punctulata, Solanum schimperianum and Tarconanthus camphoratus. The ground flora is rich in grass species like Eragrostis papposa, Aristida adscensionis and Tetrapogon villosus while other characteristic herbs are Commicarpus sinuatus, Hypoestes forskalii, Justicia flava, Osteospermum vaillantii and Pulicaria petiolaris.

Treeless Hills on the High Plateau and Eastern Slopes (Alt. 1900 - 2500m)

Most of the hills around the high plateau above 1900m are entirely treeless. In this situation it is difficult to speculate as to what the natural vegetation was; it is quite possible that these hills have

always been treeless. Certainly today the only places where trees are found are on the cliffs, which also provide a refuge for other plants which are rare in this region.

The hills are not only treeless but almost entirely shrubless as well. Instead they are covered in a sparse vegetation consisting mainly of low woody herbs of which the following are very typical: Aerva javanica, Alkanna orientalis, Andrachne aspera, Becium filamentosum, Blepharis ciliaris, Echinops spinosissimus, Eragrostis papposa, Fagonia spp., Felicia abyssinica, Gnidia somaliensis, Helichrysum pumilum, Indigofera arabica, Portulaca quadrifida, Pulicaria jaubertii, Salvia aegyptiaca, Stipagrostis obtusa and Tetrapogon villosum.

This vegetation is mostly Sahara-Sindian but significant elements are Afromontane. It seems likely that the original vegetation was more obviously Afromontane, but overgrazing has enabled the Sahara-Sindian element to increase as conditions have become more desertlike.

The Mountain Tops (Alt. above 3000m)

The mountain tops are naturally treeless and are covered with a sparse vegetation of low herbs, many of them endemic to Yemen. Many species are cushionlike and all have to be frost tolerant since the temperature regularly falls below freezing during winter nights. Possibly the most common high-altitude species is the endemic Thymus laevigatus. Other characteristic endemic species are Cichorium bottae, Delosperma harazianum and Dianthus uniflorus. Temperate weeds are also a characteristic feature of mountaintops and species like Erodium cicutarium, Marrubium vulgare and Malva parviflora are surprisingly common.

The Intermountain Plains (Alt. 1900 - 3000m)

From the Qa' al Had near Kitab north to the Qa' al Shams near Raydah are a series of intermountain plains. The plains lie between about 1900m and 3000m and are most extensive around Ma'bar. All have alluvial, often loess soils and a relatively high groundwater level though rainfall is low. Frost is common. Rather similar conditions are found in the region of Sadah, though rainfall is lower there. The plains are extensively cultivated, though uncultivated areas are frequent, and are largely treeless today, but this may not have been their original condition.

The most characteristic tree is Acacia gerrardii, which is also common on the plains around Ibb and between Taizz and Qa'idah. The only other trees found are Zizyphus spina-christi, Tamarix aphylla and T. arabica, the last two usually planted along ditches. Shrubs are virtually unknown though Lycium shawii does occur. Common herbs on the plains are Aristida adscensionis (sometimes dominant after the rains), Cassia italica, Cenchrus ciliaris, Centaurea pseudosinaica, Cynodon dactylon, Euphorbia schimperiana (very abundant), Fagonia indica, Launaea decurrens (mostly in abandoned fields), Leucas inflata,

Peganum harmala (abundant), Pulicaria crispa, Solanum glabratum, S. incanum and Withania somnifera.

The species of the mountain plains, as of the surrounding hills, are something of a mixture. Some species are broadly African in distribution (Laggera decurrens is abundant in South Africa), while others are clearly Sahara-Sindian (Pulicaria crispa), and others are Irano-Turanian or Mediterranean (Peganum harmala) in their distribution.

WADIS AND DRAINAGE LINES

Hitherto our survey of the vegetation of Yemen has neglected an important element: the wadis and drainage lines. They are, however, of great significance; many species are found primarily or exclusively along their margins, including a number of the most conspicuous plants in Yemen whose presence often indicates a relatively high water table.

Flood beds in Dry Country (Alt. 0 - 1500m)

Dry floodbeds are found principally in the eastern Tihama, in the foothills of the escarpment and in the eastern mountains where the wadis flowing east disgorge into the Empty Quarter. Floods take place at irregular intervals and may be quite frequent, occurring perhaps twenty times a year, or very infrequent. The waters dry up very rapidly but a considerable amount soaks below ground level, thus providing moisture for the trees that usually line the wadis. The most typical marginal trees are Tamarix aphylla and T. arabica but other trees are not infrequent and include Acacia ehrenbergiana, Salvadora persica and Zizyphus spina-christi. Climbers such as Cocculus pendulus and Pentatropis nivalis are quite common, but the only herb which is at all regular in occurrence is Withania somnifera.

Tamarisks can often be found colonizing the sandy flood bed itself but this is really the territory of Calatropis procera which sometimes occurs in great abundance in and beside the wadi bed. Associated species are few but Cassia senna and Pluchea discorides are also characteristic.

Low Altitude Wet Wadis on the Escarpment (Alt. 500 - 1700m)

Nearly all the major wadis have permanent flowing water or at least seasonal semipermanent stretches of flowing water along their courses through the lower slopes of the escarpment between 500 and 1700m.

Aquatic plants are found by the permanent water and almost always include Typha angustata, Kanahia laniflora, Bacopa monnieri and Phyla nodiflora. Less common are Ecliptera prostrata, Heliotropium ovalifolium and various species of sedge such as Fimbristylus sieberiana and Cyperus laevigatus. Away from the water Amaranthus spinosus and Tridax procumbens are often common.

The margins of the floodbeds are often lined with the bamboo-like grass, Arundo donax, and a number of tall trees. The majority of the trees are species of Ficus, particularly F. vasta and F. sycomorus, but other common and characteristic trees are Breonadia salicina and Trichelia emetica, which like many other species occur sporadically. Shrubs are rather infrequent but Jatropha curcas and Pandanus odoriferus, both introduced, are quite frequent and very characteristic of this habitat.

The permanent flowing wadis are often lined with irrigated fields. The fields are composed of rich alluvial soils capable of producing several crops of cereal each year or of growing tropical fruits. The fields have a characteristic weed flora which includes an abundance of Cyperus rotundus, Echinochloa colona and Solanum coagulans.

Dry Valleys at Low Altitudes on the Escarpment (Alt. 500 - 1800m)

The smaller dry valleys in the Acacia-Commiphora bushland zone carry a vegetation significantly different both from the surrounding bushland and from that found along the permanent flowing wadis. True aquatic plants are completely absent but the richer soil and additional moisture of this habitat allows certain species to thrive which would otherwise be absent from these regions. This is particularly true of trees and species like Combretum molle, Ficus populifolia, F. sycomorus, Trichelia emetica and Zizyphus spina-christi, which are virtually restricted to this habitat throughout much of the Acacia-Commiphora bushland country. The trees usually cast considerable shade; below them the vegetation is likely to consist of Acalypha fruticosa and A. indica, Abutilon bidentatum, Achyranthes aspera, Commicarpus plumbagineus, Hibiscus vitifolius, Solanum incanum and Withania somnifera. Grasses are rare or absent in this habitat.

Permanent Streams at High Altitudes (Alt. 1900 - 3000m)

Dry watercourses at higher altitudes do not usually carry a very distinctive vegetation, though their steep sides often provide a refuge for plants otherwise restricted to cliffs. Where there is permanent water, even where it is restricted to rock pools, a distinctive vegetation is found. Several of the plants occurring in such aquatic habitats are clearly Afromontane, such as Pycreus elegantulus, Pennisetum macruorum and Ranunculus multifidus, but many are widespread plants of temperate areas which extend into the mountains of Yemen, such as Apium nodiflorum, Agrostis viridis and Eleocharis palustris.

MAP 1: THE VEGETATION OF YEMEN

Sahara-Sindian Vegetation Types

△ Sand dune vegetation of the Red Sea coastal type, principally that described under "Coastal Sand Dunes in the Tihama" with intrusive elements along the wadi lines of the vegetation described under "Silt Deposits in the Western and Central Tihama."

▲ Sand dune vegetation on the Aeolian sands of the Empty Quarter, almost entirely that described under "Aeolian Sands in the East of Yemen" with a few rock outcrops bearing a depauperate vegetation of the type described in "Acacia-Commiphora Bushland in Eastern Yemen."

Savannah Bushland of a Sudanian Type

○ Undifferentiated bushland, principally Acacia-Commiphora bushland as described in "Acacia-Commiphora Bushland on Steep Slopes on the Escarpment" but with modifications depending on rainfall ("Acacia-Commiphora Bushland in Dry Areas", "Acacia-Commiphora in Areas of Good Rainfall", "Valley Forest"), altitude ("Acacia-Commiphora Bushland in the Foothills", "Acacia-Commiphora Bushland at Middle Altitudes) and soil conditions ("Sand Dunes in the Eastern Tihama", "Dobera Parkland on Silt Lands in the Extreme East of the Tihama", "Gravel Plain in the Southern Tihama").

⊖ Acacia ehrenbergiana bushland on alluvial sand in the eastern Tihama ("Sand Dunes in the Eastern Tihama"), some penetration of the escarpment along sandy watercourses. Mostly cleared for cultivation.

⦶ Dobera parkland in the eastern Tihama with some penetration of the escarpment on rich alluvial soils in valleys ("Dobera Parkland on Silt Lands in the Extreme East of the Tihama"). Mostly cleared for cultivation.

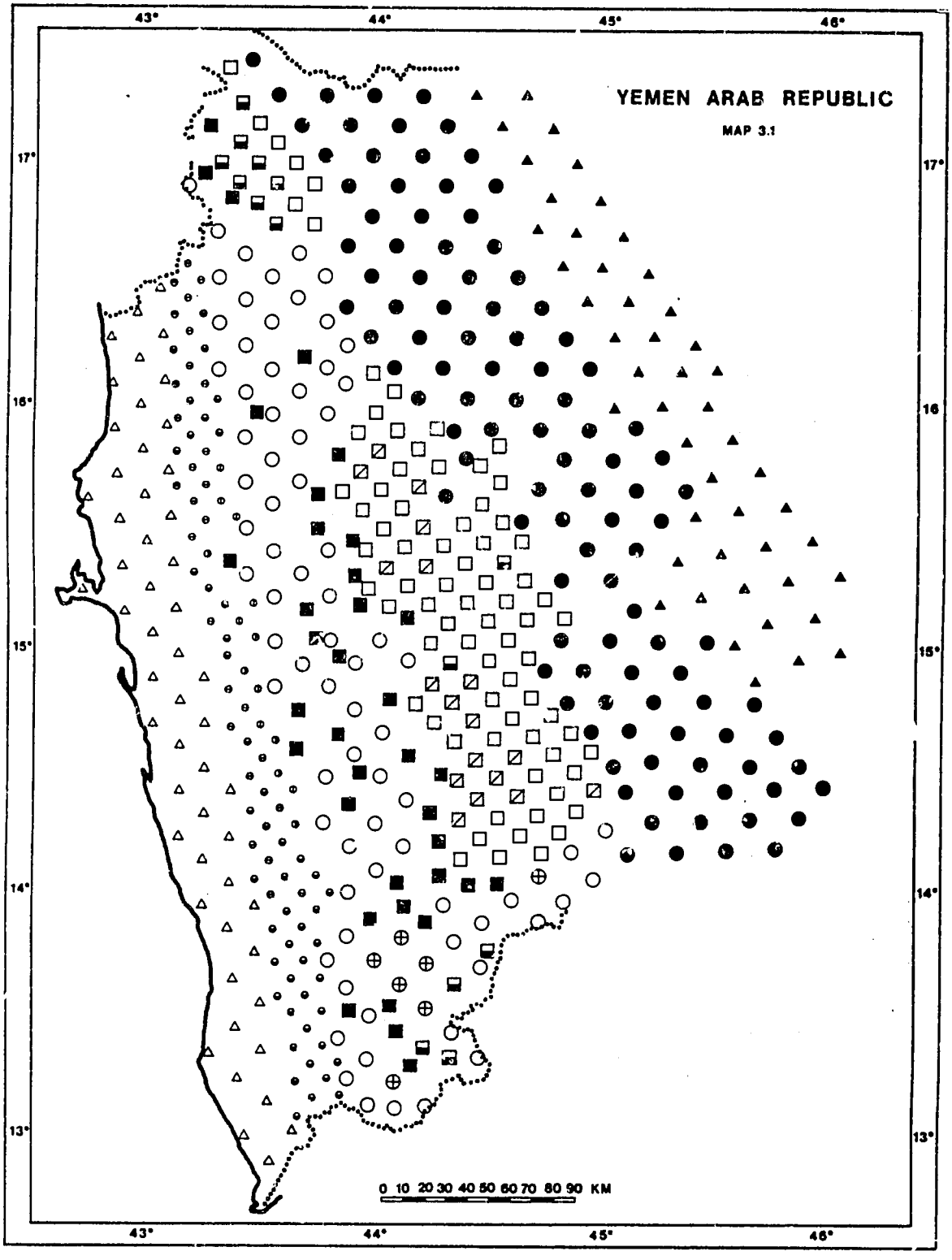
⊖ Acacia-Commiphora bushland on gravel plain in the Southern Tihama ("Gravel Plain in the Southern Tihama").

⊕ Succulent Euphorbia scrub in the southeastern mountains ("Euphorbia scrub"). Merges gradually into other bushland types.

● Acacia-Commiphora bushland in eastern Yemen. Very variable in appearance, sometimes dense, often almost completely cleared. Usually arid and species poor.

Mountain Vegetation Types

- ☐ Undifferentiated. Mostly treeless hills with little soil ("Treeless Hills on the High Plateau and Eastern Slopes").
- ⧄ Intermountain plains. Mostly heavily cultivated or grazed with a sparse, weed-rich vegetation on alluvial soils ("The Intermountain Plains").
- ■ *Acacia origena* woodland on west-facing slopes ("The West-facing Slopes"), now almost entirely cleared and replaced by terrace cultivation except on the steeper slopes where secondary scrub is prevalent.
- ⬓ *Juniperus* woodland on mountains lying in rainshadow ("Mountains Lying in Rainshadow"). *Juniperus* now almost entirely cleared and replaced with low open scrub. Very little soil retention and no significant cultivation except in valleys.


YEMEN ARAB REPUBLIC
MAP 3.1
43°
44°
45°
46°
17°
16°
15°
14°
13°
0 10 20 30 40 50 60 70 80 90 KM

DISTRIBUTION MAPS

The following maps have been drawn up principally from my own field records supplemented by those listed by O. Schwartz in the Flora von Tropischen Arabien. The information available is, of necessity, incomplete.

MAP 3.2: ODYSSEA MUCRONATA (SHAWKHAM) AND RHAZYA STRICTA (HARMIL)

The former is restricted to duneland within about thirty kilometers of the Red Sea and is sometimes subdominant in this region. The latter is often dominant in dunes on the sands east of Ma'rib but also penetrates the mountains along sandy water courses. It is completely absent from the west of Yemen. Both have therefore a similar ecology but are geographically separated from each other.

Odyssea mucronata is a rhizomatous grass with erect stems to 1m and spiky leaves. The inflorescence is a spike of closely packed racemes.

Rhazya stricta is a poisonous, leathery-leaved undershrub about 50cm high. It has small cymes of yellow flowers and a pod-like fruit. It flowers and appears vigorous even after the most prolonged drought.

MAP 3.3: ACACIA EHRENBERGIANA (SILAM)

This species, mostly of alluvial soils, is abundant in the eastern Tihama, particularly on sand, and also frequent along wadis penetrating the mountains up to about 2000m, though in fact very rare at heights above 1000m. It is absent from the steep hillsides favored by Acacia mellifera whose distribution is complementary to that of A. ehrenbergiana.

Acacia ehrenbergiana is a spiny bush or small tree about 4m high. It is usually branched near the base with several trunks. The bark peels off in papery strips. The spines are usually straight. The flowers are in globular yellow heads and the pod is narrow and constricted between the seeds.

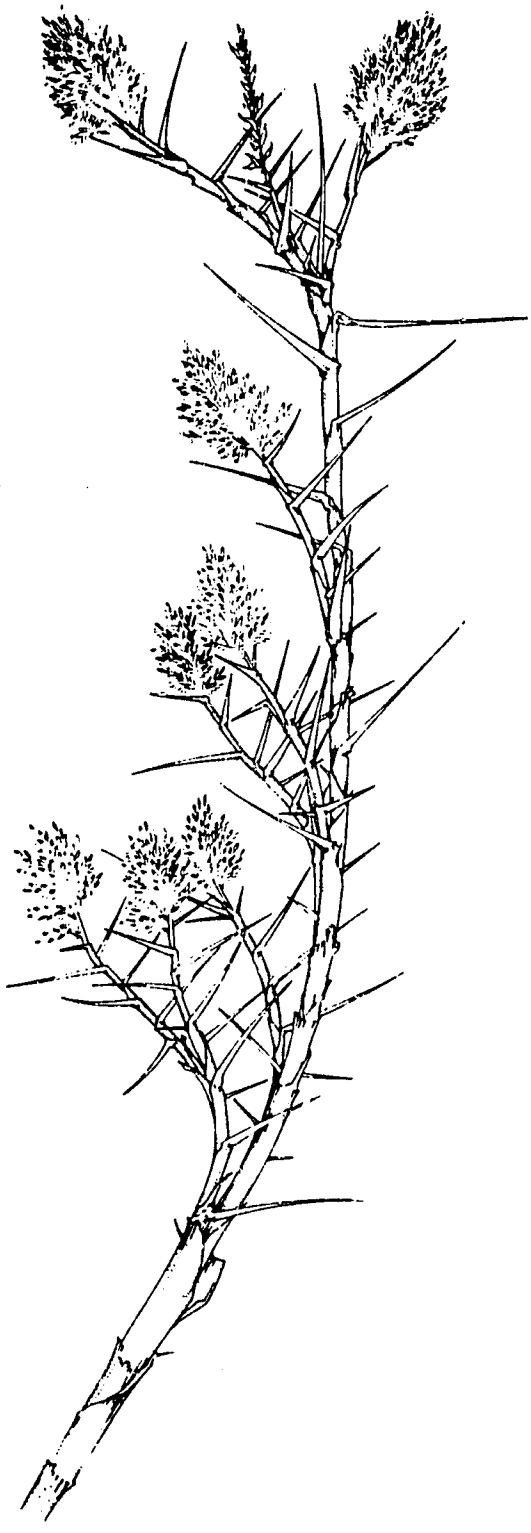


FIGURE 3.1 ODYSSEA MUCRONATA

FIGURE 3.2 RHAZYA STRICTA

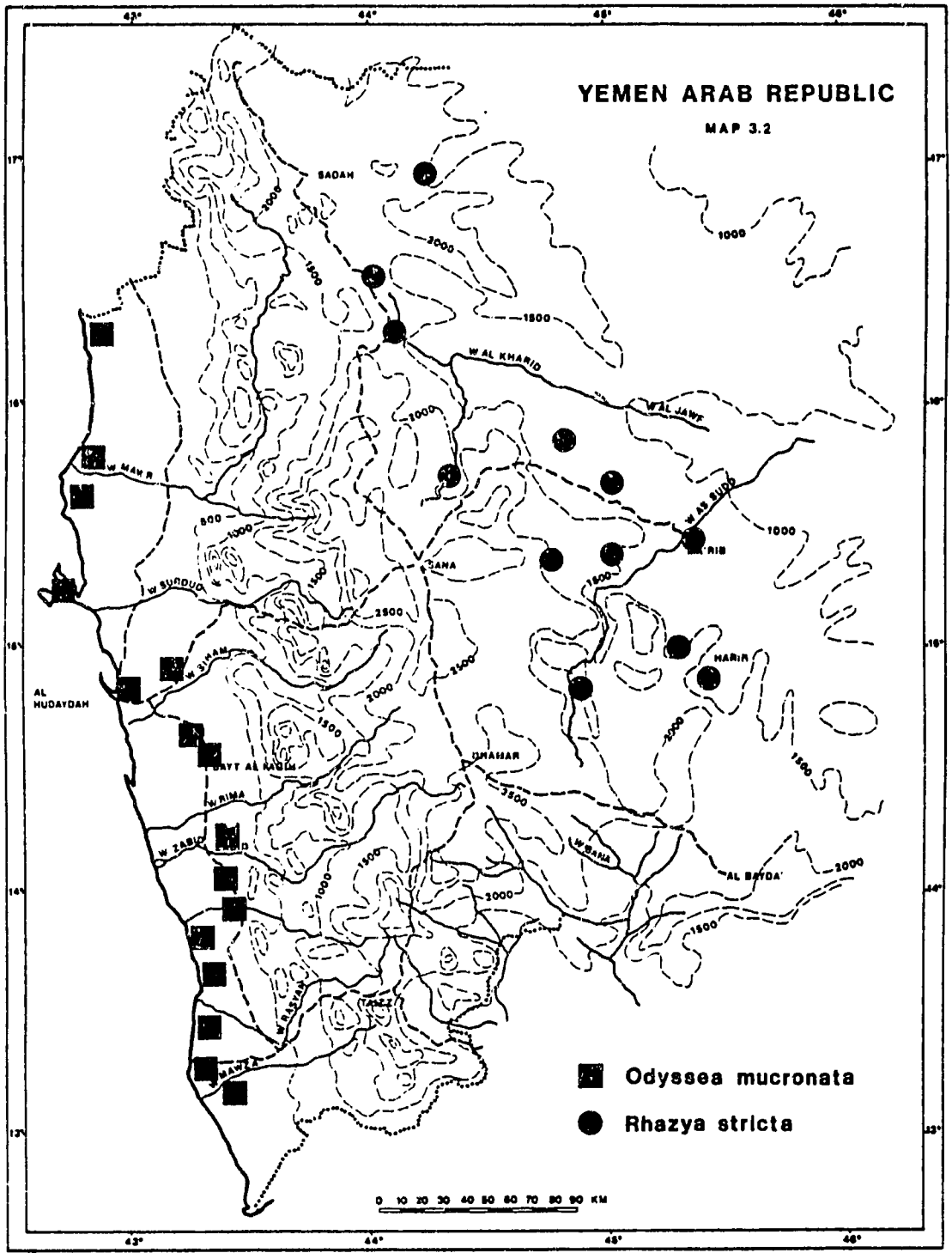
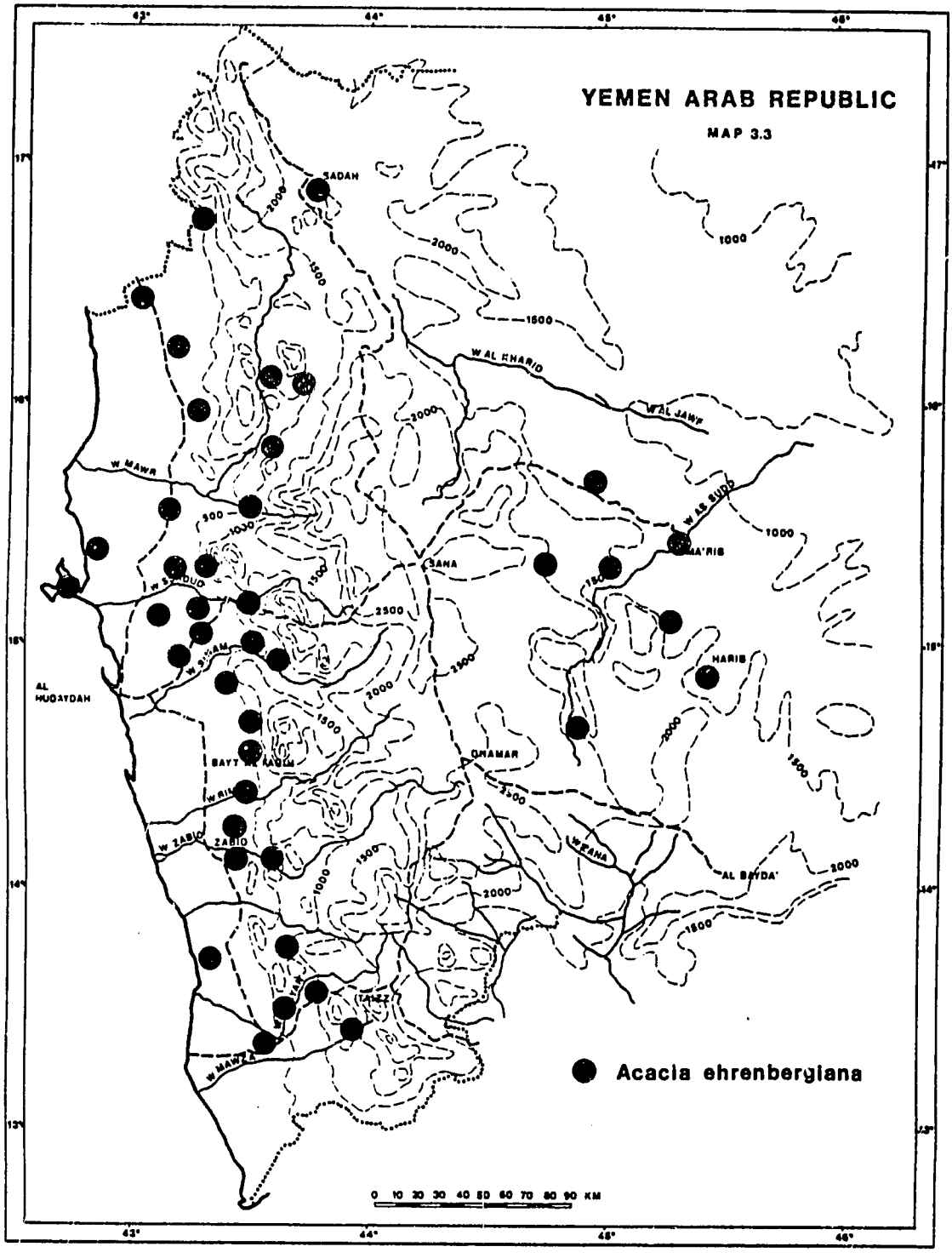

YEMEN ARAB REPUBLIC
MAP 3.2
SADAH
SANA
MARIB
AL HUDAYDAH
W AL KHARID
W AL JAWF
W AS SUDD
W MAWR
W SUNDUD
W SIHAM
W RIMA
W ZABID
W BANA
W RASYAN
TAIZZ
AL BAYDA'
Odyssea mucronata
Rhazya stricta
0 10 20 30 40 50 60 70 80 90 KM

FIGURE 3.3 ACACIA EHRENBERGIANA


YEMEN ARAB REPUBLIC
MAP 3.3
SADAH
SANA
HARIB
AL HUDAYDAH
ZABID
TA'IZZ
W MAWR
W AL KHARID
W AL JAWF
W AS SUDD
W ZABID
W RANA
AL BAYDA'
Acacia ehrenbergiana
0 10 20 30 40 50 60 70 80 90 KM

MAP 3.4: JATROPHA GLAUCA

This species is restricted to the richer silt deposits in the east of the Tihama and of the alluvial valleys penetrating the escarpment up to 1000m. It is one of the best indicators of those soils and is often associated with Dobera glabra and Abutilon pannosum.

Jatropha glauca is a small undershrub about 30cm high. The stem is fleshy and rich in a colorless latex. The leaves are palmately lobed and ± jglabrous and have fine pin-like stipules. The flowers are inconspicuous and green; the fruit is a capsule.

MAP 3.5: GREWIA TENAX

This species is characteristic of small rock outcrops in alluvial plains and along alluvial valleys from 200 to 1000m. It is one of the most characteristic plants of Acacia-Commiphora bushland in the foothills of the western escarpment, but is absent from both the steeper, more highly eroded hillsides and from the alluvial plains.

Grewia tenax is an unarmed deciduous undershrub rarely exceeding 1-1/2m in height. It has small suborbicular, crenate leaves and solitary, pedicellate, white flowers. The fruit is a four-lobed drupe.

MAP 3.6: ACACIA MELLIFERA (ZUBAH, DHUBAYAN)

This is the most characteristic species of dry bushland on steep rocky slopes which retain little soil. It is abundant throughout the escarpment region of Yemen and is also widespread in the eastern mountains, though its full distribution is unknown.

Acacia mellifera is a small tree or shrub, 2 - 4m in height, viciously armed with pairs of curved spines. The bark is smooth and dark blackish-brown. The leaves consist of pinnate leaves bearing 1 - 2 pairs of leaflets. The flowers are in dense white spikes and the fruit is a pod.

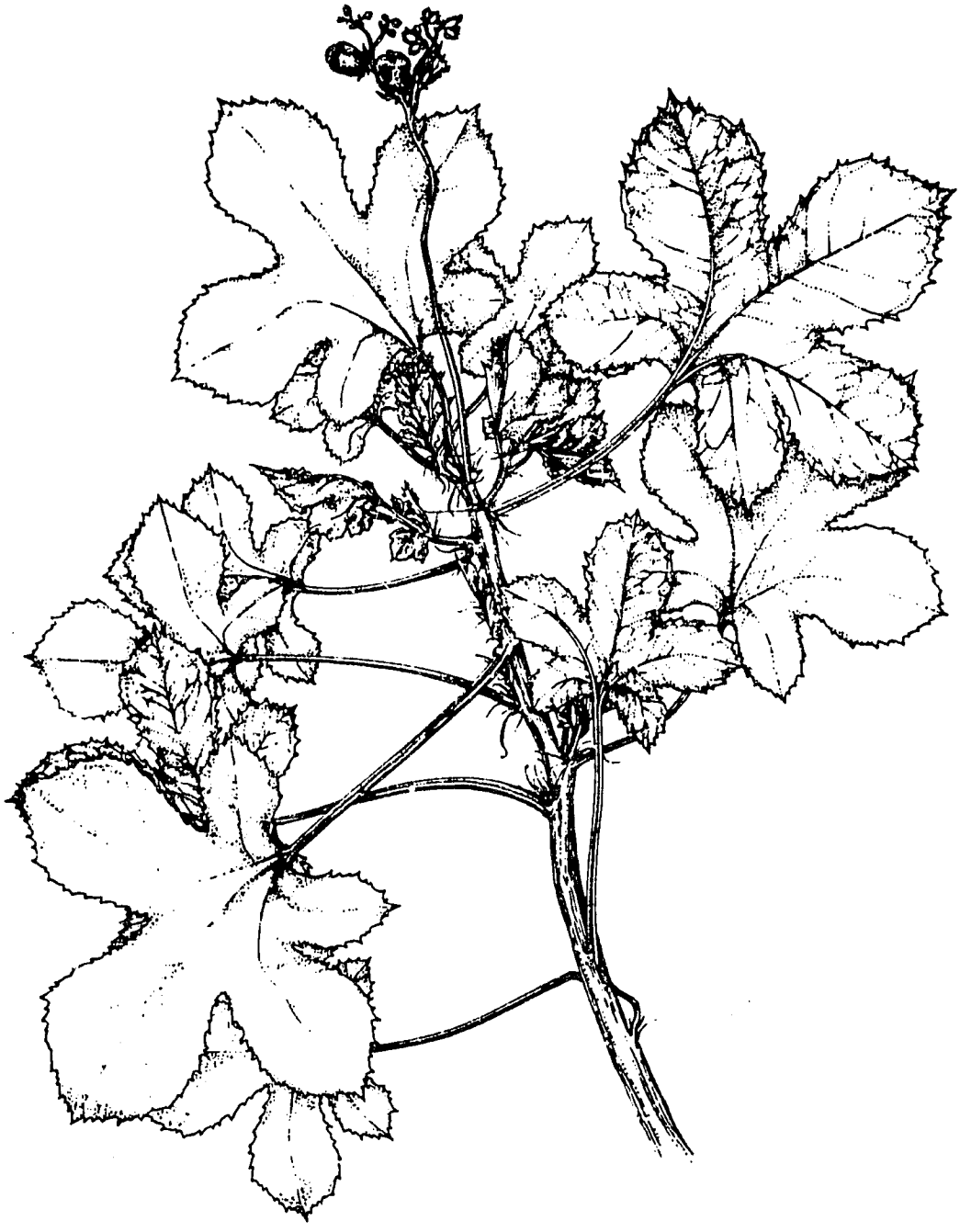


FIGURE 3.4 JATROPHA GLAUCA

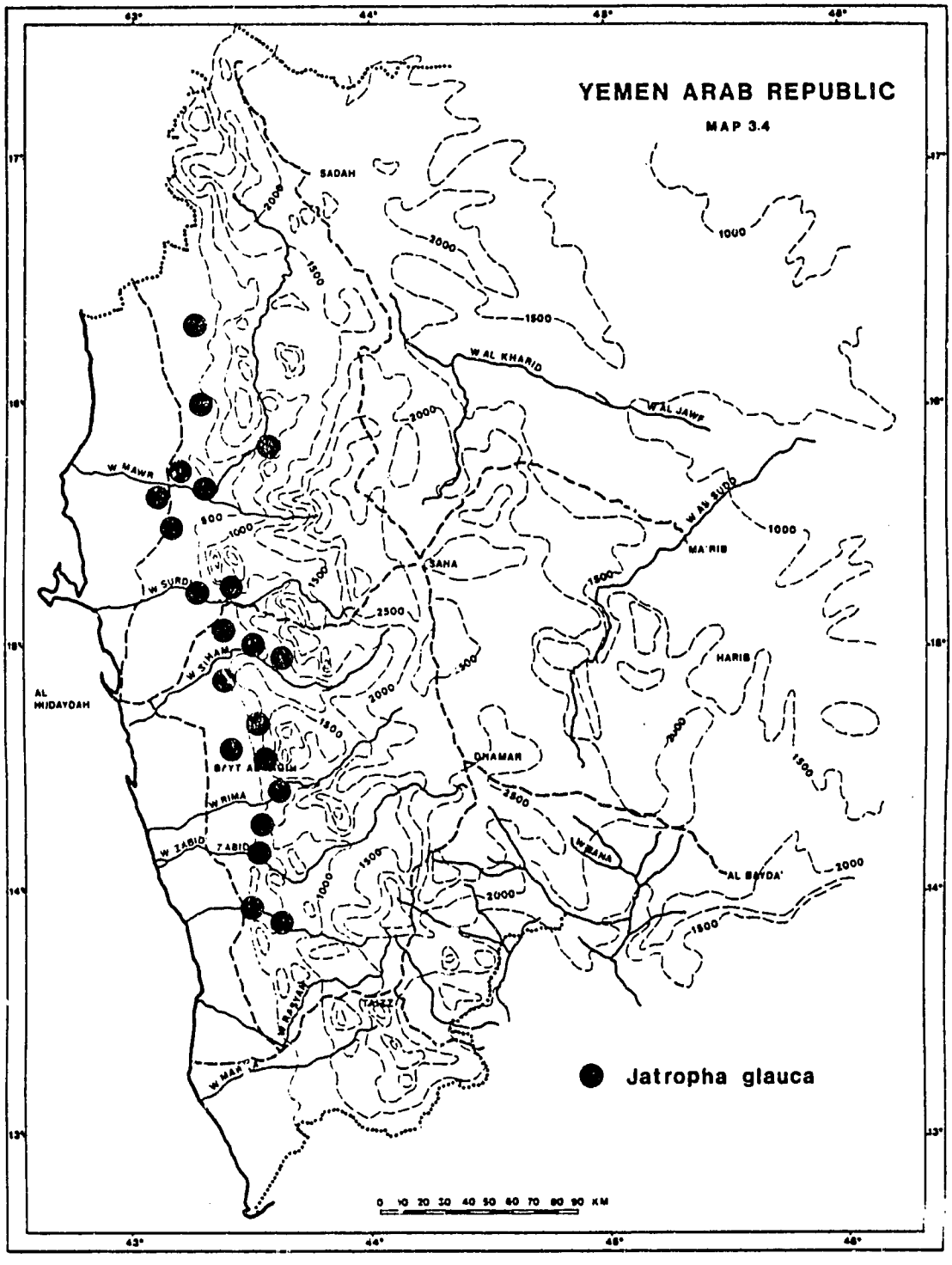

YEMEN ARAB REPUBLIC
MAP 3.4
SADAH
SANA'A
MA'RIB
HARIB
AL HIDAYDAH
DHAMAR
AL BAYDA'
TA'IZZ
W. AL KHARID
W. AL JAWF
W. AN SUDD
W. MAWR
W. SURD
W. SIHAM
W. RIMA
W. ZABID
W. BANA
W. MAR'
Jatropha glauca
0 10 20 30 40 50 60 70 80 90 KM

FIGURE 3.5 GREWIA TENAX

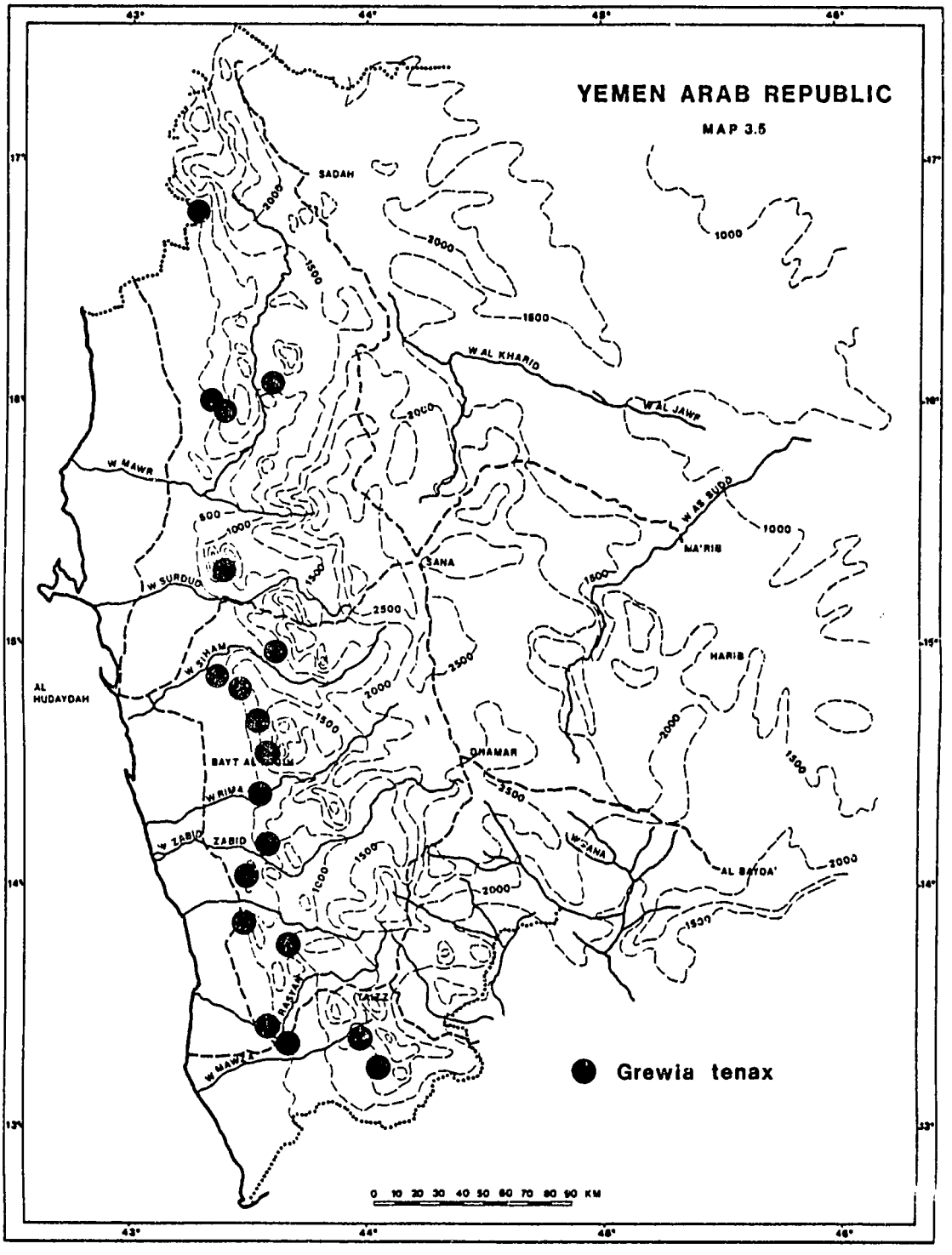
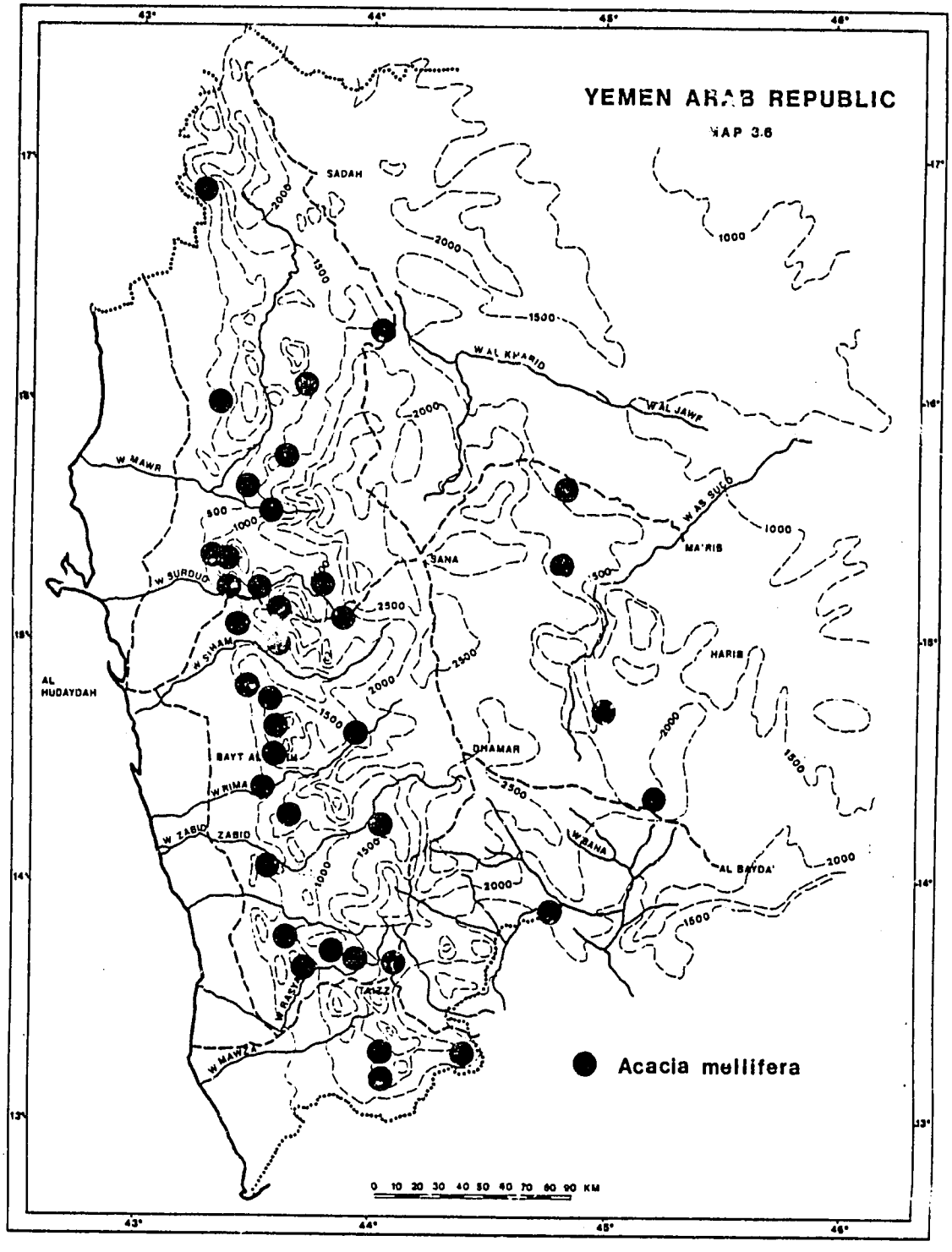

YEMEN ARAB REPUBLIC
MAP 3.5
SADAH
SANA
DHAMAR
MA'RIB
HARIB
AL BAYDA'
AL HUDAYDAH
BAYT AL FAQIH
ZABID
TAIZZ
W AL KHARID
W AL JAWF
W AS SUDD
W MAWR
W SURDUD
W SIHAM
W RIMA
W ZABID
W DANA
W MAWR
Grewia tenax
0 10 20 30 40 50 60 70 80 90 KM

FIGURE 3.6 ACACIA MELLIFERA


YEMEN ARAB REPUBLIC
MAP 3.6
SADAH
SANA
DHAMAR
TAIZZ
AL HUDAYDAH
MA'RIB
HARIB
AL BAYDA'
W AL KHARID
W AL JAWF
W AS SULO
W MAWR
W SURDUD
W SIHAM
W RIMA
W ZABID
ZABID
W BANA
W MAWZA
Acacia mellifera
0 10 20 30 40 50 60 70 80 90 KM

MAP 3.7: CADABA HETEROTRICHA AND GREWIA VILLOSA

Both species are limited to Acacia-Commiphora bushland below 1600m, but whereas the former is indicative of arid conditions, the latter is restricted to areas with a rainfall above about 450mm per annum. Cadaba heterotricha is mostly found on steep slopes including broken cliffs while Grewia villosa is as common in open bushland as on cliffs.

Cadaba heterotricha is a small, usually gnarled tree. The suborbicular, entire leaves are grey and minutely hairy. The flowers are whitish in terminal corymbs. The fruit is a torulose pod.

Grewia villosa is an unarmed shrub with large, prominently veined, hairy, toothed, orbicular leaves which are wrinkled in texture. The flowers are small, yellow-green, and arise in the leaf axils. The fruit is small with a yellow shell-like casing.

MAP 3.8: ACACIA ORIGENA (TULH)

This is a characteristic species of highland areas (2000 - 3000m) on the western mountains and probably a dominant species in prehistoric forest. (See "The West-facing Slopes.") It is usually found around fields but is equally at home on alluvial plains (as at Turbah) or on steep rocky slopes (as in the Manakhah area).

Acacia origena is a piny tree 4 - 6m in height. The bark is very distinctive, peeling off in yellowish, papery layers. The twigs, massive thorns, and pods are hairless or nearly so. The flowers are in cream, globular heads.

MAP 3.9: SPINILUMA OXYACANTHA (JIRUM) AND TEUCRIUM YEMENSE

Both these species are mountain plants, being found essentially above 800m. The former, however, is an uncommon shrub restricted to areas enjoying a high rainfall, probably above 800mm a year. Although some areas it grows in enjoy plentiful mist, this is not the deciding factor in its distribution, which is probably rainfall. Teucrium yemense, in contrast, is a species restricted to areas with a rainfall below about 500mm per annum. Both species grow on open rocky ground, on both gentle and steep slopes.

Teucrium yemense is a prostrate labiate smelling of incense. It has small grey leaves, a pink corolla with a reduced upper lip, and an inflated, scarious calyx.

Spinilluma oxyacantha is a weakly armed shrub, 2 - 3m high with small, leathery leaves borne in whorls on short lateral branchlets. The flowers are small, solitary, and pedicellate.

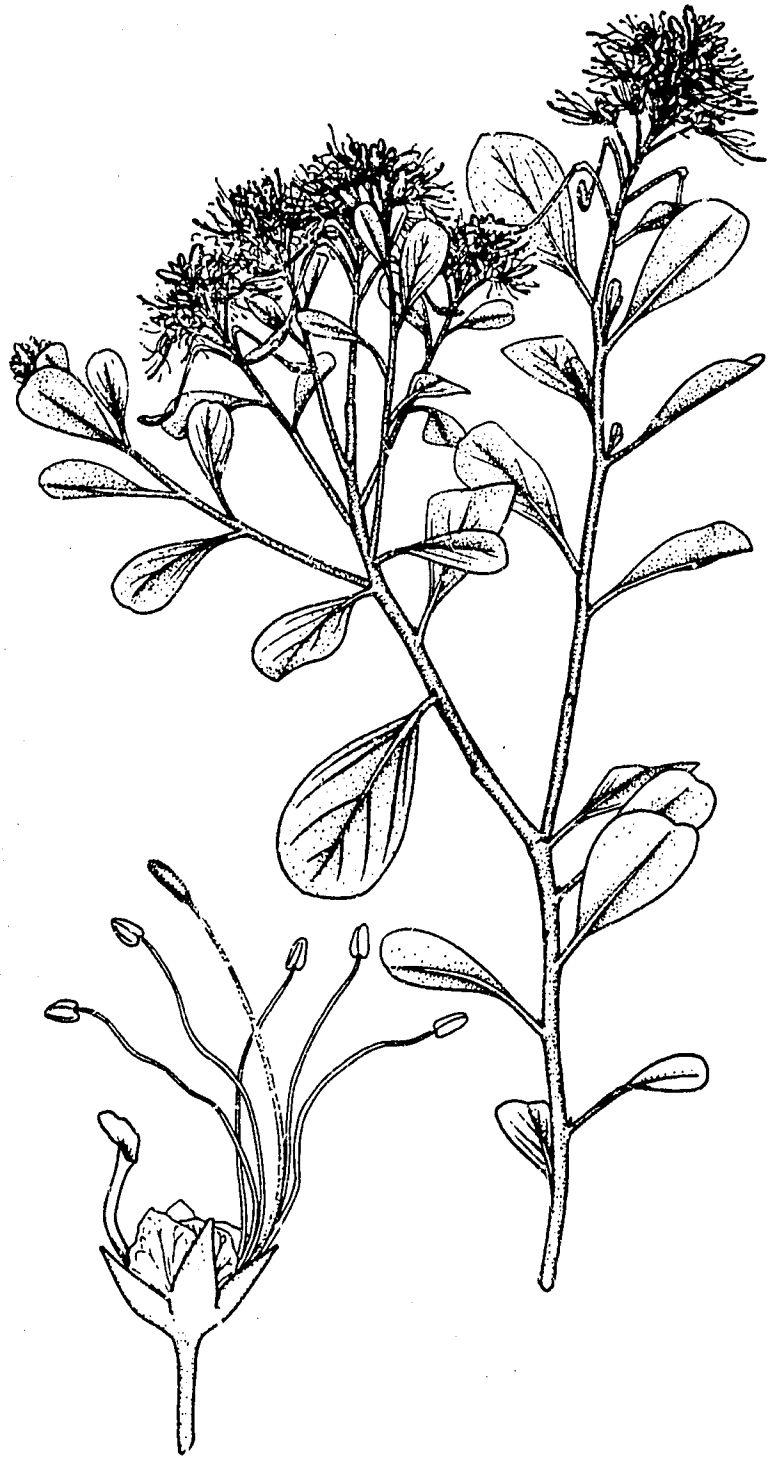


FIGURE 3.7 CADABA HETEROTRICHA

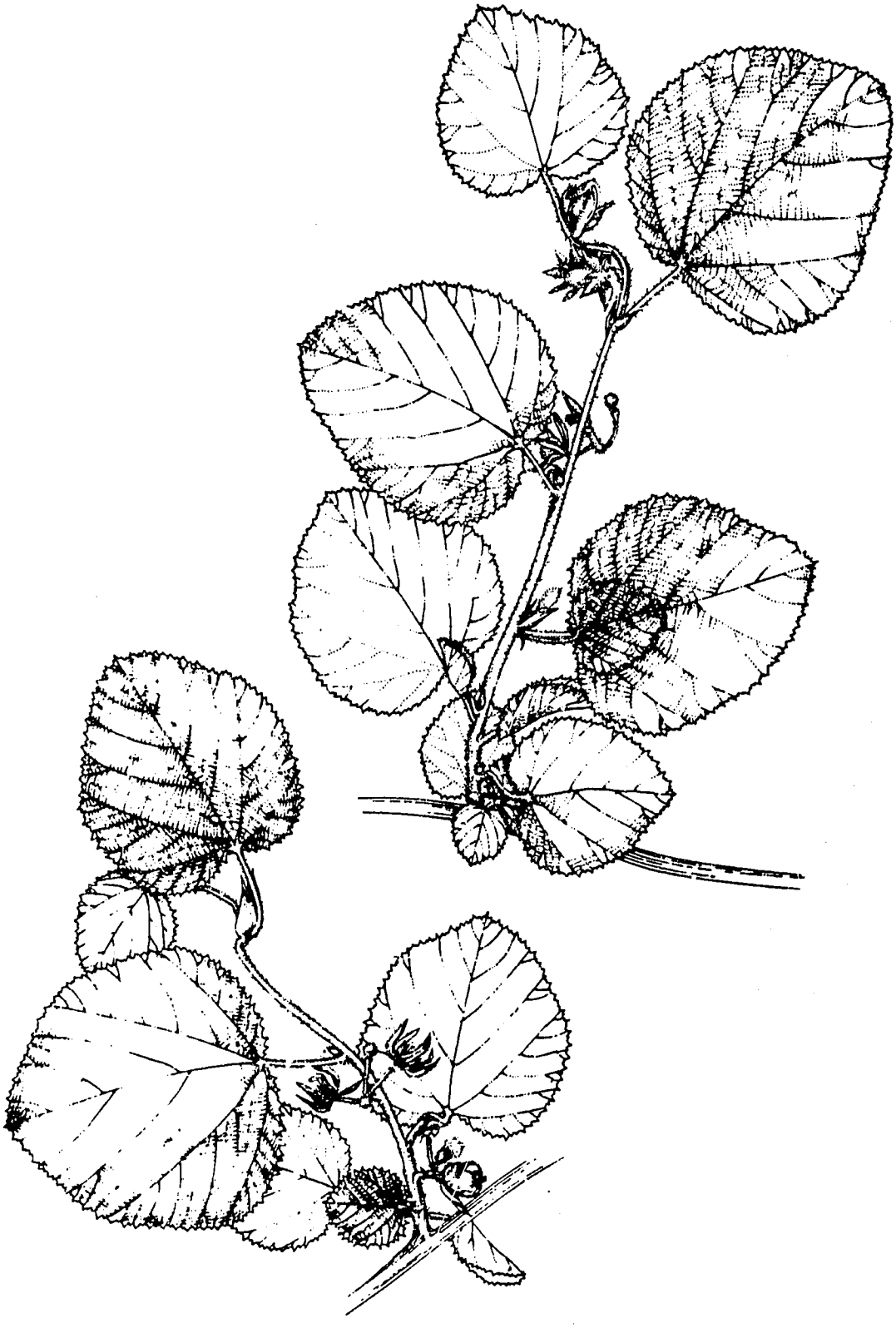
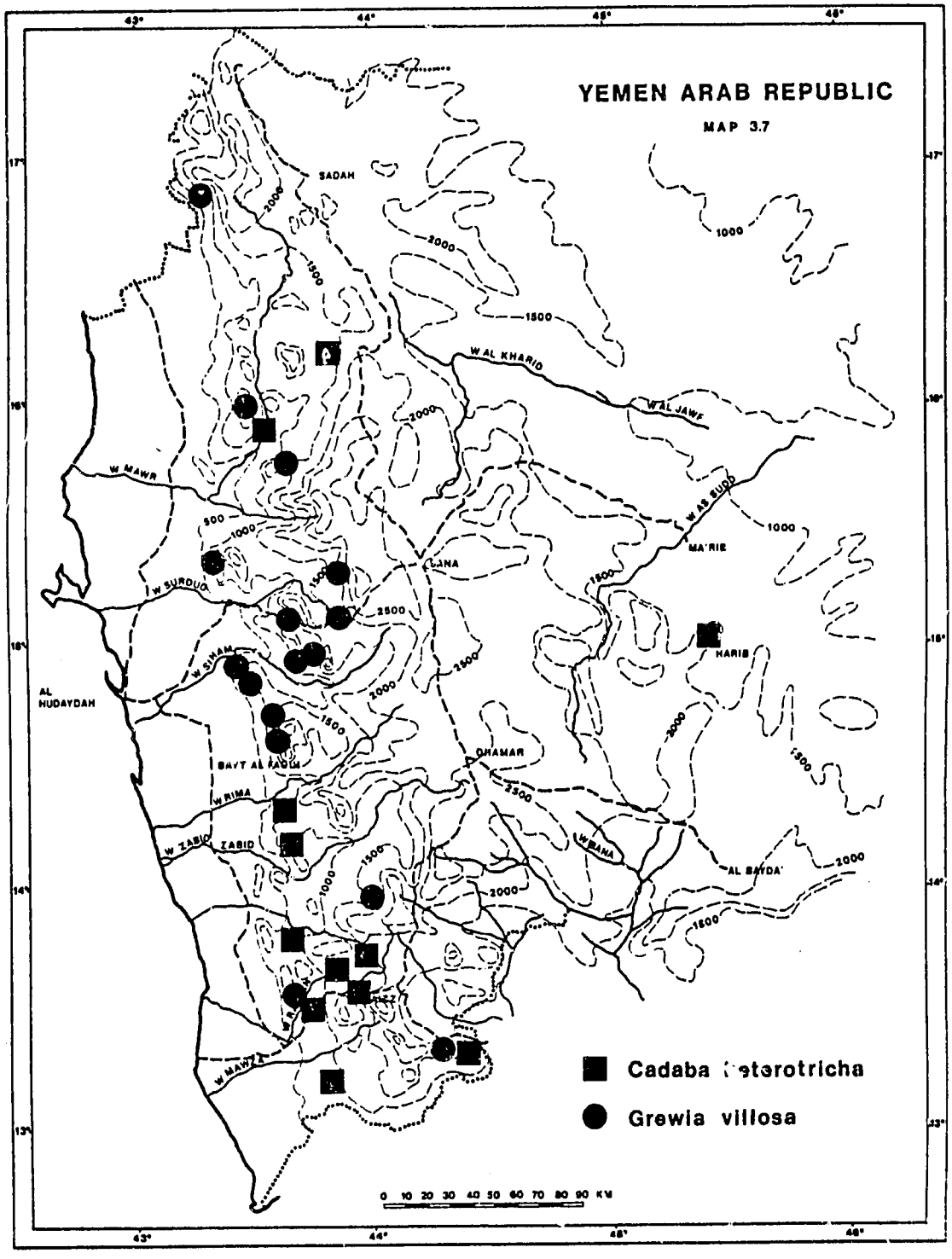


FIGURE 3.8 GREWIA VILLOSA


YEMEN ARAB REPUBLIC
MAP 3.7
SADAH
W AL KHARIB
W AL JAWF
W AS SUDD
MA'RIB
W MAWR
W SURDUD
SANA
W SIHAM
AL HUDAYDAH
BAYT AL FAQIH
W RIMA
W ZABID
ZABID
DHAMAR
W BANA
AL BAYDA'
HARIB
W MAHZA
Cadaba heterotricha
Grewia villosa
0 10 20 30 40 50 60 70 80 90 KM

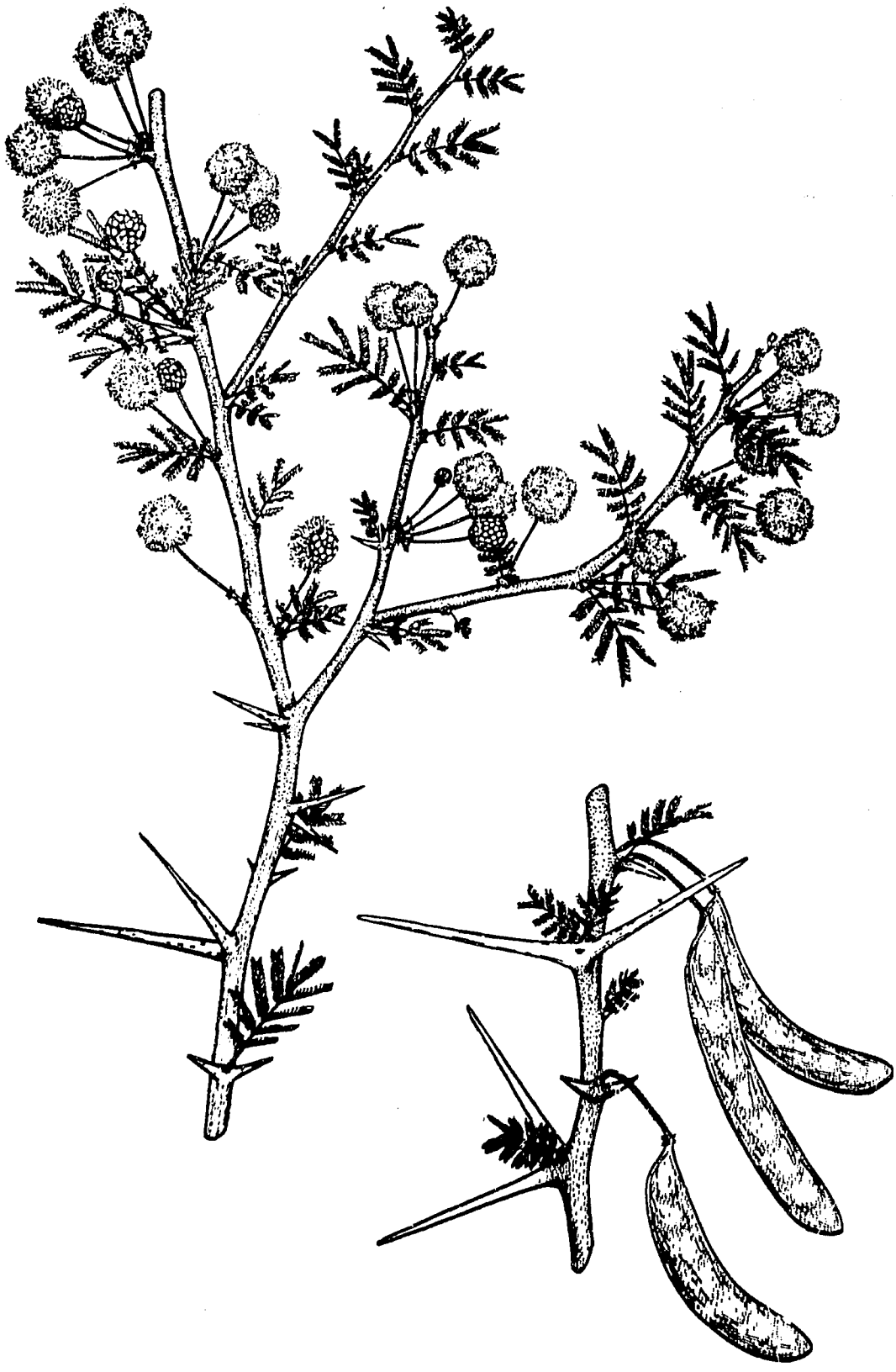


FIGURE 3.9 ACACIA ORIGENA

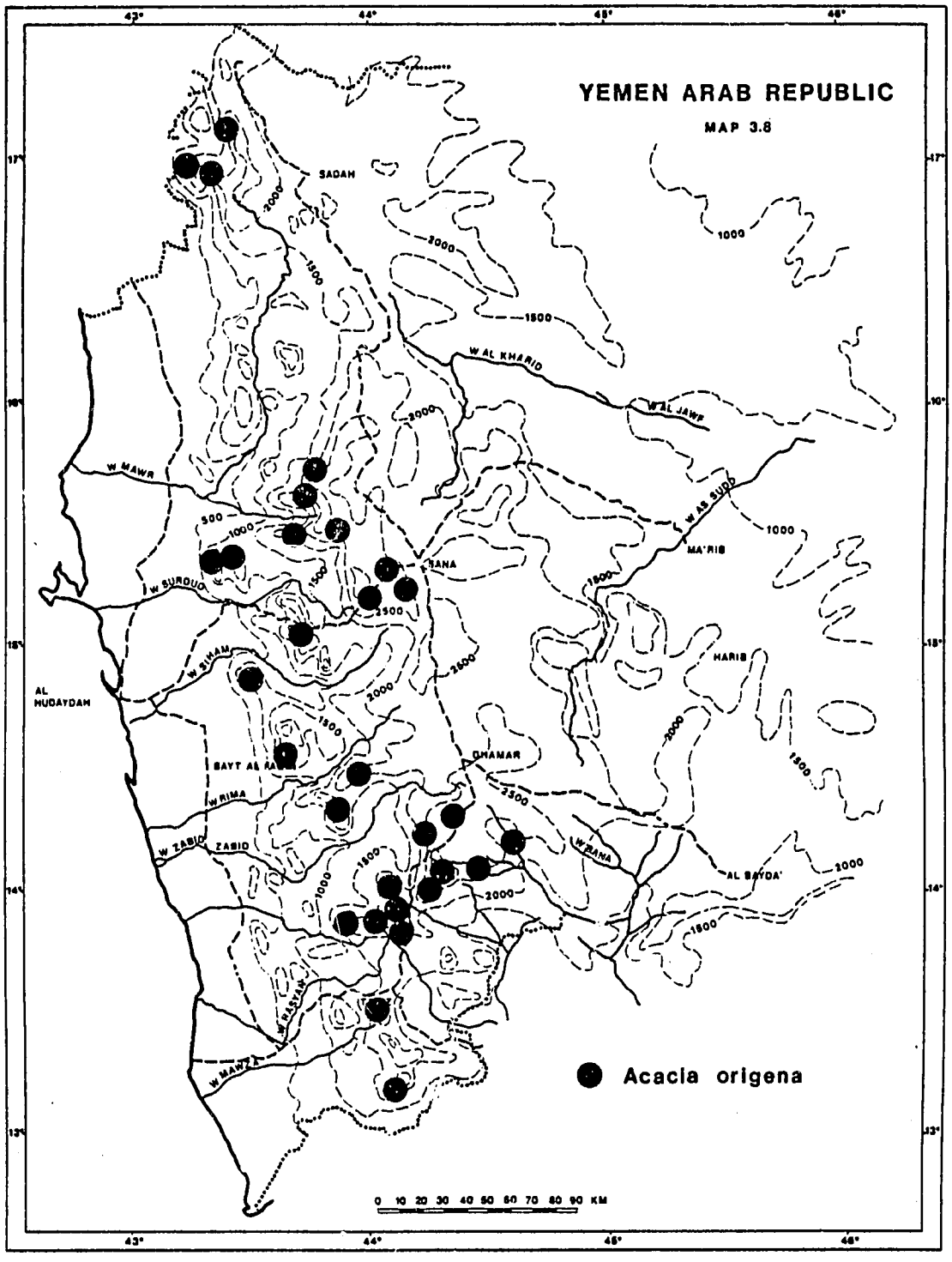
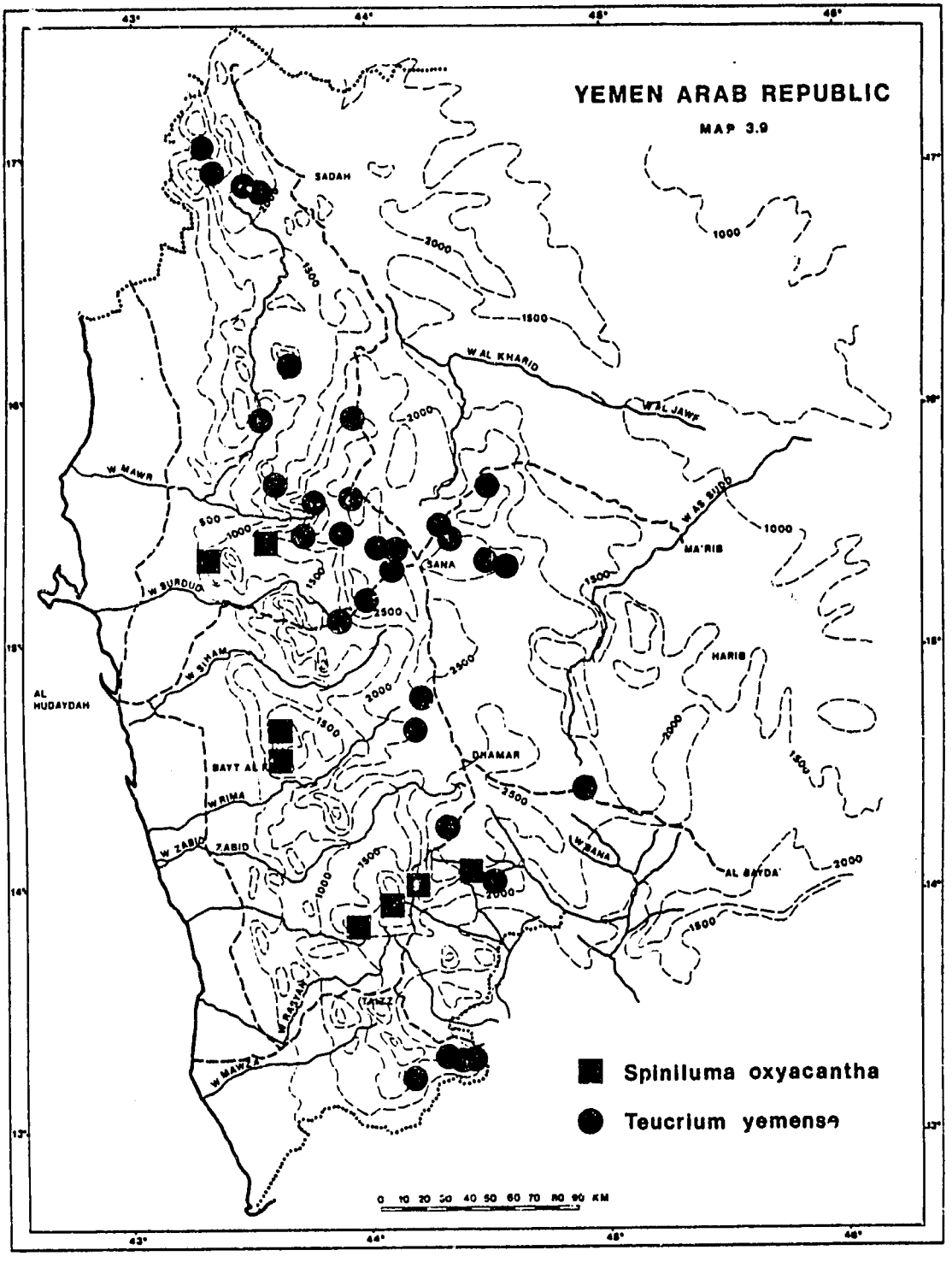

YEMEN ARAB REPUBLIC
MAP 3.8
SADAH
SANA
DHAMAR
MA'RIB
HARIB
AL HUDAYDAH
BAYT AL AS
ZABID
AL BAYDA'
W AL KHARID
W AL JAWF
W AS SUDD
W MAWR
W SURDUD
W SIHAM
W RIMA
W ZABID
W RANA
W MASTAN
W MAWZA
Acacia origena
0 10 20 30 40 50 60 70 80 90 KM

FIGURE 3.10 SPINILUMA OXYACANTHA

FIGURE 3.11 TEUCRIUM YEMENSE


YEMEN ARAB REPUBLIC
MAP 3.9
SADAH
SANA
MA'RIB
HARIB
DHAMAR
AL HUDAYDAH
BAYT AL FAQIH
ZABID
TA'IZZ
AL BAYDA'
W AL KHARID
W AL JAWF
W AS SUDD
W MAWR
W SURDUD
W SIHAM
W RIMA
W ZABID
W BANA
W MASYAN
W MAWZ
Spiniluma oxyacantha
Teucrium yemense
0 10 20 30 40 50 60 70 80 90 KM

MAP 3.10: THYMUS LAEVIGATUS (SA'TAR, ZA'TAR)

This species is restricted to the summit ridges of mountains above 2500m and probably the commonest of all species at extreme altitudes above 3200m. It is frost tolerant and its prostrate habit is well adapted to exposed conditions.

Thymus laevigatus is a prostrate, wiry herb, smelling strongly of thyme. The flowers are two-lipped, pink, and arranged in dense heads.

MAP 3.11: ACACIA GERRARDII (TULH)

This species is virtually restricted to alluvial soils between 1500 and 2500m and the common species of the plains around Sadah, Sana, Ibb, and Qa'idah.

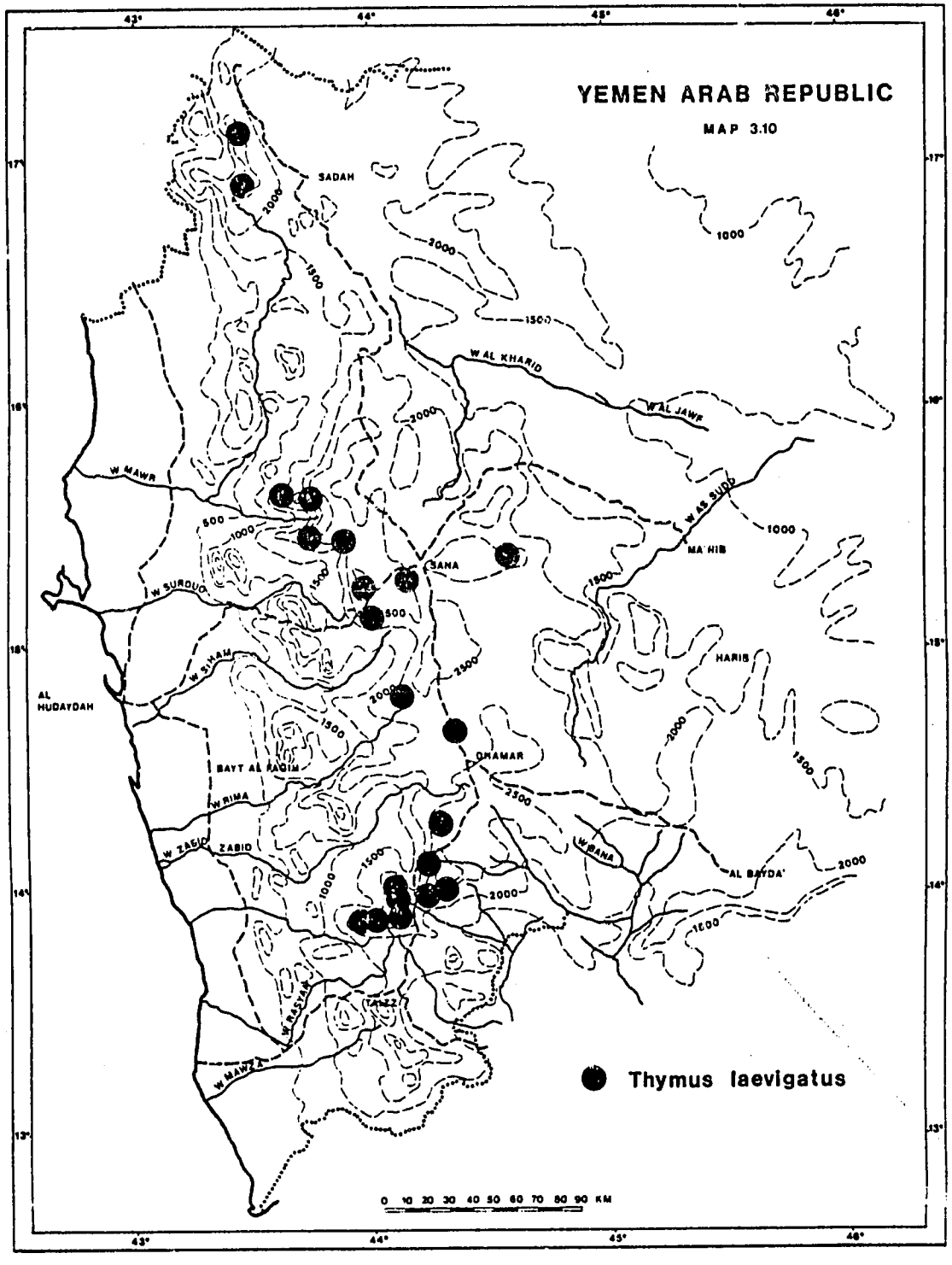
Acacia gerrardii is a spiny tree with smooth, slightly fissuring, but not flaking, bark and pubescent branchlets and leaves. The flowers are in cream, globular heads and the pubescent pod varies from being straight to almost coiled.

MAP 3.12: CALOTROPIS PROCERA ('USHAR, OUSHAR)

A species found principally on and by the sandy floodbeds in dry country up to 2300m, its basic distribution is somewhat obscured by its propensity to occur as isolated individuals on roadsides and similar waste places.

Calotropis procera is a shrub or small tree with pale brown bark and copious white latex. The leaves are large and leathery and the flowers occur in dense clusters, the corolla purple but the central corona whitish. The fruit is soft, inflated, and about the size of a tennis ball.

FIGURE 3.12 THYMUS LAEVIGATUS


YEMEN ARAB REPUBLIC
MAP 3.10
SADAH
SANA'A
DHAMAR
TAIZZ
AL HUDAYDAH
BAYT AL FAQIH
ZABID
HARIS
MA'RIB
AL BAYDA'
W AL KHARID
W AL JAWF
W AS SUDD
W MAWR
W SURDUD
W SIHAM
W RIMA
W ZABID
W BANA
W RASYAN
W MAWZA
Thymus laevigatus
0 10 20 30 40 50 60 70 80 90 KM

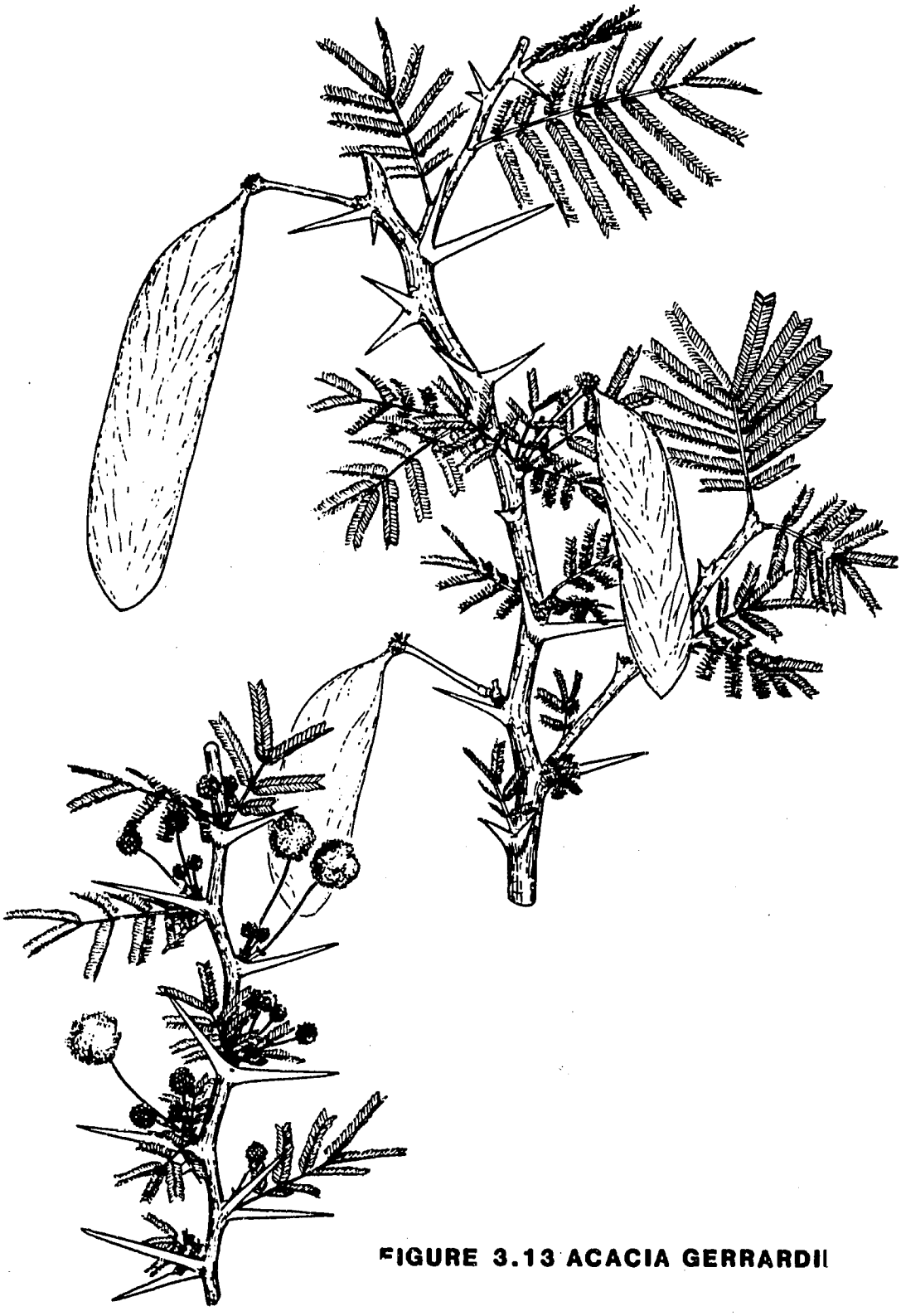
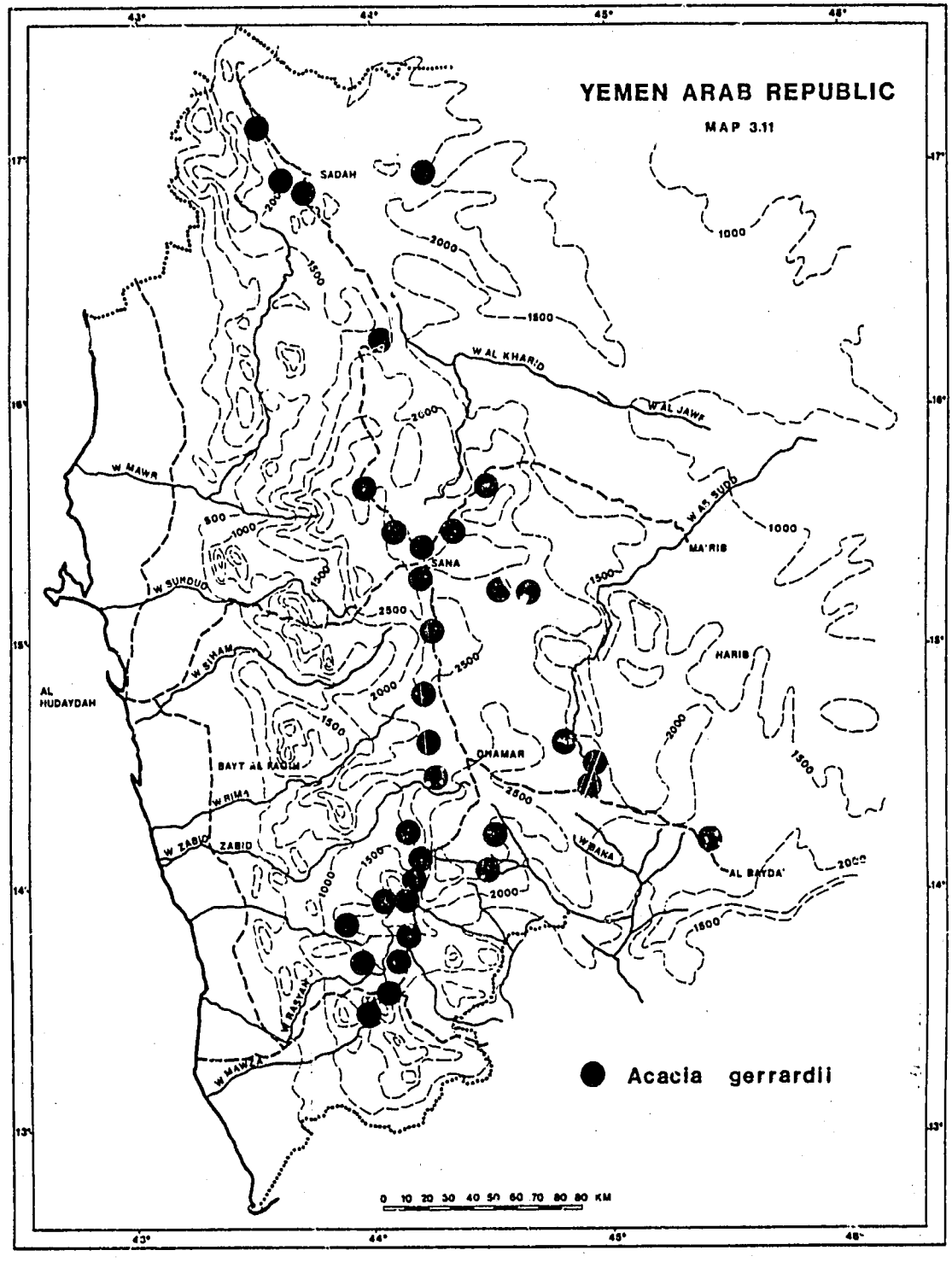


FIGURE 3.13 ACACIA GERRARDII


YEMEN ARAB REPUBLIC
MAP 3.11
SADAH
SANA
W AL KHARID
W AL JAWF
W AS SUDD
MA'RIB
W MAWR
W SUHOUD
W SUHAM
AL HUDAYDAH
BAYT AL FAQIH
W RIMA
W ZABID
ZABID
DHAMAR
HARIB
W BANA
AL BAYDA'
W BASYAN
W MAWZA
Acacia gerrardii
0 10 20 30 40 50 60 70 80 90 KM

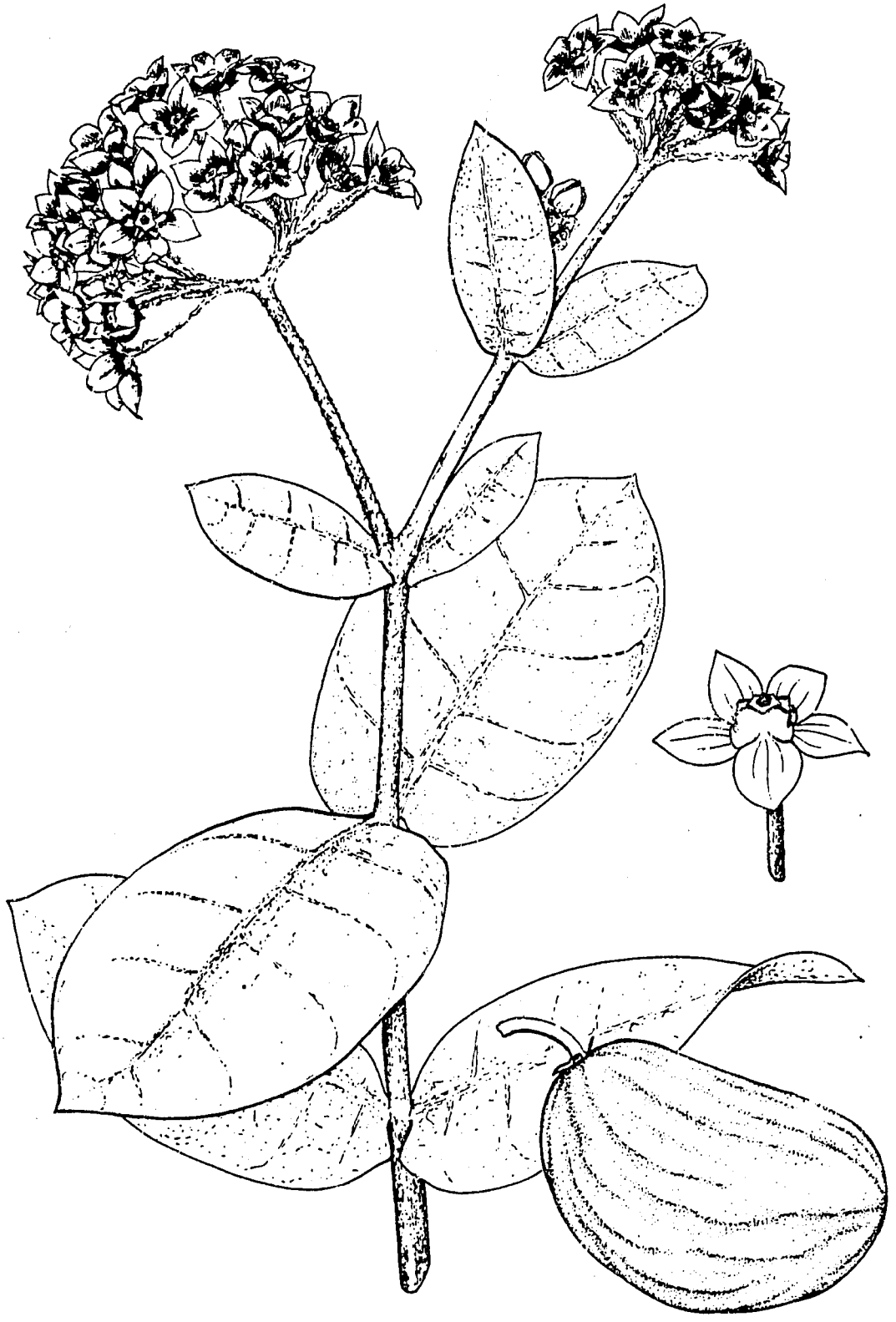
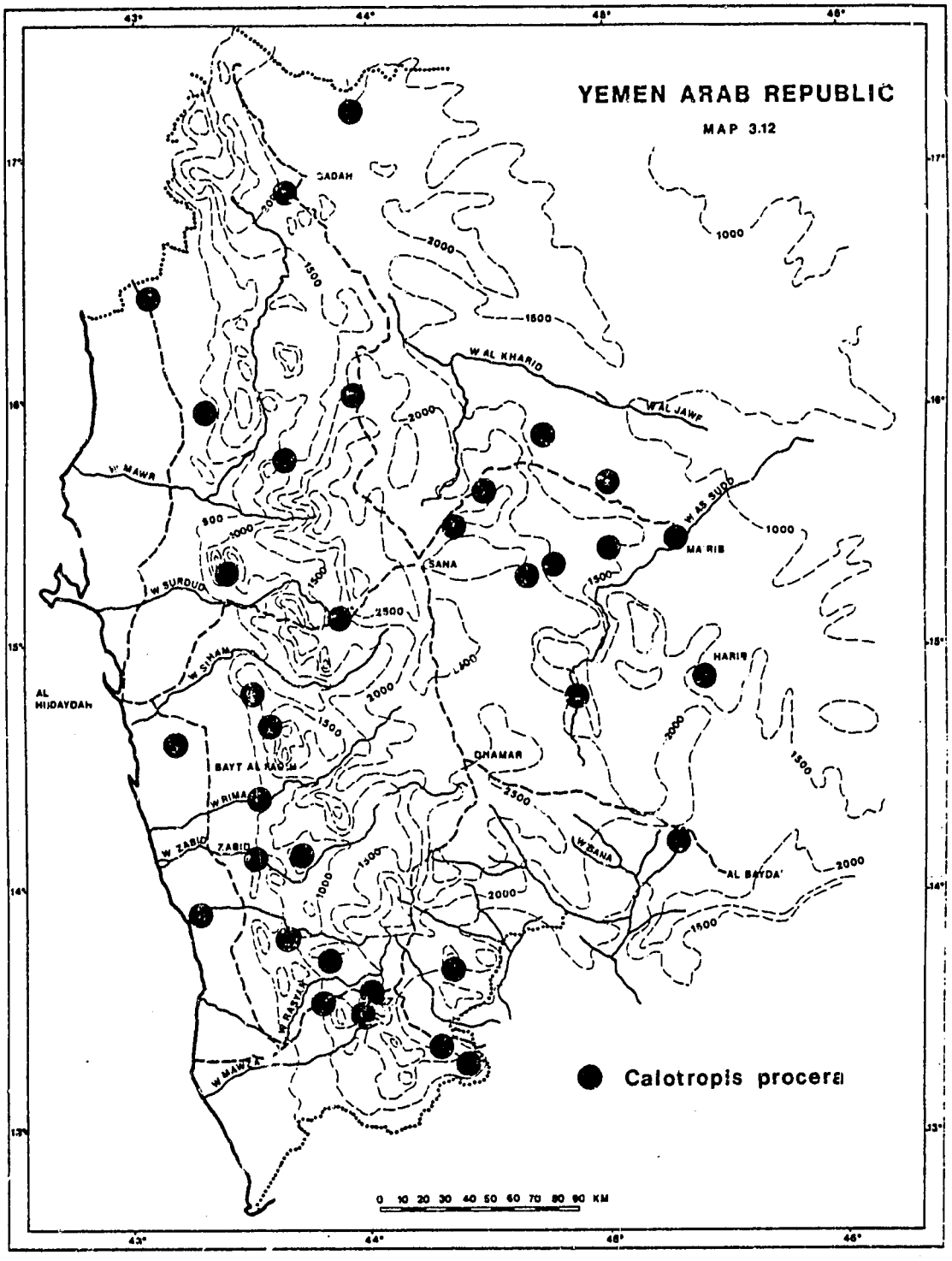


FIGURE 3.14 CALOTROPIS PROCERA


YEMEN ARAB REPUBLIC
MAP 3.12
SADAH
SANA
MA'RIB
HARIB
DHAMAR
AL BAYDA'
AL HUDAYDAH
BAYT AL FAQIH
W. AL KHARIB
W. AL JAWF
W. AS SUDO
W. MAWR
W. SURDUD
W. SIHAM
W. RIMA'
W. ZABID
ZABID
W. RASYAN
W. MAWR
W. BANA
Calotropis procera
0 10 20 30 40 50 60 70 80 90 KM

MAP 3.13: APIUM NODIFLORUM

A species characteristic of marsh and streamsides above 2000m, it is only found in permanently damp places. It is tolerant of subzero temperatures.

Apium nodiflorum is a prostrate herb with soft, semisucculent stems, pinnate leaves, and umbels of white flowers. It sometimes smells weakly of parsnip.

MAP 3.14: BACOPA MONNIERI

A species characteristic of streamsides and marsh below 2000m, it is found only in permanently damp places but appears to be intolerant of frost. Its distribution is complementary to that of Apium nodiflorum.

Bacopa monnieri is a small, glabrous, creeping herb with pedicellate axillary flowers. The corolla is pale mauve or white.

MAP 3.15: SPOROBOLUS SPICATUS

The presence of this halophytic species almost always indicates some degree of salinity, though it is usually found only in damp situations. Its ecology is of some interest since it is absent from the very halophytic locations favored by the truly maritime species such as Suaeda fruticosa and its presence on the coast is indicative of brackish groundwater rather than signalling its membership of the strictly coastal flora. Cyperus laevigatus and Fimbristylis cymosa are plants with a very similar ecology.

Sporobolus spicatus is a creeping sward-forming grass with spiky leaves and a short, whitish, spike-like inflorescence, the spikelets being single-flowered.

FIGURE 3.15 APIUM NODIFLORUM

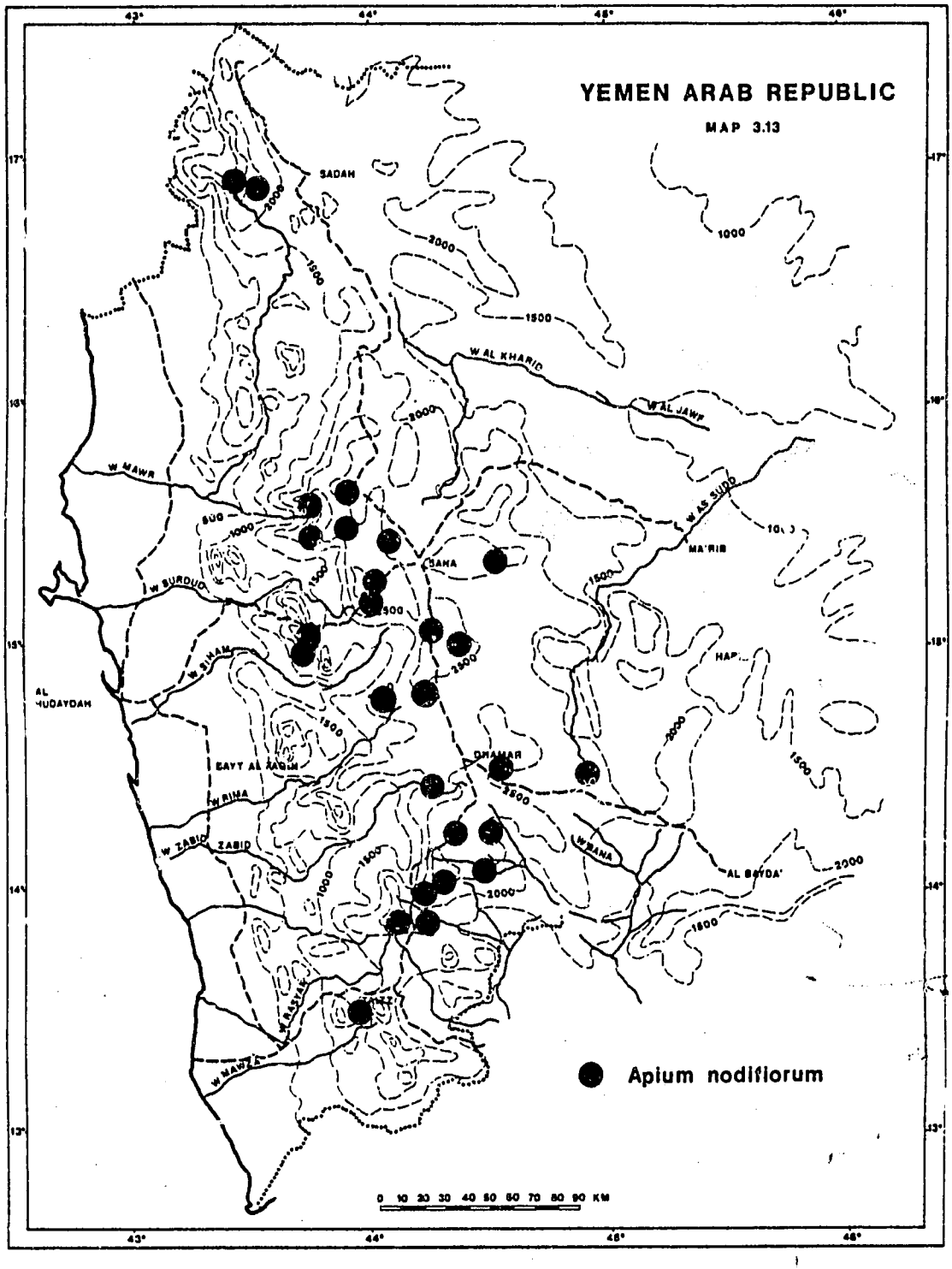
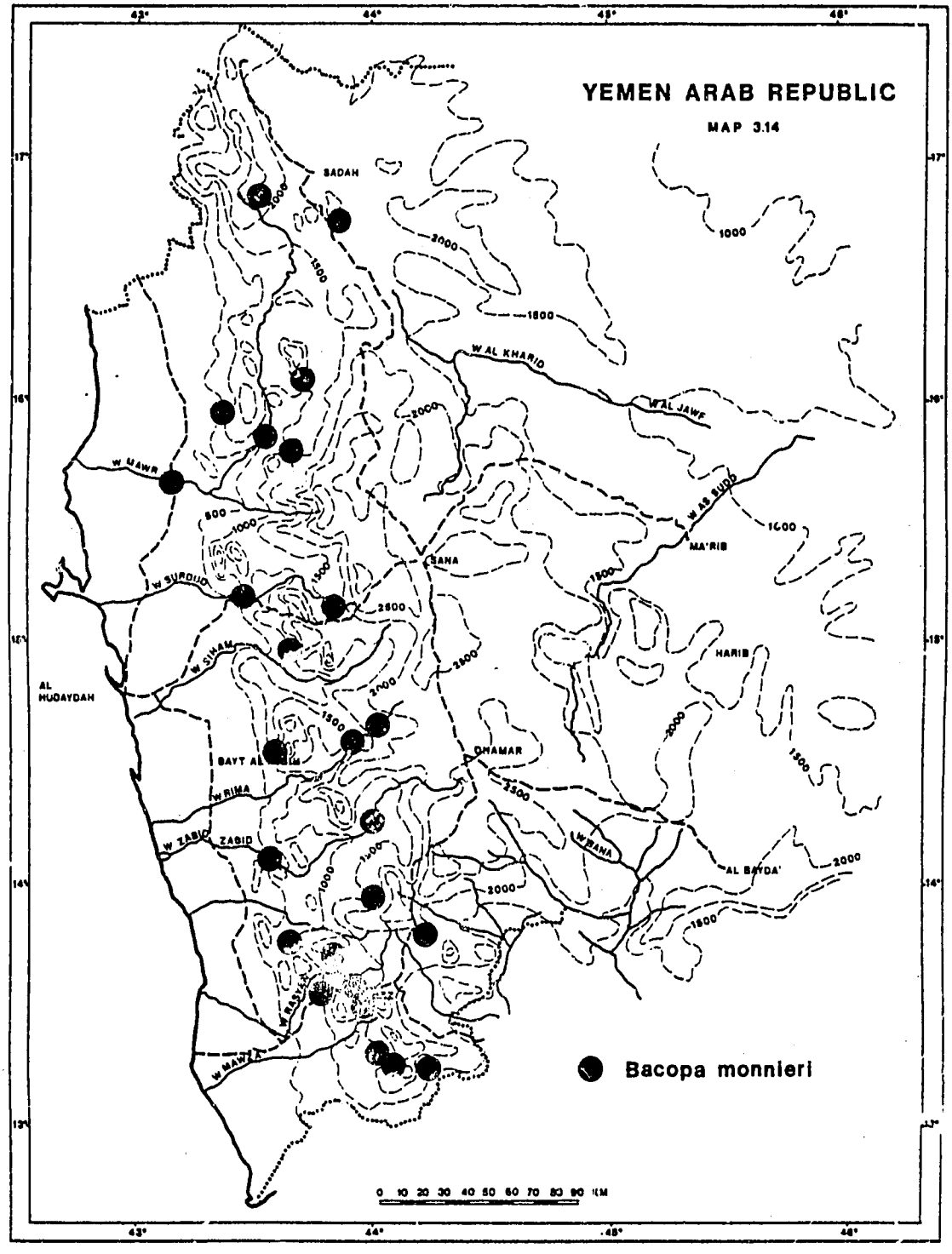

YEMEN ARAB REPUBLIC
MAP 3.13
SADAH
SANA
DHAMAR
MA'RIB
AL BAYDA'
W AL KHARID
W AL JAWF
W AS SUDD
W MAWR
W BURDUD
W SIHAM
W RIMA
W ZABID
ZABID
W BANA
W MAWR
Apium nodiflorum
0 10 20 30 40 50 60 70 80 90 KM

FIGURE 3.16 BACOPA MONNIERI


YEMEN ARAB REPUBLIC
MAP 3.14
SADAH
SANA
MA'RIB
HARIB
DHAMAR
AL BAYDA'
AL HUDAYDAH
W AL KHARID
W AL JAWF
W AS SUDD
W MAWR
W SURDUD
W SIHAM
W RIMA
W ZABID
ZABID
W BANA
W MAWR
Bacopa monnieri
0 10 20 30 40 50 60 70 80 90 KM

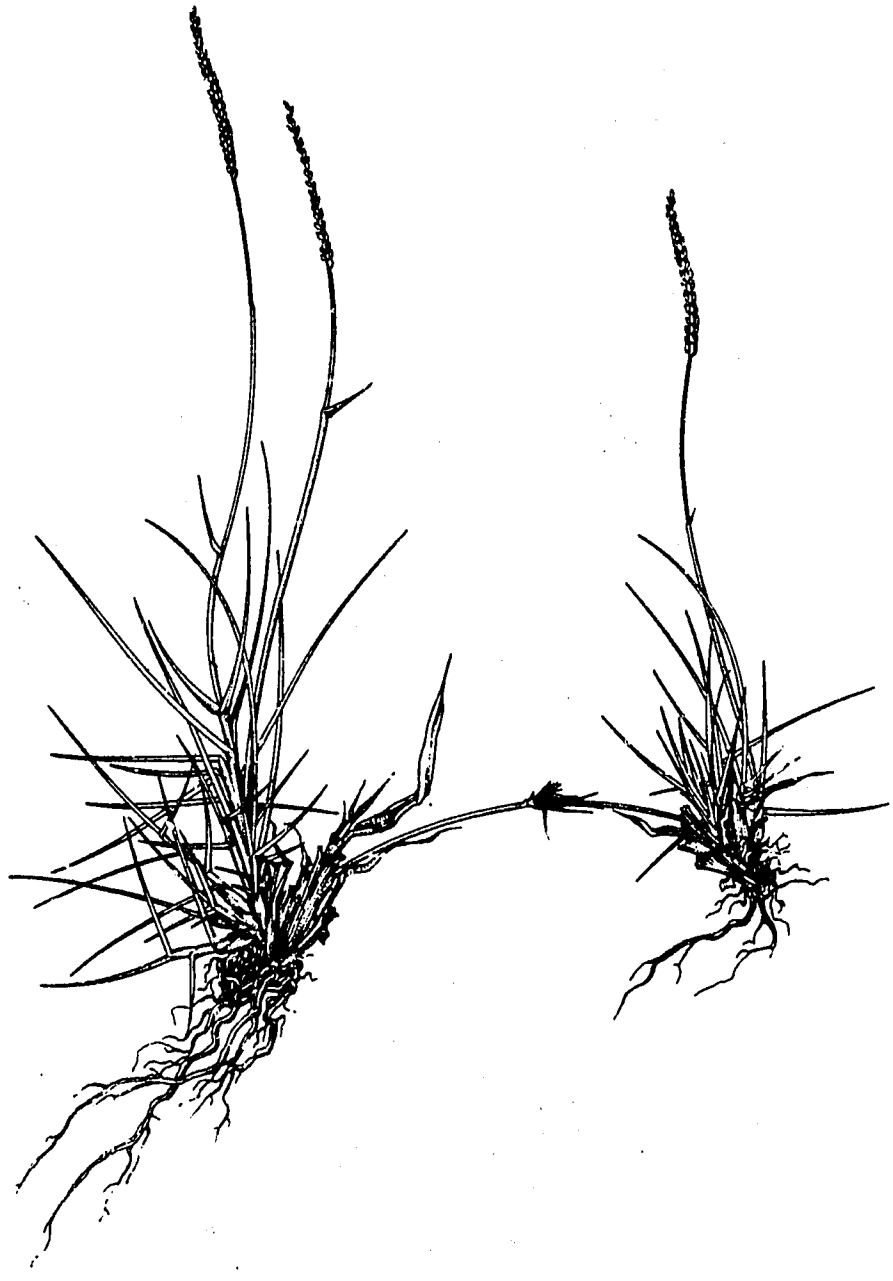
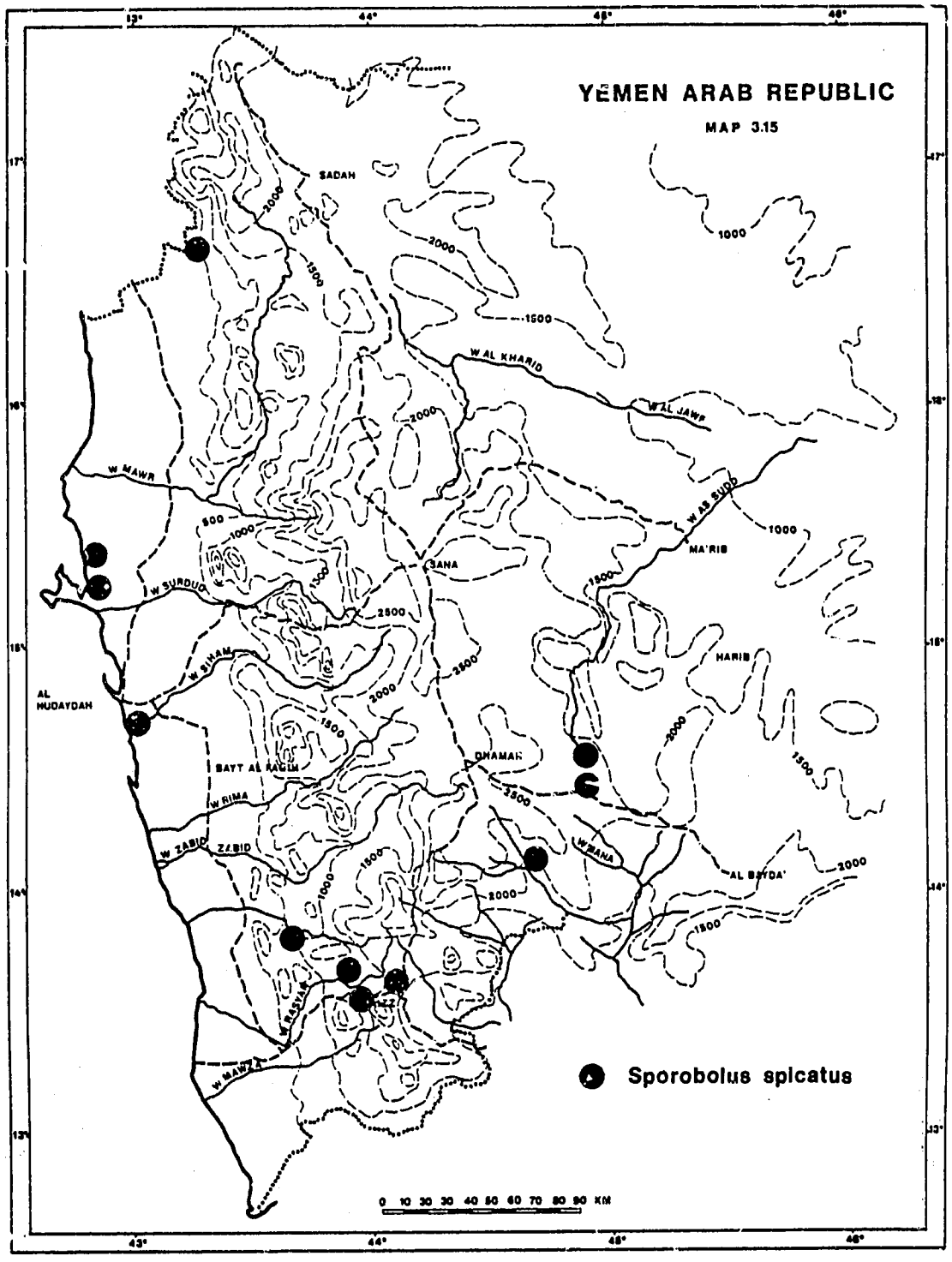


FIGURE 3.17 SPOROBOLUS SPICATUS


YEMEN ARAB REPUBLIC
MAP 3.15
SADAH
SANA
MA'RIB
HARIB
DHAMAR
AL HUDAYDAH
BAYT AL FAQIH
ZABID
AL BAYDA'
W AL KHARID
W AL JAWF
W AS SUDD
W MAWR
W SURDUD
W SIHAN
W RIMA
W ZABID
W BANA
W RASYAN
W MAWR
Sporobolus spicatus
0 10 20 30 40 50 60 70 80 90 KM

MAP 3.16: FORSSKALEA TENACISSIMA

This widespread species, very tolerant of altitude variations (100 - 3000m), is almost always found on volcanic rocks and particularly on lavas of recent origin. Particularly significant in this context is the record from the Tihama. *F. tenacissima* is absent, however, from areas with a rainfall above about 600mm per annum.

Forsskalea tenacissima is a much branched grey perennial about 30cm in height and is usually recognized by the leaves which readily cling to clothing. The leaves are whitish below and the minute flowers are in clusters in the leaf axils.

MAP 3.17: PLECTRANTHUS HEDIENSIS (MADAN)

This species is found from 1000 to 2500m on mountains enjoying prolonged periods of mist. The mist appears to be the crucial factor influencing the distribution of this species since it occurs in both low and high rainfall areas.

Plectranthus hediensis is a low, semisucculent herb with a trailing stem at the top of which is a cluster of leaves. The inflorescence is a terminal raceme of blue flowers. It is sometimes strongly aromatic.

MAP 3.18: CENTAUREA SCHIMPERI

This species is virtually restricted to sandstone rocks. Although rather local, it is a conspicuous plant which is abundant where it occurs.

Centaurea schimperi is an unarmed undershrub, about 30cm high, with numerous upright, stiff, almost leafless branches. The flowerheads are yellow and are enclosed in a campanulate involucre with many imbricate bracts.

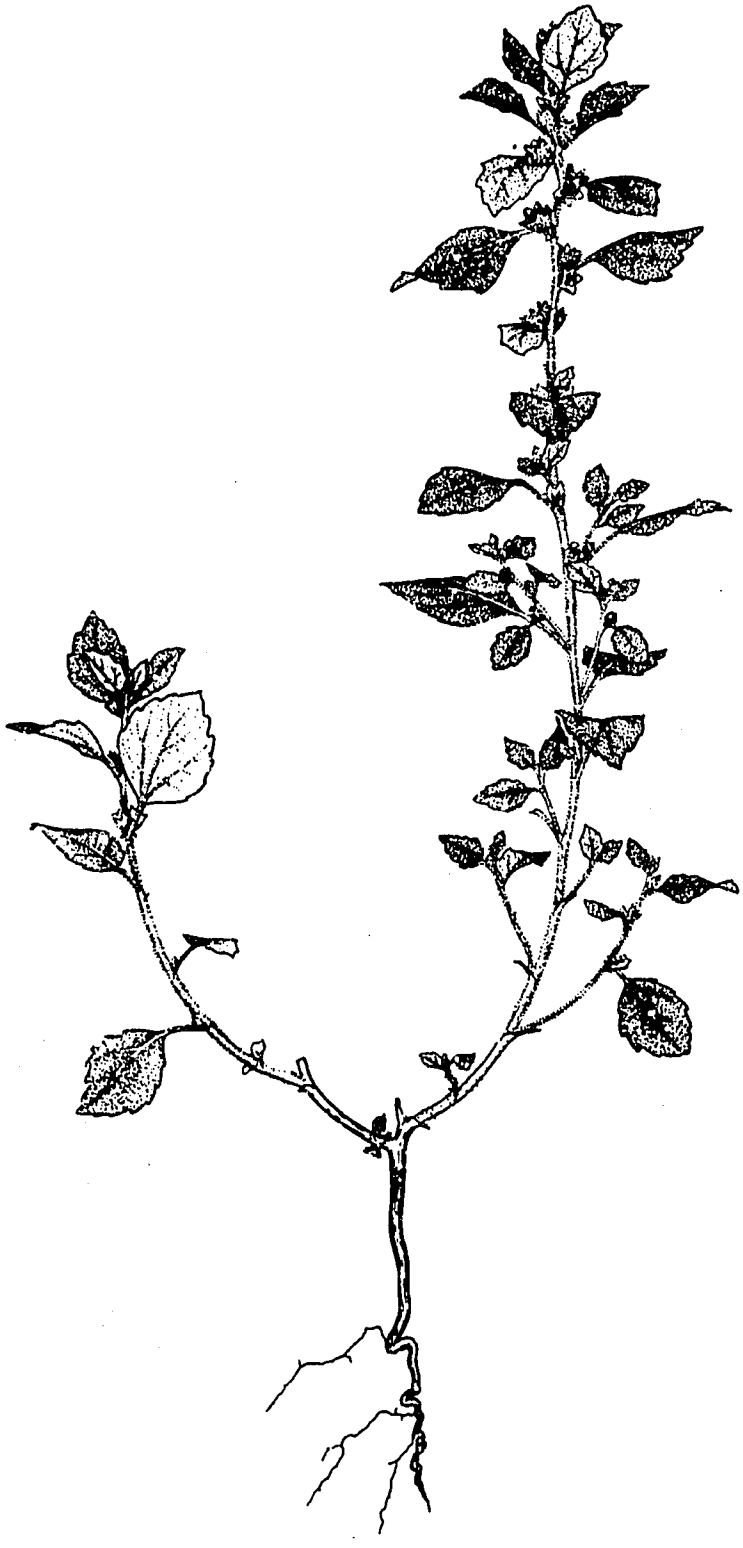
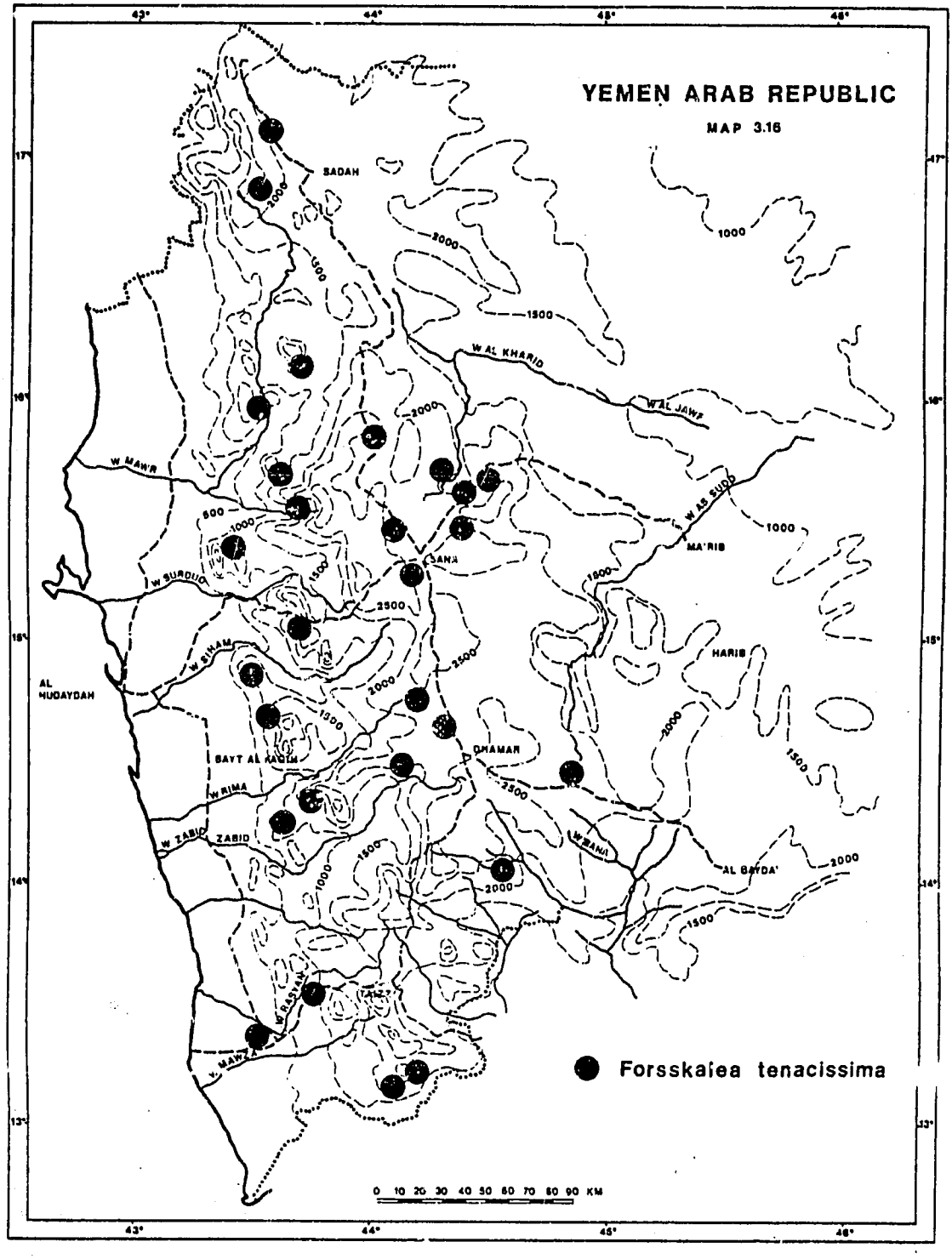


FIGURE 3.18 FORSSKALEA TENACISSIMA


YEMEN ARAB REPUBLIC
MAP 3.16
SADAH
SANA
DHAMAR
MA'RIB
HARIB
AL BAYDA'
AL HUDAYDAH
SAYT AL HAGIM
ZABID
W AL KHARID
W AL JAWF
W AS SUDD
W MAW'R
W SURDUD
W SIHAM
W RIMA
W ZABID
W BANA
W BASTAN
W MAWR
Forsskalea tenacissima
0 10 20 30 40 50 60 70 80 90 KM

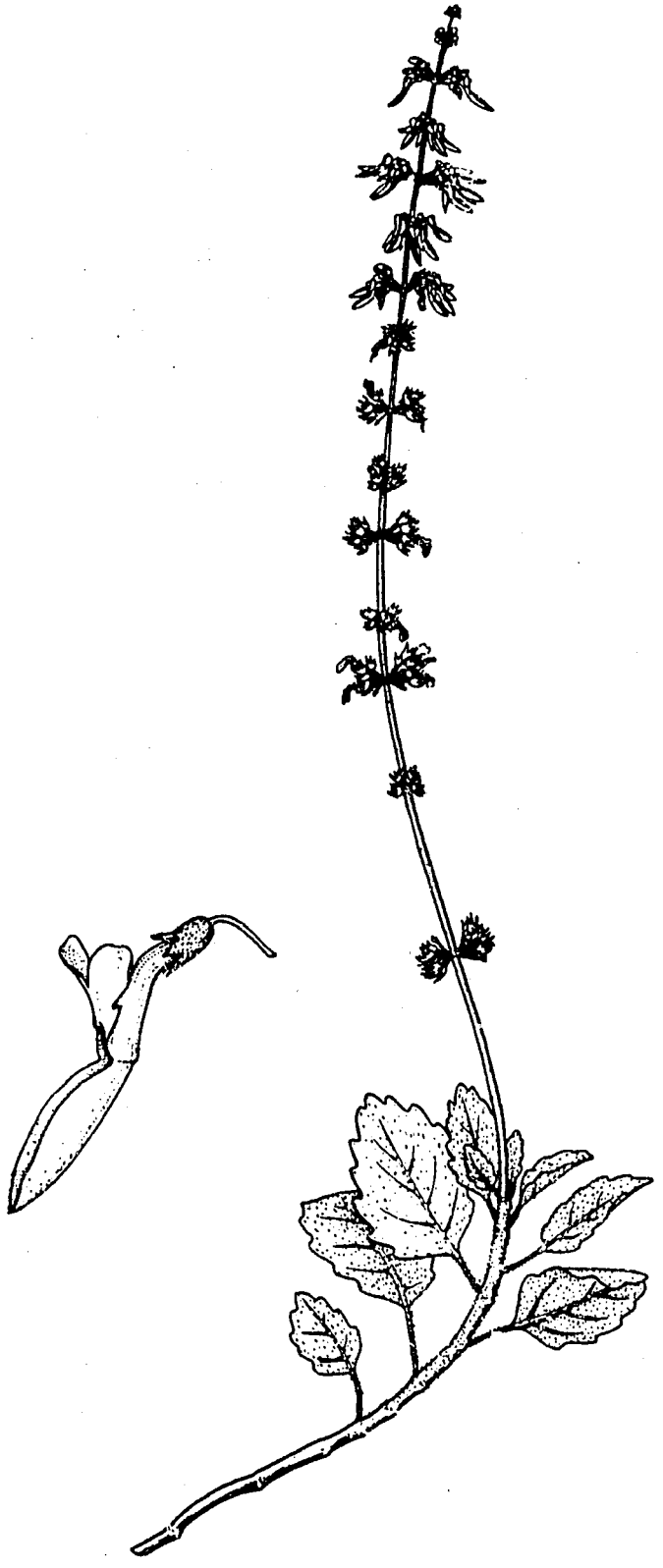
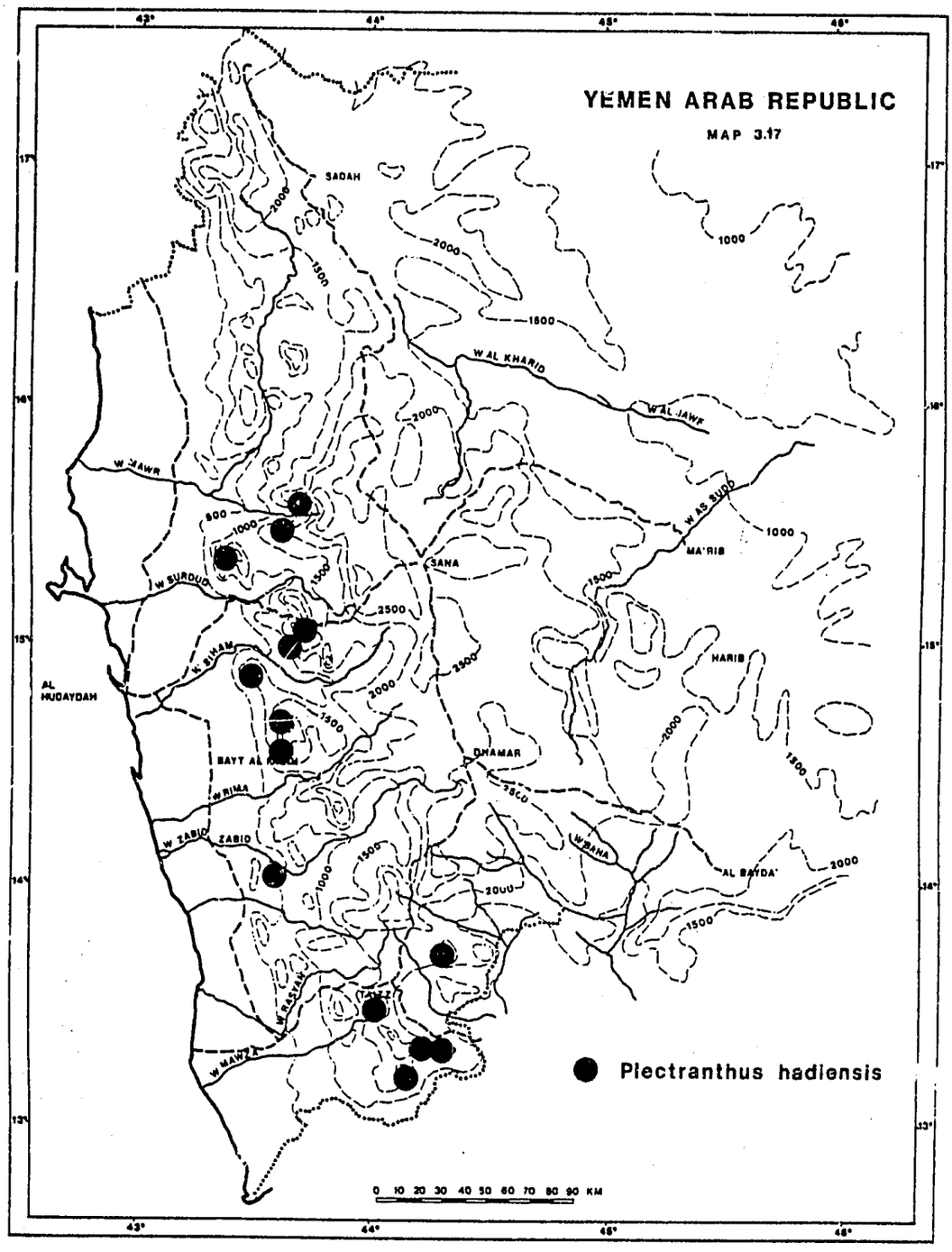


FIGURE 3.19 PLECTRANTHUS HADIENSIS


YEMEN ARAB REPUBLIC
MAP 3.17
SADAH
SANA
MA'RIB
HARIB
AL HUDAYDAH
DHAMAR
AL BAYDA'
W AL KHARID
W AL JAWF
W AS SUDD
W JAWR
W SURDUD
W BIHAM
W RIMA
W ZABID
ZABID
W RASIAN
W MAWR
W BANA
Plectranthus hadiensis
0 10 20 30 40 50 60 70 80 90 KM

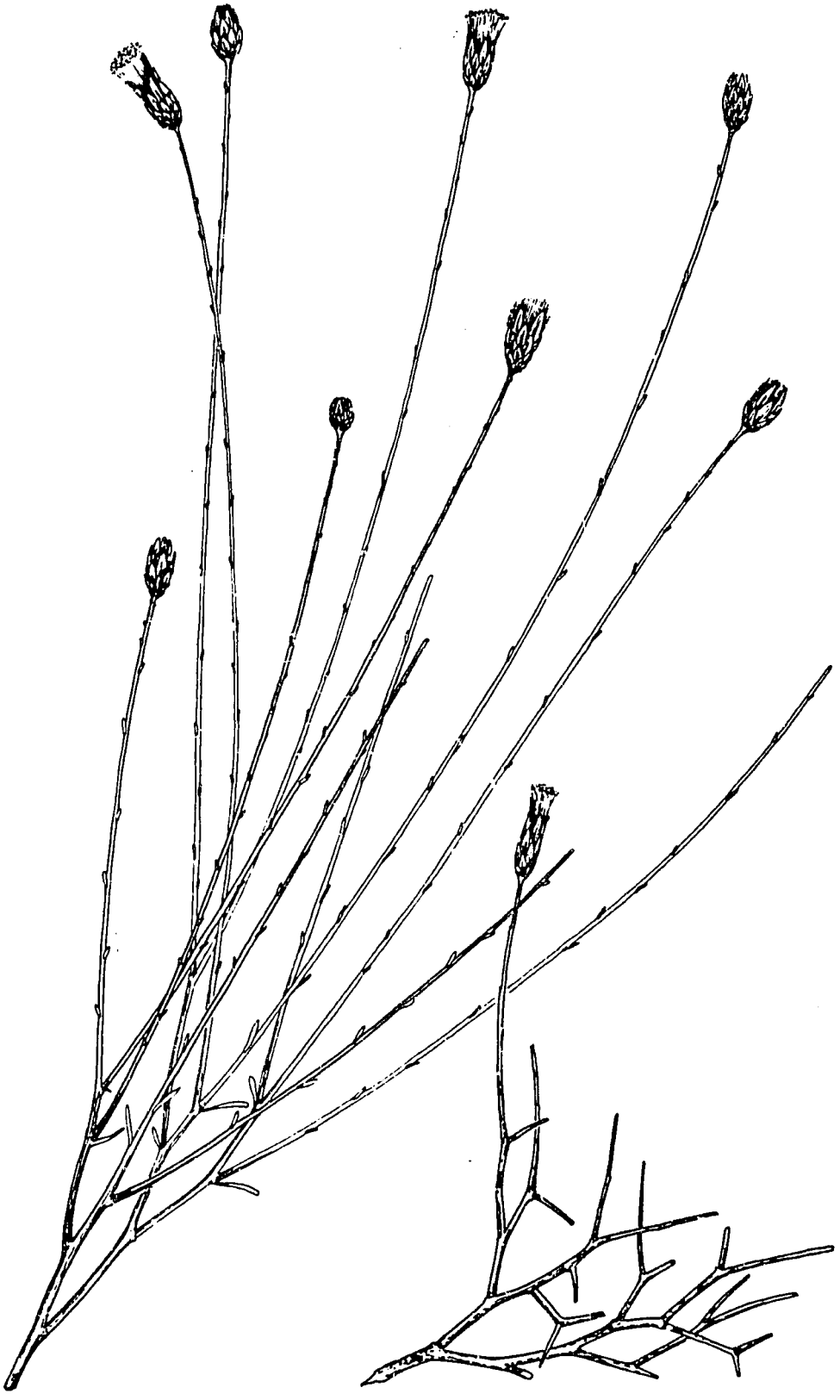
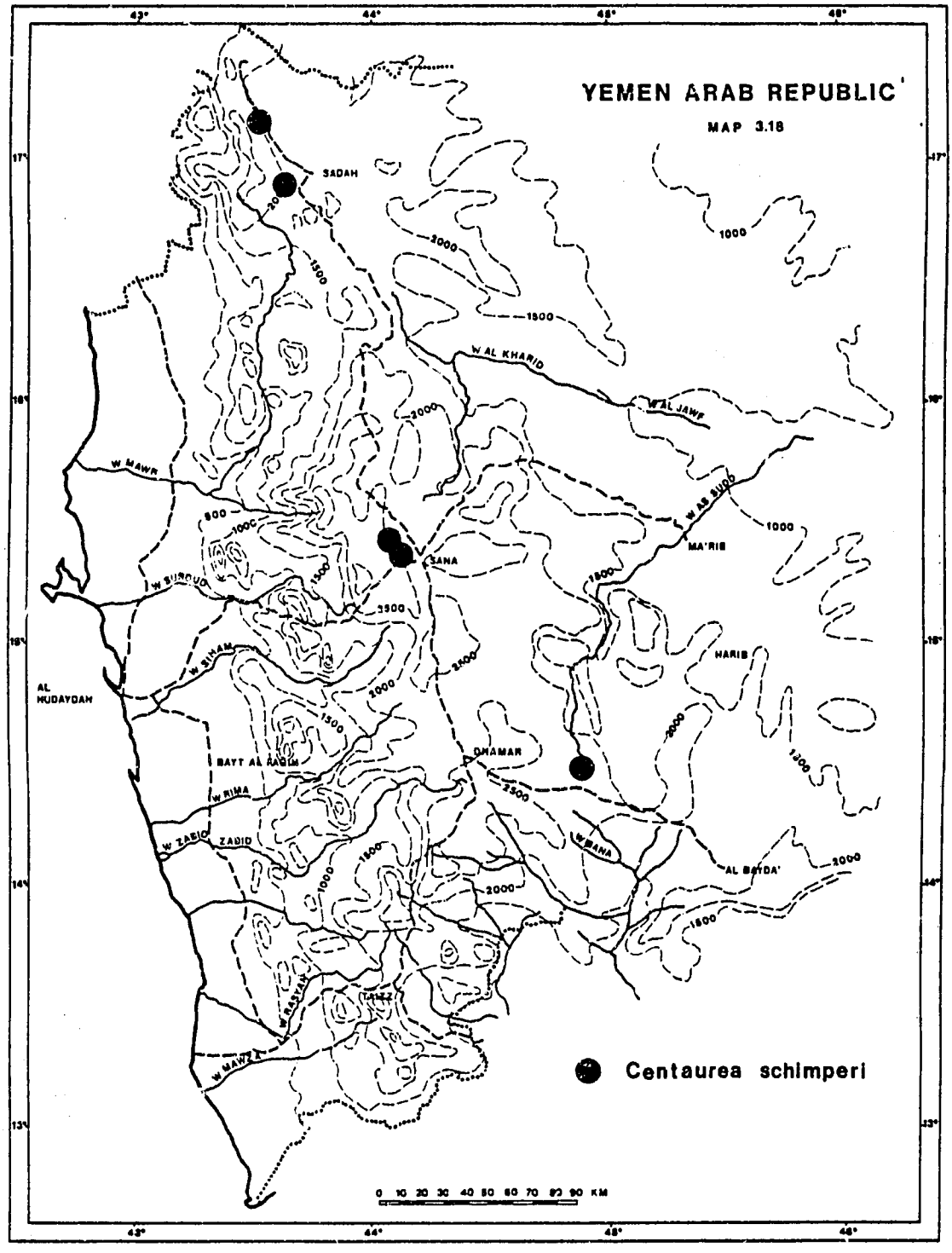


FIGURE 3.20 CENTAUREA SCHIMPERI


YEMEN ARAB REPUBLIC
MAP 3.18
SADAH
SANA
DHAMAR
MA'RIB
HARIB
AL BAYDA'
AL HUDAYDAH
BAYT AL FAQIH
ZABID
TAIZZ
W AL KHARID
W AL JAWF
W AS SUDD
W MAWR
W SIRDUD
W SIHAM
W RIMA
W ZABID
W BANA
W RASYAN
W MAWR
Centaurea schimperi
0 10 20 30 40 50 60 70 80 90 KM

BIBLIOGRAPHY

Since the description of the vegetation of Yemen is based almost entirely on personal observations, few references have been included in the text. Further information which has some relevance to the Yemen vegetation can be found in the works listed under the following three headings:

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Wickens, G. E. 1976. The flora of J. Marra. London H.M.S.O. (Good discussion of phytogeographical regions of Africa.)

Zohary, M. 1973. Geobotanical foundations of the Middle East. 2 vols. Stuttgart. (Poor on Arabia but good on the rest of the Middle East.)

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Vesey-Fitzgerald, D. F. 1955. Vegetation of the Red Sea coast south of Jeddah, Saudi Arabia. J. Ecol. 43:477-489.

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Deflers, A. 1889. Voyage au Yemen. Paris. (Sketchy account of some vegetation types, the taxonomy rather suspect.)

Hepper, F. N. 1977. Outline of the vegetation of the Yemen Arab Republic. Publ. Cairo Univ. Herb. 7 & 8:307-322. (A taxonomically accurate but not very enlightening account since neither the dominant species nor the distinct vegetation types are clearly stated.)

Popov, G. B., and W. Zeller. 1963. Ecological survey report on the 1962 survey in the Arabian Peninsula. Unpubl. rep. ref. UNSF/DL/ES/6. FAO, Rome, Italy.

Schoch, K. 1978. Land evaluation and classification from landsat-imagery in the Yemen Arab Republic. Swiss Technical Co-operation Service, Zurich, Switzerland. (Excellent interpretative map of the dynamics of vegetation growth.)

Westinga, E., and D. C. P. Thalen. 1980. A survey and problem analysis of the rangelands in the Rada' District. Rada' Integrated Rural Development Project Tech. Note 5. ILACO, Netherlands. 4.08.034. (Excellent account of the vegetation around Rada.)

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Wood, J. R. I. 1983a. The vegetation of the Tihama in the report of the 1982 Tihama Expedition. London, U. K.

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Chapter 4

FIELD SURVEY AND LABORATORY METHODS

The soil survey methods were adapted to the 1:500,000 scale of the final map. This scale permitted the delineation of associations of subgroups (USDA-SCS, 1975) of soils which occur in a repeated pattern in the landscape. The map units were recognized on the basis of climate, geology, relief, vegetation, soil morphology. The extent of the defined units was determined by analyzing satellite and aerial photography imagery.

The survey work included identifying the soils, classified to the subgroup level, which form the major soil associations and delineating these associations on 1:250,000 topographic maps. The field maps were to be reduced to the final scale of 1:500,000 for publication.

Progress was made by individual sheets, the locations of which are shown in Map 4.1, starting from the south and going north. All field operations were completed in eighteen months.

OFFICE METHODS BEFORE FIELD OBSERVATIONS

A published geological map at 1:500,000 (Grolier and Overstreet, 1978) and selected airphotos at 1:60,000 were used to define landform regions (see Map 2.3). These regions are uniform in lithology, climate, and relief.

Some information was available at the beginning of the project for specific areas of the Yemen Arab Republic. A major part of office operational tasks before field operations was compiling and reviewing all the available soils, geological, and climatic data and reports.

Preliminary studies before field operations in Yemen included a search and review of existing soil studies (published and unpublished government consultant's reports) and soil surveys. The Yemen Ministry of Agriculture had commissioned soil reports and surveys of selected areas for possible intensive agricultural development. A listing of these reports and surveys are as follows (Table 4.1):

Table 4.1: Previous Yemen soils reports.

Reports indexed in Map 4.1:

1) Acres, B. D. 1978. Landforms and soils of the Dhamar Agricultural Improvement Centre. Yemen Arab Republic Montane Plains and Wadi Rima Project: a land and water resource survey. Ministry of Overseas Development, Land Resources Division, Surbiton, Surrey, England.

2) Acres, B. D. 1980. Soils and land suitability of the Montane Plains and Wadi Rima. Yemen Arab Republic Montane Plains and Wadi Rima Project: a land and water resource survey. Overseas Development Administration, Land Resources Development Centre, Surbiton, Surrey, England.

3) Agrar- und Hydrotechnik GmbH. 1980. Development of Wadi Jawf and its tributaries; technical report: soils. Yemen Arab Republic Ministry of Agriculture.

4) Boros, I. J., I. Szabolcs, and G. Varallyay. 1970. Soil survey in the Tihama lowland (Yemen Arab Republic); I. factors of soil formation; II. soils and land capability classes. Agrokemia es Talajtan 19:405-464.

5) Boros, I. J., and Lesztak, J. 1971. Soil survey in the Tihama lowland (Yemen Arab Republic); III. water management properties of soils. Agrokemia es Talajtan 20:217-230.

6) Egli, E. 1978. "Landnutzung und landnutzungsveraenderung in der region Wadi Mawr Arabische Republik Jemen." Geographischen Institut der Universtat Zurich.

7) Electrowatt Engineering Services, Ltd. 1978. Marib Dam and Irrigation Project; Yemen Arab Republic; annexes I. soil and land classification; III. agriculture; V. geology and geotechniques; VII. hydrology. Government of Abu Dhabi, Presidential Court.

8) Halcrow, W., and Partners. 1978. Wadi Surdad: Development on the Tihama; vol. 4: soils and land capability; annex C. Yemen Arab Republic Ministry of Agriculture.

9) Pacheco, R. A. 1978. The application of landsat imagery to soil and land-use mapping in the central region of the Yemen Arab Republic. FAO Seris AGLT, FAO, Rome.

10) Tesco-viziterv-vituki. 1971. Survey of the agricultural potential of the Wadi Zabid, Yemen Arab Republic, soils and land capability. AGL: SF/YEM 1. Technical Report 8. Budapest.

11) Western, S. 1972. The classification of arid zone soils; II. the classification of Sedasols in Saudi Arabia. Journal of Soil Science 23:279-297.

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Asmaev, L. R. 1969. Data on soils of the southwestern part of the Arabian penisula. pp. 249-257. In Kovda, V. A., and E. V. Labova (ed.). Geography and classification of soils of Asia. Israel Program for Scientific Translations. pp. 249-257.

Grolier, M. J., G. C. Tibbitts, Jr., and M. M. Ibrahim. 1981. A qualitative appraisal of the hydrology of the Yemen Arab Republic from Landsat images. USGS. Open-file Report 80-565.

Kopp, H. 1975. Die raumliche differenzierung der agrarlandschaft in der Arabischen Republik Jemen (Nordjemen). Erdkunde 29:59-68.

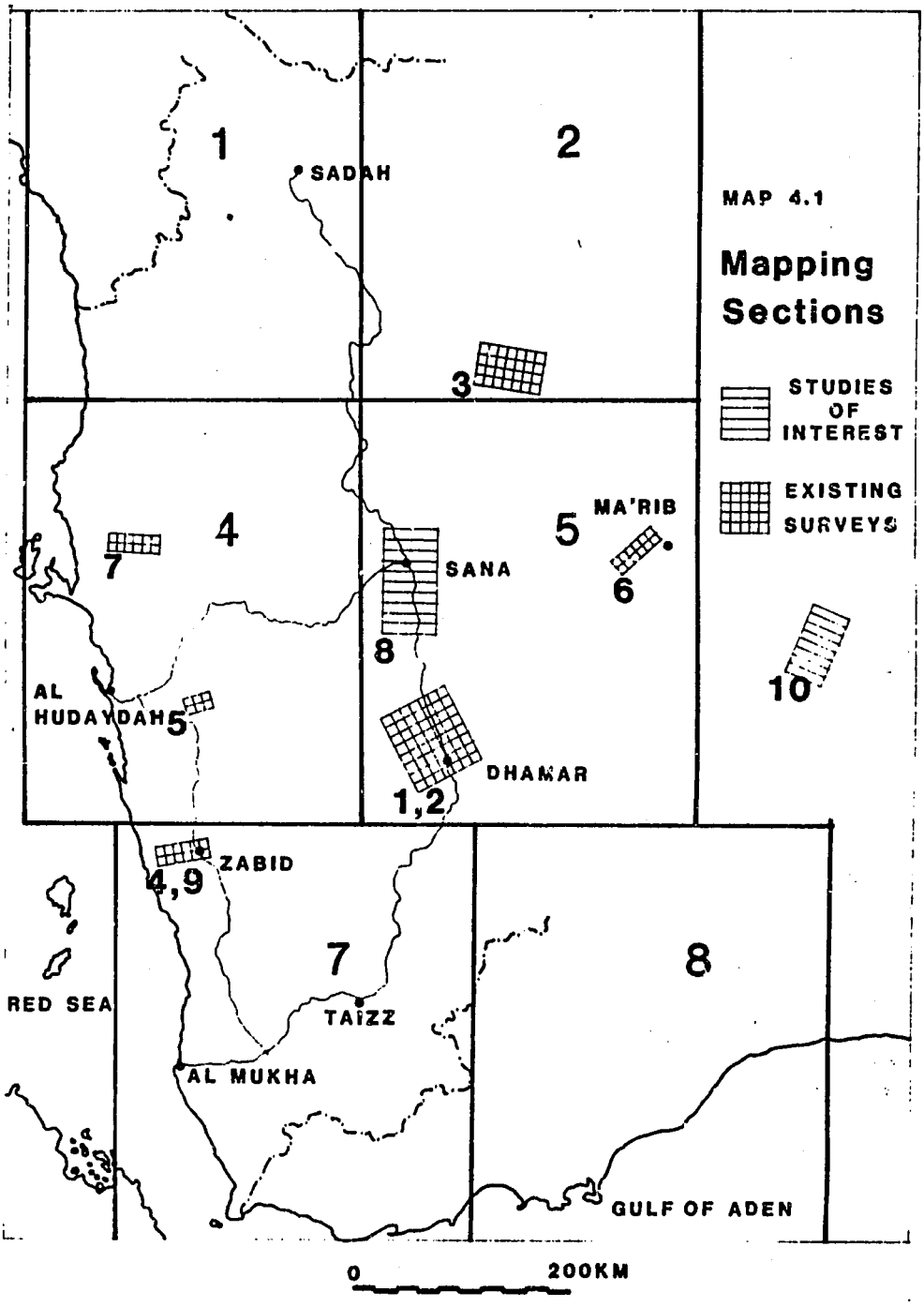
Schoch, R. 1977. Regionale gliederung der Jemenitischen Arabischen Republik mit hilfe von landsat-satellitenbildern. Thesis, Geographischen Institut der Universitat Zurich.

These reports supplemented field studies for the production of the 1:500,000 soils map. No attempt has been made to duplicate the detailed work done in these areas.

Computer-processed digital Landsat satellite imagery was used. Three Landsat bands, 4, 5, and 7, were digitally processed into a false-color infrared composite, which was then enlarged to 1:250,000 and 1:100,000. Homogenous areas on the false-color infrared imagery were checked to see if they corresponded with the landform regions previously defined. If necessary, adjustments were made. A general idea of the relief, intensity of vegetation, drainage systems, and lithology was derived from the false-color imagery.

Black and white airphotos (1:60,000) of selected sites were examined for pilot areas to be visited in the field. Relief, drainage, vegetation, soil parent materials, and present agricultural land use were distinguished in greater detail in these photos. The pilot sites estimated the soil pattern in each landscape and were used to select the location of characteristic pits for description and sampling.

YEMEN ARAB REPUBLIC



FIELD METHODS

The purpose of mapping the major components of the soil associations at large scales (about 1:25,000) in the pilot areas was to estimate the percentage each individual soil (as classified at the subgroup level) occupied in the association. The methodology followed the guidelines of the USDA Soil Survey Manual (1975, draft version). During these field observations, an effort was made to study the correlation between field characteristics, airphotos, and satellite imagery, in order to elaborate an identification key for the interpolation and extrapolation of soils data to inaccessible areas. Another objective of the field studies was to relate crop production and potential with soil and land characteristics, and to make interpretations for land-use. (See Chapter 7.) During reconnaissance trips to selected pilot areas, the dominant lithologies and their position in the landscape were noted as well as the presence and position of transported materials: colluvium, alluvium, and aeolian deposits. The distribution of the geological formations and the associated transported materials was important for understanding the genesis of the soils. (See Chapter 2.) This in turn permitted more efficient mapping.

The predominant landscape units such as colluvial slopes, alluvial terraces, man-made terraces, wadis, coastal plains, lake beds, barchan dunes, etc., formed the basis for description and selection of characteristic soil profiles for the pilot area. Traverses were made and soils were augered and examined at different sites along the landscape. Typical surface horizons were noted and checked for uniformity and average depth. The traverses gave an idea of the extent of the various soils in the mapping unit.

Sites for characteristic profiles were selected away from slope breaks and excessive human disturbances (except for man-made terraces). The profiles were described according to Guidelines for Soil Profile Description (FAO, 1977). Bulk samples were collected by horizon, as well as other samples for mineralogical, micromorphological, and sedimentalogical studies.

LABORATORY METHODS

The samples collected during the soil survey were analyzed by the FAO soils laboratory in Aussefeire, Yemen. The analyses were necessary to define the soil characteristics important for classification. Specialized analyses, such as mineralogy and micromorphology, were conducted as needed at the Agronomy Department at Cornell University.

The soil analyses are a complement to the field observations, to confirm and verify the accuracy of the classification. The level of detail is probably not adequate for purposes beyond the objectives of the general survey, such as feasibilty studies of irrigation or other development projects.

Routine analyses of all horizon samples included the following:

1) particle-size analyses by the pipette method (Day, 1965, pp. 545-562);

2) ordinary particle-size distribution of sand, silt, and clay by the hydrometer method (Day, 1965, pp. 562-566)

3) soil pH in 1:1 and 1:5 soil water ratio suspension

4) electrical conductivity (EC in mmhos) of a 1:1 soil/water suspension (modification of method by Bower and Wilcox, 1965, pp. 935-940)

5) cation exchange capacity at pH 8.2 by NaOAc (Chapman, 1965, pp. 899-900)

6) carbonate by acid-neutralization using hydrochloric acid (Allison and Moodie, 1965, pp. 1387-1388)

7) organic matter by the Walkley-Black method (Jackson, 1958)

8) total nitrogen (Bremner, 1965, pp. 1162-1164)

9) available phosphorus, measured as P soluble in sodium bicarbonate (Olsen and Dean, 1965, pp. 1044-1047)

Some profiles were selected for specialized mineralogical, micromorphological, and sedimentological analyses. These analyses were used to define more clearly the genetic relationships of soils in Yemen. The analyses included:

1) clay mineralogy by X-ray diffraction (Whittig, 1965, pp. 671-698) and thermal analysis (Barshad, 1965, pp. 699-742)

2) micromorphological features by petrographic microscope techniques (Cady, 1965, pp. 604-631)

3) mineralogy of the sand fraction by observation under a 10x microscope

OFFICE METHODS AFTER FIELD OBSERVATIONS

Soil descriptions were combined to define a legend of typical soil associations. Profiles were classified to the subgroup level according to Soil Taxonomy (USDA-SCS, 1975) and to the family level for the profile descriptions (Appendix I). The extent of benchmark soils were estimated for the pilot area.

Areas of similar soil associations were delineated on the satellite imagery. These areas were checked in the field to be sure they conformed to the description of the pilot area. The selection of typical profiles and the extent of association-delineations was revised as further observation and new field information deemed necessary.

Chapter 5

SOIL MAP LEGEND

The soil map legend (Table 5.1) was defined on the basis of soil genesis concepts and field survey principles discussed previously in Chapters 2 and 4, respectively. Since Soil Taxonomy (USDA-SCS, 1975) was the classification used for the map units, it was decided to divide the legend into five parts based on the predominant soil order of each of the individual map units. The predominant soil orders are: 1) Aridisols, 2) Entisols, 3) Inceptisols, and 4) Mollisols. A fifth division was based on those map units which are predominantly rock outcrops. This five-part subdivision of map units groups those units which are most similar.

Individual soil profiles were classified to the family level (Appendix I). Appropriate phases were also designated for the profiles when the phase information was deemed useful for future land use decisions. Phase designations referring mainly to the predominant topography, stoniness, or presence or absence of terraces were also included in the soil map legend.

The importance of soil moisture regimes, which range from aridic to udic, are apparent to anyone with any practical, agricultural experience in Yemen. In the legend, the predominant soil moisture regime is usually given in the soil subgroup name. Further information on the soil moisture regimes for the families and subgroups for agricultural land uses are given in Chapter 7. Soil moisture regimes were estimated from available climatic data and are given in Appendix II.

The importance of the soil temperature regime designation may not be as immediately evident as that of the soil moisture designation. This does not in any way, however, diminish its importance for agricultural planning. Yemen is a mountainous country with many small microclimate areas. Air temperature and therefore soil temperature are a direct function of elevation. The warmest soil temperature regimes occur at the lowest elevations and the coolest at the highest elevations. The soil temperature regimes were estimated from known elevations and limited climatic data for several locations in Yemen. The methodology of estimation and results are reported in Appendix II. The dominant soil temperature regime is given in the legend (Table 5.1) for each map unit.

A map at 1:500,000 scale should be useful in determining the approximate areas of different kinds of soils classified at a high level of generalization. The percentage of total area of different subgroups in each map unit is given in the legend. A further breakdown of the areas in square kilometers of each different kind of soil subgroup and soil order has also been determined for planning purposes (Table 5.2). From this table one sees that the map units

predominantly Entisols are the most extensive. The second largest area is composed of those map units which are predominantly rock outcrops (this is a particularly large area in the southeastern part of the survey). After these areas the next most predominant are those of Aridisols, followed by Inceptisols, and Mollisols in decreasing order.

Finally, the designation number of the soil profiles characteristic for some of the soil subgroups in the map units is given in the legend (Table 5.1). Full descriptions of these profiles along with laboratory data are given in Appendix I.

Table 5.1: Legend of the soil mapping units; soil groups, units, symbols, phases, temperature regimes, and profiles for soils in the Yemen Arab Republic.

UNIT	SYMBOL	PHASE	DOMINANT TEMP. REGIME	PERCENT OF TOTAL AREA	PROFILE NOS.
SOILS PREDOMINANTLY ARIDISOLS					
1. Typic Calciorthids	Act	stony to bouldery	isohyperthermic	60%	K7, K9, K36
Typic Torrifluvents		stony to bouldery	isohyperthermic	20%	-
Typic Torriorthents		stony to bouldery	isohyperthermic	20%	K35
2. Typic Gypsiorthids	Agr	stony, mountainous	isohyperthermic	40%	K75, K76
Lithic Torriorthents		stony, mountainous	isohyperthermic	20%	-
Rock Outcrops		stony, mountainous	isohyperthermic	40%	-
3. Typic Salorthids	Asf	flat	isohyperthermic	70%	K46, K49
Tropic Fluvaquents		flat	isohyperthermic	15%	K40
Tropaquents		flat	isohyperthermic	15%	K38
4. Typic Salorthids	Ast	flat	hyperthermic	70%	K59
Typic Torrifluvents		flat	hyperthermic	30%	-
SOILS PREDOMINANTLY ENTISOLS					
5. Typic Torriorthents	Etc	stony, undulating	hyperthermic	40%	K58
Typic Torrifluvents		stony, undulating	hyperthermic	40%	K55
Typic Calciorthids		stony, undulating	hyperthermic	20%	-
6. Typic Torrifluvents	Etu	flat	hyperthermic	60%	-
Typic Udifluvents		flat	hyperthermic	40%	K56
7. Typic Torrifluvents	Ett	flat	isohyperthermic	30%	K37, K41, K42, K48
Typic Torripsamments		flat	isohyperthermic	30%	K39
Typic Torriorthents		flat	isohyperthermic	30%	K50
Typic Calciorthids		flat	isohyperthermic	10%	K47
8. Typic Torriorthents	Etf	flat	isothermic, hyperthermic	50%	K4
Typic Torripsamments		flat	isothermic, hyperthermic	35%	K71
Typic Torrifluvents		flat	isothermic, hyperthermic	15%	K5

Table 5.1 continued...

9.	Typic Torriorthents	Ehu	undulating	iso-, isohyper-,* hyperthermic	20%	F1, K12, K14
	Typic Ustifluvents		undulating, terraced	isothermic	20%	K20, K21, K22
	Typic Haplargids		undulating	iso-, isohyper-,* hyperthermic	10%	K13
	Typic Calciorthids		undulating	isohyperthermic	10%	K18
	Typic Ustorthents		undulating	isothermic	10%	K19
	Typic Camborthids		mountainous	isothermic	10%	F2
	Aquollic Salorthids		flat	isothermic	10%	F3
	Typic Fluvaquents		flat	isohyperthermic	10%	K15
10.	Typic Torriorthents	Eur	mountainous	isothermic, isohyperthermic	25%	K1, K11
	Lithic Torriorthents		mountainous	isothermic, isohyperthermic	25%	-
	Typic Ustorthents		mountainous, terraced	isothermic, isohyperthermic	20%	-
	Rock Outcrops		mountainous	isothermic, isohyperthermic	30%	-
11.	Typic Torripsamments	Est	undulating	isohyperthermic	85%	-
	Typic Torrifluvents		undulating	isohyperthermic	15%	-
12.	Typic Torripsamments	Ess	undulating	hyperthermic	80%	-
	Typic Torrifluvents		undulating	hyperthermic	20%	-
13.	Typic Ustipsamments	Eut	undulating	hyperthermic	85%	-
	Typic Torrifluvents		undulating	hyperthermic	15%	-
14.	Typic Ustifluvents	Euu	almost flat	hyperthermic, isohyperthermic	60%	K10, K28, K30
	Typic Ustorthents		almost flat	hyperthermic, isohyperthermic	20%	-
	Typic Ustipsamments		almost flat	hyperthermic, isohyperthermic	10%	-
	Typic Torrifluvents		almost flat	hyperthermic, isohyperthermic	10%	F6
15.	Typic Ustifluvents	Eup	undulating	isohyperthermic	60%	K72
	Typic Ustipsamments		undulating	isohyperthermic	30%	K73
	Typic Torrifluvents		undulating	isohyperthermic	10%	K74, K77
16.	Typic Ustifluvents	Euo	mountainous, terraced	isothermic, isohyperthermic	60%	-
	Typic Ustorthents		mountainous, terraced	isothermic, isohyperthermic	30%	K16, K17
	Lithic Torriorthents		mountainous	isothermic, isohyperthermic	10%	-
17.	Typic Ustorthents	Eto	mountainous, terraced	iso-, isohyper-,* isomesic	30%	F9, K31
	Typic Ustifluvents		mountainous	iso-, isohyper-,* isomesic	5%	K23, K24
	Tropofluvents		flat	iso-, isohyper-,* isomesic	5%	F11
	Lithic Torriorthents		mountainous	iso-, isohyper-,* isomesic	5%	-
	Typic Torriorthents		mountainous	iso-, isohyper-,* isomesic	5%	-
	Typic Natrustalfs		mountainous	iso-, isohyper-,* isomesic	5%	F10
	Entic Haplustolls		mountainous	isothermic, isomesic	5%	K25
	Typic Argiudolls		mountainous	isothermic, isomesic	5%	K32
	Lithic Ustorthents		mountainous	iso-, isohyper-,* isomesic	5%	K33
	Rock Outcrops		mountainous	iso-, isohyper-,* isomesic	30%	-
18.	Typic Ustifluvents	Eft	flat	isothermic, hyperthermic	60%	K67
	Typic Torrifluvents		flat	isothermic, hyperthermic	30%	-
	Typic Calciorthids		flat	isothermic, hyperthermic	10%	K68

Table 5.1 continued...

19.	Typic Ustifluvents	Eub	undulating	isothermic	50%	-
	Ustic Torriorthents		rolling	isothermic	10%	A82
	Typic Ustorthents		terraced	isothermic	10%	K87
	Basalt Flow		undulating, rubble land	isothermic	30%	-
20.	Typic Ustorthents	Eoc	undulating	isothermic	50%	A34
	Typic Ustifluvents		undulating	isohyperthermic	30%	K79
	Typic Calciorthids		undulating	isohyperthermic	10%	-
	Typic Torriorthents		undulating	isohyperthermic	10%	K29, K78
21.	Typic Ustorthents	Ehc	mountainous, terraced	isothermic, isomesic	45%	-
	Udic Haplustolls		mountainous, terraced	isothermic, isomesic	10%	A3
	Entic Ustropepts		mountainous	isothermic, isomesic	10%	-
	Petrocalcic Calciustolls		mountainous	isothermic, isomesic	5%	K80
	Typic Calciustolls		mountainous	isothermic, isomesic	5%	F4
	Typic Ustropepts		mountainous, terraced	isothermic, isomesic	5%	F5
	Typic Calciorthids		mountainous	isothermic, isomesic	5%	K81
	Rock Outcrops		mountainous	isothermic, isomesic	15%	-
SOILS PREDOMINANTLY INCEPTISOLS						
22.	Typic Ustropepts	Iuc	flat	isothermic	55%	-
	Ustollic Calciorthids		flat	isothermic	20%	-
	Vertic Haplustolls		flat	isothermic	10%	K45
	Udic Pellusterts		flat	isothermic	5%	F8
	Typic Torrerts		flat	isothermic	5%	F7
	Udic Haplustolls		flat	isothermic	5%	K2
23.	Typic Ustropepts	Iuu	mountainous, terraced	isothermic	60%	K27
	Entic Ustropepts		flat	isothermic	20%	-
	Typic Ustifluvents		flat	isothermic	10%	-
	Ustollic Camborthids		flat	isothermic	5%	K26
	Ustollic Calciorthids		flat	isothermic	5%	A89
SOILS PREDOMINANTLY MOLLISOLS						
24.	Typic Calciustolls	Mct	flat, sand cap	isothermic	40%	A62, K66
	Typic Calciorthids		flat	isothermic, isohyperthermic	20%	K60, K61, K64, K69, A70
	Typic Torriorthents		flat	isothermic	15%	K6
	Ustic Torripsamments		flat	isothermic	15%	A63
	Typic Haplustolls		flat	isothermic	10%	A65
25.	Typic Hapludolls	Mhr	mountainous	isothermic	40%	K44
	Entic Hapludolls		mountainous	isothermic	10%	A43
	Lithic Torriorthents		mountainous	isomesic	10%	-
	Rock Outcrops		mountainous	isomesic	40%	-

Table 5.1 continued...

26. Vertic Haplustolls	Muh	flat	isothermic	50%	K83, K88
Typic Ustifluvents		flat	isothermic	30%	-
Aridic Haplustolls		flat	isothermic	10%	-
Typic Torriorthents		flat	isothermic	5%	A84
Typic Haplustolls		flat	isothermic	5%	K85
SOILS PREDOMINANTLY ROCK OUTCROPS					
27. Typic Calciorthids	Rcc	stony, mountainous	isothermic, isohyperthermic	20%	K8
Lithic Calciorthids		stony, mountainous	isothermic, isohyperthermic	10%	-
Rock Outcrops		stony, mountainous	isothermic, isohyperthermic	70%	-
28. Lithic Torriorthents	Rtt	mountainous	isohyperthermic	20%	-
Typic Torriorthents		mountainous	isohyperthermic	20%	-
Typic Calciorthids		mountainous	isohyperthermic	10%	-
Rock Outcrops		mountainous	isohyperthermic	50%	-
29. Typic Torriorthents	Rtc	mountainous	hyperthermic	25%	A51
Lithic Torriorthents		mountainous	hyperthermic	10%	K54
Typic Torrifluvents		flat	hyperthermic	5%	A53
Typic Ustifluvents		flat	hyperthermic	5%	K52, K57
Typic Calciorthids		mountainous	hyperthermic	5%	-
Rock Outcrops		mountainous	hyperthermic	50%	-
30. Typic Ustifluvent	Ruo	flat	isothermic	40%	A86
Rock Outcrops		steep	isothermic	60%	-

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*isothermic, isohyperthermic

Table 5.2: Areas of soils in the Yemen Arab Republic by subgroup, map unit, and soil order.

UNIT	SYMBOL	AREAS BY SUBGROUP km^2	AREAS BY MAP UNIT km^2	AREAS BY SOIL ORDER km^2
SOILS PREDOMINANTLY ARIDISOLS				
1. Typic Calciorthids	Act	950.09	1583.47	Aridisols:
Typic Torrifluvents		316.69		
Typic Torriorthents		316.69		10,097.35
2. Typic Gypsiorthids	Agr	160.88	402.21	
Lithic Torriorthents		80.45		
Rock Outcrops		160.88		
3. Typic Salorthids	Asf	655.64	936.62	
Tropic Fluvaquents		140.49		
Tropaquents		140.49		
4. Typic Salorthids	Ast	17.41	24.87	
Typic Torrifluvents		7.46		
SOILS PREDOMINANTLY ENTISOLS				
5. Typic Torriorthents	Etc	3935.46	9838.66	Entisols:
Typic Torrifluvents		3935.46		
Typic Calciorthids		1967.74		70,223.32
6. Typic Torrifluvents	Etu	212.95	354.91	
Typic Udifluvents		141.96		
7. Typic Torrifluvents	Ett	1365.69	4552.29	
Typic Torripsamments		1365.69		
Typic Torriorthents		1365.69		
Typic Calciorthids		455.22		
8. Typic Torriorthents	Etf	889.10	1778.19	
Typic Torripsamments		622.37		
Typic Torrifluvents		266.72		

Table 5.2 continued...

9.	Typic Torriorthents	Ehu	629.61	3148.05
	Typic Ustifluvents		629.61	
	Typic Haplargids		314.81	
	Typic Calciorthids		314.81	
	Typic Ustorthents		314.81	
	Typic Camborthids		314.80	
	Aquollic Salorthids		314.80	
	Typic Fluvaquents		314.80	
10.	Typic Torriorthents	Eur	1458.21	5832.85
	Lithic Torriorthents		1458.21	
	Typic Ustorthents		1166.57	
	Rock Outcrops		1749.86	
11.	Typic Torripsamments	Est	1621.48	1907.62
	Typic Torrifluvents		286.14	
12.	Typic Torripsamments	Ess	1878.39	2347.99
	Typic Torrifluvents		469.60	
13.	Typic Ustipsamments	Eut	1699.38	1999.27
	Typic Torrifluvents		299.89	
14.	Typic Ustifluvents	Euu	3415.14	5691.90
	Typic Ustorthents		1138.38	
	Typic Ustipsamments		569.19	
	Typic Torrifluvents		569.19	
15.	Typic Ustifluvents	Eup	712.60	1187.66
	Typic Ustipsamments		356.30	
	Typic Torrifluvents		118.76	
16.	Typic Ustifluvents	Euo	2020.09	3366.81
	Typic Ustorthents		1010.04	
	Lithic Torriorthents		336.68	
17.	Typic Ustorthents	Eto	3364.19	11,213.95
	Typic Ustifluvents		560.70	
	Tropofluvents		560.70	
	Lithic Torriorthents		560.70	
	Typic Torriorthents		560.70	
	Typic Natrustalfs		560.70	
	Entic Haplustolls		560.68	
	Typic Argiudolls		560.69	
	Lithic Ustorthents		560.69	
	Rock Outcrops		3364.19	
18.	Typic Ustifluvents	Eft	1101.67	1836.11
	Typic Torrifluvents		550.83	
	Typic Calciorthids		183.61	

Table 5.2 continued...

19.	Typic Ustifluvents	Eub	947.46	1894.91	
	Ustic Torriorthents		189.49		
	Typic Ustorthents		189.49		
	Basalt Flow		568.47		
20.	Typic Ustorthents	Eoc	1380.46	2760.92	
	Typic Ustifluvents		828.28		
	Typic Calciorthids		276.09		
	Typic Torriorthents		276.09		
21.	Typic Ustorthents	Ehc	416.88	926.40	
	Udic Haplustolls		92.64		
	Entic Ustropepts		92.64		
	Petrocalcic Calciustolls			46.32	
	Typic Calciustolls		46.32		
	Typic Ustropepts		46.32		
	Typic Calciorthids		46.32		
	Rock Outcrops		138.96		
SOILS PREDOMINANTLY INCEPTISOLS					
22.	Typic Ustropepts	Iuc	2656.54	4830.08	Inceptisols:
	Ustollic Calciorthids		966.02		
	Vertic Haplustolls		483.02		4923.11
	Udic Pellusterts		241.50		
	Typic Torrerts		241.50		
	Udic Haplustolls		241.50		
23.	Typic Ustropepts	Iuu	1595.71	2659.52	
	Entic Ustropepts		531.90		
	Typic Ustifluvents		265.95		
	Ustollic Camborthids		132.98		
	Ustollic Calciorthids		132.98		
SOILS PREDOMINANTLY MOLLISOLS					
24.	Typic Calciustolls	Mct	226.00	565.00	Mollisols:
	Typic Calciorthids		113.00		
	Typic Torriorthents		84.75		2809.24
	Ustic Torripsamments		84.75		
	Typic Haplustolls		56.50		
25.	Typic Hapludolls	Mhr	11.02	27.54	
	Entic Hapludolls		2.75		
	Lithic Torriorthents		2.75		
	Rock Outcrops		11.02		

Table 5.2 continued...

26.	Vertic Haplustolls	Muh	370.61	741.22	
	Typic Ustifluvents		222.37		
	Aridic Haplustolls		74.12		
	Typic Torriorthents		37.06		
	Typic Haplustolls		37.06		

SOILS PREDOMINANTLY ROCK OUTCROPS

27.	Typic Calciorthids	Rcc	110.24	551.22	Rock Outcrops:
	Lithic Calciorthids		55.12		
	Rock Outcrops		385.86		29,259.59
28.	Lithic Torriorthents	Rtt	1744.56	8722.82	
	Typic Torriorthents		1744.56		
	Typic Calciorthids		872.28		
	Rock Outcrops		4361.42		
29.	Typic Torriorthents	Rtc	8712.55	34,850.20	
	Lithic Torriorthents		3485.02		
	Typic Torrifluvents		1742.51		
	Typic Ustifluvents		1742.51		
	Typic Calciorthids		1742.51		
	Rock Outcrops		17,425.10		
30.	Typic Ustifluvent	Ruo	729.22	1823.05	
	Rock Outcrops		1093.83		

Chapter 6

THE AGRICULTURE OF THE INTERMOUNTAIN PLAINS

John Farnworth

Formerly Project Leader, Dhamar Agricultural Improvement Center, 1980-82, John Farnworth gained his Ph.D. in Agriculture (hill land improvement) at the University of Wales. He has worked extensively with agricultural research and development on the Arabian peninsula specializing in dryland and irrigated crop production and managing multi-disciplinary projects in Saudi Arabia and the Yemen Arab Republic. Between residential assignments in Arabia he has advised Arabian agricultural entrepreneurs and lectured in Arid Zone Agriculture at the University of Wales.

PRESENT AGRICULTURAL PRACTICES

BACKGROUND

The Intermountain Plains area, which is part of the Yemen Highlands, lies roughly between the Yisloh Pass in the north and the Sumarah Pass in the south between 14° 55' and 14° 10' N. It is roughly dissected on this north-south line by the main asphalt highway linking Sana and Taizz. To the west the area is bounded by the scarp which descends from the highlands to the Red Sea and more indefinitely to the east by the watershed to the Rub Al Khali. The area's population is in the order of 200,000 and Dhamar city is the main market center on the main highway.

The area comprises some 2700km^2 at elevations above 2200m with large plains dissected by hills and valleys. Administratively, all but the south of the area falls in the Dhamar governorate, with the southern end included in the Ibb governorate. The plains are all utilized for agriculture, but more intensive agriculture is practised in surrounding mountain or hillside terraces, or in valleys where there is usually a higher rainfall or water catchment opportunity and warmer climate. Over the centuries all possible land has been adapted to arable agriculture by terracing plains and mountainsides.

Rainfall of the region is locally and seasonally erratic but generally annual precipitation increases from north to south. Rainfall records for localities within the region are relatively recent but

suggest local annual averages ranging between 185mm to 600mm. Rainfall is split into two main seasons--spring (March and April) and summer (July and August)--but storms or showers can fall at any time of the year. Precipitation may fall as hail or dew at any time of the year; the latter has not been quantified. Hail damages crops.

The "efficiency" of the rainfall is low but has not been calculated over a long period. Nonseasonal and pre-rainy season showers are undoubtedly of little consequence to crop growth. In heavy storms when runoff occurs, water is lost to lower valleys by surface flow.

Potential evapotranspiration is in the order of 1500mm per year for much of the region, but lower in the south.

Frosts occur mainly in winter but have been recorded between October and April, as low as -20^0C in the south and -12.5^0C to the north. Frosts are less frequent on the lower plains.

The plains offer some of the most extensive tracts of flat land in Yemen. While this suggests opportunities for crop mechanization, small field size and small holding size place severe constraints. Even within holdings there is little prospect for amalgamating adjacent fields, because all fields are terraced to a greater or lesser extent. Height differences can be up to four meters on mountainsides, but as little as 0.25m on the plains. To indiscriminately amalgamate adjacent fields and re-level would destroy the heritage of near perfectly levelled fields which in times of heavy rain, control both runoff and percolation.

About 6000 hectares of land are irrigated, which represents some 5% of the cultivated area. Irrigation water is principally from surface wells and boreholes, but increasingly the latter. Smaller quantities of water are obtained from perennial or seasonal springs and seasonal wadi flows. Groundwaters generally classify as having low sodium and medium salinity hazards. Groundwater abstraction is probably already exceeding the rate of recharge in many areas and falling water tables are observed. Over the total area a potential for developing possibly another 1000ha exists. There are however large opportunities for more efficient use of water.

Of the dryland area, probably a third to half of the area is out of production due to low yields and labor shortage. More land appears to be out of production in drier regions. Such abandoned arable areas are grazed by sheep and goats.

A livestock economy is tightly integrated with both the irrigated and dryland crop production sectors. Livestock comprise cattle, sheep, goats and poultry together with draft oxen, donkeys and camels. Irrigated vegetable production is expanding and offers one of the highest returns from irrigation water. Because of frosts 'qat', the highest value cash crop of all, is rarely grown on the plains, thus it is virtually excluded from the plains agricultural economy. It is however grown quite widely in warmer valleys and mountainside terraces

which respectively lead from and border the plains. The plains and surrounding area are more or less totally devoid of trees other than for very small-scale plantings of eucalyptus in the south. Tamarix shelterbelts are found close to boreholes and wells.

The extensive grazing offered by surrounding steep mountainsides is utilized by herded sheep and goats. Their feed supply is supplemented seasonally and in drought situations with conserved fodder--principally small grain straws--from the arable plain areas and cultivated mountainside terraces.

Dry land in the southern plains has a high price--in the south 70 YR/m^2 is not uncommon--due to the higher rainfall. Mountainside terraces are also higher priced because they have a good opportunity for water catchment. Irrigated land is also highly priced.

Due to the emigration of labor to Saudi Arabia, manpower for agriculture is scarce, generally highly priced and skilled in only traditional practices. However, due to the remittances of wealth from Saudi, a large modern tractor force has developed in the hands of specialist contractors rather than farmers *per se*. The tractors, using only tillers and ploughs, have replaced a considerable volume of the traditional draft cultivations, but the true potential of these tractors is still grossly underexploited due to the slow speed of operations and lack of more suitable implements and harvesting equipment.

The following is a general summary of agricultural activities in the region but it is emphasized that there are many local variations in practice determined largely by rainfall, incidence of frost, availability of groundwater, and soil depth.

IRRIGATED AGRICULTURE

This is the most rapidly developing sector of the agriculture of the area as it offers secure returns free from the vagaries of rainfall. As such it is the only truly commercial sector of the region's agriculture. The Dhamar governorate extension service reports that 99% of its queries for assistance (except animal health) are received from this sector. Irrigation is usually carried out on deeper soil sites.

The major crops are alfalfa, wheat and barley with small but increasing areas of potatoes, maize and vegetables. Minor crops include lentils, mustard and fenugreek. The principal vegetables are tomatoes, onions, cabbages, leeks, lettuce, radishes, peas and carrots. Most of these have been newly introduced in the last decade and the range of varieties and species grown is expanding to include melons, courgettes, cauliflowers, peppers, etc. A limited amount of fruit is also grown, particularly in milder areas.

Alfalfa has been the traditional high value cash crop of irrigated areas for centuries. Being a perennial crop with noncritical harvest times, it is ideally suited to this role. Additionally, as a high protein fodder it importantly complements the dry sorghum stover, wheat barley and lentil straws which constitute the bulk of the diets for house cows and draft animals. Alfalfa is recognized as a fertility builder and thus is grown in a long rotation with the cereal crops. Wheat and barley are also traditionally irrigated crops; the grain is utilized for subsistence, the straw for animal fodder and until recently quite extensively in building (mortar). Maize is a crop relatively new to the region (perhaps two decades) and on the increase probably at the expense of the barley crop. Sorghum is seldom grown under irrigation. Wheat, barley, sorghum, maize and lentils are all used alone or in combination for breadmaking, bread being the staple diet.

Very recently vegetable production has started to increase as affluence has created interest in a more varied diet. Wholesale and retail vegetable and fruit markets now exist in the main market centers carrying both local and imported produce. Some vegetables, e.g. tomatoes and potatoes, already suffer from occasional seasonal overproduction and low prices. Under irrigation, weed and pest problems are in vegetable production, clearly escalating in contrast to the traditional grain and alfalfa crops where weeds and pests only occasionally reach problem levels.

Fertilizer use and crop protection is increasing rapidly on irrigated crops, as is the adoption of imported varieties of wheat, barley, maize and vegetables. Traditional cultivating and harvesting procedures for grain crops are not improving, nor are water management practices for all crops.

Three relatively large-scale "agro-industry" crop production units have recently been established in the region. Two produce forage for large-scale dairy enterprises, the other seed potatoes.

DRYLAND AGRICULTURE

This sector includes all arable land which is not irrigated. Soil depth is variable, reaching only 30cm on the plains edges. Deeper soils are found on hill and mountainside terraces and in the middle of the larger plains. Water input onto these areas varies with local rainfall and the opportunity for water catchment. The latter is from hill/mountainside runoff, runoff from adjacent abandoned fields or nonterraced gravel, scarp areas, etc. In good water catchment situations the actual water received may be four or five times that from the rainfall but such run off contribution remains unestimated in any situation.

The principal dryland crops are sorghum, barley and lentils. Some wheat, maize, occasionally peas, cowpeas, beans or even potatoes are grown. There is also a large perennial area of alfalfa. The arable

dryland which has been abandoned in recent years has reverted to perennial weed grasses with seasonal flushes of grass and broadleaved weeds. This vegetation is grazed hard by sheep and goats. Because of its extent, this abandoned but grazed arable land is a major contributor to the livestock economy of the area, integrating with mountainside grazing, and stubble grazing on crop-producers' areas. A peculiarity of the grazing of abandoned arable fields is that it is open to any flock owner and cannot be reserved exclusively by the land owner or tenant.

Efficient arable dryland crop production depends on the maintenance of field levels and a large bund around the perimeter of the field to prevent runoff. On the abandoned areas the latter is neglected, consequently with loss of water to the area unless it is captured on a lower field which is in production.

As with the irrigated areas, tractor power has replaced draft animal power. Tillers more or less simulate the action of traditional ploughs. The use of deep digger tractor-drawn mouldboard ploughs is a new concept which is widely used and highly valued. However it is a high cost operation because of low operating speed and small field size. Traditional handseeding methods are being replaced by fitting of simple tube seeders to tiller shares or onto traditional animal-drawn ploughs. Seed in both cases is handmetered into the tubes. Harvesting of dryland crops remains traditional with no attempt at mechanization.

Yields of dryland crops are very low in comparison to irrigated crops yields. They also vary from year to year due to the erratic rainfall. In some poor years, seed input may not be recovered. Whatever standard of crop is produced, the dry stover or straw component is always important. Great care is taken in complete recovery from the fields and careful storage.

Much of the dryland crop production is uneconomical due to high cultivation and labor costs coupled with low yields and the unpredictable level of output. This to some extent accounts for the abandoning of many arable fields. That land is still cropped must be largely due to needs for traditional security, a home-produced food resource, and the considerable social group intercourse involved in the nature of dryland production. Certainly in strict economic terms it would often be cheaper for families to purchase grain and stover from the market.

Apart from the adoption of tractor power, improved technology has not been adopted in the dryland situation. Recently improved varieties of wheat and barley which have proved successful under irrigation have been adopted on a limited scale in good water catchment situations.

CROP ROTATIONS AND SOWING DATES

Crop rotations vary from district to district. In general, successive grain crops revolve in a long rotation around alfalfa in both irrigated and drylandsectors and lentils on dryland only. The same cereal may be cropped in consecutive years or alternated with another. Fallows occur in both irrigated and dryland situations.

Cropping intensity is probably lower than would be possible with modern technology. Intensity might also be higher if there were more financial incentives.

Table 6.1: Average sowing dates.

Crop	Irrigated	Dryland
Wheat/Barley	January, June/July	March/April, July
Maize	March/April (rarely grown)	March/April/May
Sorghum	March/April (rarely grown)	April/May
Lentils	March/April (rarely grown)	March/April, July (limited)
Potatoes	January/February, June/July	(rarely grown)
Alfalfa	January (usually sown to barley or wheat)	April/May (usually sown to sorghum)

ANIMAL PRODUCTION

The major productive enterprises are cattle for calves and milk, and sheep and goats for meat. Minor enterprises include poultry, rabbits, pigeons and honey. Draft animals may be considered as an input into crop production practice, or when hired, as a cash remunerative operation.

Cattle are essentially handfed house animals and are only grazed on relatively limited areas of wet valleys where there is perennial grass. Mature animals are the main consumers of sorghum stover, which is usually fed plaited with fresh alfalfa. Few young stock are kept beyond the veal stage and most replacement stock are imported from lower altitudes to spend their mature life in the highlands. Milk yields are low but the ownership of a cow provides important status. Cattle are quite widely traded; they are of a small Zebu type.

Feed for cattle originates from arable, irrigated or dryland areas. In contrast sheep and goats predominantly graze areas not in arable production. They are seasonally supplemented with crop residue grazing on arable areas and wheat, barley or lentil straw in the dry season or

drought situations. Little grain is fed to any class of stock, but small house flocks of poultry receive household waste and surplus. All stock are housed in the villages at night; sheep and goats have only a short grazing day of about eight hours.

Two types of sheep, bred for larger hair and small fleece, are found in the region. Currently meat prices for these and goats are high and the resulting flock productivity good, providing the real cost of labor in shepherding is excluded. On all areas grazing pressure is heavy. Many class the area as overgrazed, but there is no longterm evidence that this is the true picture and stock numbers may well be in balance with average seasonal productivity.

For neither sheep nor cattle is any effort made at high quality feed supplementation in critical production periods, e.g. pre-calving, pre-mating sheep. Increasing veterinary care is being brought to bear on the livestock population both in terms of endemic disease control and routine treatment of minor ailments. By-product industries, e.g. hides and wool, are minimal and primitive.

Draft oxen and camels are fed in much the same manner as cows plus frequent feeding while working in the field. Donkeys are handfed only to a limited extent.

Modern egg production units are increasing in the region, utilizing imported hybrids and imported compound feedstuffs which may or may not be formulated in Yemen. Such units are quite successful based on the deep litter system.

The two largest modern dairy units in Yemen have been developed based on Friesian cattle; one has 60, the other 240 head of milking stock, both plus followers. There have been no fundamental problems with the cattle but the low fat milk appears to be unsuited to the local market.

Improved methods of honey production have very recently started to be promoted in the region.

NONARABLE LAND GRAZINGS

These areas comprise valley sides, gravel ridges, hillsides, etc., which have not been terraced and which immediately adjoin or intersect the Intermountain Plain areas. They are often referred to as "range," but are not so by comparison to classical ranges of the world. Their productivity is low due to steep slopes combined with shallow stony soils offering little opportunity for infiltration of rain water. Individual village grazing rights are clearly and historically defined. There is virtually no scope for effecting grazing control over large areas due to these rigidly defined and almost inalienable rights.

Such areas are subject to seasonal flushes of vegetation after rains and are principally grazed by the smaller fleece type sheep, while larger breeds tend to graze the abandoned or active arable areas.

With community cooperation, the best scope for improving nonarable grazings may be the planting of deeper soil sites with fodder shrubs.

FORESTRY

The whole area is virtually treeless with only small plantings of eucalyptus to the south, and small tamarisk shelterbelts around irrigated areas. Afforestation interest is primarily limited to amenity plantings while the potential for timber fuel and fodder production remains largely unappreciated. Because of the land tenure structure and uncontrolled grazing rights on uncultivated arable and nonarable land, there is little prospect for large plantations. The number of trees that can be established is also limited by the small number of suitable (rainy) days occurring in any given year.

POTENTIAL FOR DEVELOPMENT OF AGRICULTURE

RESEARCH, DEVELOPMENT, AND EXTENSION

In very recent years a considerable research and development input into the region by British and Dutch aid teams has demonstrated the biological possibilities for improving or changing existing patterns of production. Prior to this the natural resources of the area were documented in detail with British aid.

Clearly, it is biologically possible to raise animal and crop production levels and develop a forestry sector, but the severe limitation to increasing production is the almost total lack of an active and practical field extension corps.

Under the present British aid scheme, improved methods of grain, fodder, and livestock production for dryland and irrigated arable areas are being evaluated, and are yielding promising results. The potential for establishing a forestry sector is being defined for all land types, and a nursery for bulk production of suitable species has been established. The British and Dutch aid schemes include limited extension components. Dutch aid has concentrated its efforts on developing a seed potato industry based in Dhamar governorate. The Dutch are also working on the improvement of nonarable and abandoned arable land productivity using a "range management" approach. F.A.O. has also conducted a limited range of grain variety trials in the

region. To date the efforts in "range management" have perhaps been the least rewarding.

IRRIGATED CROPS

Grains

Imported wheat varieties are now available which will consistently outyield the local type. The local barley Sagla appears very reliable and yield advantages from imported types are not as great as with wheat. Kenyan hybrid maize varieties dramatically and consistently outyield the local variety. Oats and triticale also give high grain yields. Of the small grains, oats offer the highest "total crop" yield potential---an important factor in a region where straw is a basic component of ruminant livestock diets. However, maize probably offers the best potential for grain production in relation to irrigation water use. Local varieties of sorghum and lentils give low yields under irrigation.

Fodders

Small improvements in yield are possible from imported varieties of alfalfa compared with the local type. Oats and hybrid maize give high yields of fodder in a short period. Italian and hybrid ryegrasses appear to be able to outyield alfalfa, and more recently white and red clovers are proving high yielding. As short-term cash crops wheat and barley have potential. Tropical grasses and legumes only have a application in warm valleys because of frost hazards.

Vegetables

Except for potatoes, virtually no research has been conducted on vegetables. The considerable development of the industry in very recent years is due to local farmers' initiative and the distribution of sample seeds by the extension service. A wide range of vegetables can now be considered proven at the farm level. The potato crop for ware and seed has been developed with technical backup. European varieties considerably outyield local varieties and modern production methods are being adopted (ridges, mechanical lifting).

Irrigation and Mechanization

Border strip irrigation can easily be developed where water flows are large enough. A border field layout, in contrast to traditional basins, creates the opportunity for improved cultivation, harvesting and threshing systems. Minimal cultivations and simple mechanized harvesting practices have potential.

Fertilizer Use

Good responses to N and P fertilizers have been obtained.

DRYLAND CROPS

Grains

Imported wheats can give higher yields than local varieties in high rainfall or good water catchment situations but no improved types of sorghum, maize, barley or lentils are yet available.

Fodder Production

No information is available on improved methods of forage production with the important exception of the potential for grazing the local barley variety. In combination with minimal cultivation systems it is a low cost system for bringing abandoned arable areas back into production. It also provides high quality grazing which cannot be communally grazed. Atriplex fodder shrubs also have potential on abandoned arable areas.

Fertilizer use

Small responses to phosphate appear possible.

Mechanization

Minimal cultivation systems are under evaluation and show promise. They are based on the use of chisel plough, chisel plough seeder and harrows. Where perennial grasses are present, ploughing is necessary for their initial control. The systems require wider evaluation under farmers' field conditions.

NONARABLE LAND GRAZINGS

Fodder Shrubs

Atriplex species are initially very promising and merit trial in controlled community grazing situations.

FORESTRY

Timber and Fuel Species

Firm recommendations, particularly with regards to frost tolerance and rainfall requirements, will become available in the next two years based on trials which are being established in the different climatic zones of the area.

Fodder Species

These were noted above under "Dryland Crops" and "Nonarable Land Grazings."

Shelter Species

The use of tamarisk is a well established local practice.

SEED AND SEEDLING SUPPLIES

Seeds of imported wheats, barleys and maize are available from the Dhamar Extension Service and Dhamar Agricultural Improvement Center. Seed potatoes are available through the extension service and Seed Potato Production Project. Tree seedlings of most promising varieties are available in small and large quantities respectively at the Land Resources Improvement division station and Dhamar Agricultural Improvement Center; also at extension service offices and some retailers.

LIVESTOCK

Cattle

Friesian cattle have been introduced in large numbers on two commercial enterprises, and Jersey cattle as a demonstration. Both adapt well to the climate and there are no fundamental management problems. Jerseys appear preferable because of their high fat milk, suitability for crossing onto local cattle, lower feed requirement and possible lower management requirements. A Jersey bull will be available for crossbreeding in the coming year.

Goats

Anglo Nubian goats have recently been introduced as a demonstration. Kids will be available for trial distribution to local farmers in the coming year.

Sheep

The local "Burri" is the only breed to come under close investigation and with good nutrition (quality) appears capable of 100% lambing (from ewe lambs) and high lamb growth rates.

Bees

Modern hives are available from a commercial Y.A.R. company also offering extraction and marketing services.

Poultry

Hybrid layers and broilers have been proven at farm level without previous research and development. Their success is self-evident.

Concentrate Rations (Sheep and Cattle)

It is possible to purchase locally and within Yemen, Yemeni-produced ingredients for cattle and sheep rations--including dried fish--for simple compounding at farm level. Compound feedstuffs for intensive poultry can be purchased in Sana.

Grazing systems

See "Fodder Production" under "Dryland Crops" above.

Cattle and Sheep Accommodation

Simple housing and yard accommodation can be viewed at the Dhamar Agricultural Improvement Center.

PRODUCTION LEVELS

The following tables indicate in very general terms current and possible levels of production attainable from the main sectors of the agricultural industry. "Possible" yield levels are generally from experimental data which is very recent and not long-term in nature.

Table 6.2: Production levels of irrigated grain crops, irrigated fodder crops, and irrigated potatoes and vegetables.

	Current	Possible	Comment
Irrigated Grain Crops (estimated yield t/ha/crop):			
Barley	2	4.0	2 crops per year possible
Wheat	1	4.0- 5.0	2 crops per year possible
Maize	2	10.0	
Oats	Not grown	5.0	2 crops per year possible
Triticale	Not grown	4.5	2 crops per year possible
Irrigated fodder crops (estimated yield t/ha fresh fodder/annum):			
Maize	Not grown for green fodder	100	
Oats	Not grown for green fodder	200	From two crops in one year
Alfalfa	80	110	About 6 - 7 cuts/year
Barley	Not grown for green fodder	30	From two crops in one year
Wheat	Not grown for green fodder	40	From two crops in one year
Italian ryegrass	Not grown	120	About 7 cuts/year
Clovers	Not grown		

Irrigated potatoes and vegetables:

Local potato variety, traditional management	5	Two crops per year possible, but not on same site
Introduced potato varieties, good management	30	
Vegetables	no yield data available	Considerable expansion of the industry in last five years indicates the underlying profitability of this sector

Dryland Cropping

Traditional yields are extremely variable for both grain and fodder; for example:

Sorghum (grain) 0.1 - 1.5 t/ha.
Wheat (grain) 0.1 - 2.5 t/ha.

The main prospects for improving dryland crop production are 1) bringing abandoned arable areas back into production, and 2) reducing cultivation and seeding costs. 50% cost reductions may be possible.

So far, only introduced wheat varieties have shown an advantage over the local varieties of dryland crops. Imported wheats can show a 30% grain yield advantage over local varieties in favorable moisture situations.

Livestock Production

Table 6.3: Cattle milk yields (gals/lactation).

Breed	Current	Possible	Comments
Local cows	125	Not tested	Probably little scope for improvement
Friesian cows	1000-1200	1000-1200	Only achievable in large modern herds
Jersey[1] cows	600[2]	800-900	
Jersey local	-	300-400	Based on evidence from other countries using above average local management
Jersey (as single house cow)	-	500-600	

[1] The Jersey is preferred to Friesian for its high fat milk.
[2] Heifer yields only available to date.

Sheep meat: Experimental evidence is just becoming available that when well-managed the local "Burri" hair type sheep can approach 100% lambing percentage with lamb growth rates to weaning in the order of 110g/day. This compares with about a 50% lambing percentage in local flocks and growth rates of 20 - 30g/day.

Goats: Local goats are utilized for milk and meat. Recently Anglo Nubians have been imported to the Dhamar Agricultural Improvement Center and comparative productivity data will become available in the next two years.

Honey production: Very recent introduction of modern hives show a potential for 5kg honey/hive/year compared with 1kg from traditional hives.

Table 6.4: Livestock numbers (approximate), quoted to indicate the size of the industries.

Cows	24,000
Sheep	400,000
Goats	26,000
Donkeys	35,000
Camels	5,500
Oxen	8,500

These numbers emphasize the importance of the livestock sector and how any agricultural development effort must be an integrated approach to the crop and livestock sectors.

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Chapter 7

CRITERIA FOR INTERPRETATIONS AND GENERAL MANAGEMENT CONSIDERATIONS

SOIL LIMITATIONS AND CROP SUITABILITY

The names of the map units in the soil map legend (Chapter 5) are given according to their classification for Soil Taxonomy (USDA-SCS, 1975). This system is quite accurate and highly technical. For planning purposes and for making useful interpretations one needs to list the kinds of limiting factors which these highly technical names imply. This section will take the names of the soils at the soil family and subgroup level and list the limiting factors implied by each name. Finally, some interpretations on the suitability of each soil for selected crops will be given.

LIMITING SOIL PROPERTIES IN YEMEN

In order to make accurate interpretations for specific, proposed agricultural land uses, consideration of possible limiting soil properties must be taken. As a first approximation, a listing is made of all the potentially limiting soil properties as observed in Yemen and as implied by the soil name according to Soil Taxonomy. These limiting soil properties are listed as follows (not necessarily in order of importance):

1. Soil moisture regime limitations:
   - aridic or torric-- irrigation always needed
   - ustic-- supplemental irrigation occasionally needed
   - udic-- irrigation not needed, no limitation

2. Micronutrient deficiencies (mainly concerning availability of Fe, Zn, Mn, Cu and Co) as related mainly to the calcareousness of the soil under consideration:
   - highly calcareous-- need to apply micronutrients
   - calcareous-- potential micronutrient deficiencies
   - slightly to noncalcareous-- probably no problem

3. Water-retention capacity as estimated by the family textural classes:
   - coarse loamy, sandy skeletal, stony, bouldery-- low capacity
   - finer loamy and finer (except clayey)-- probably adequate capacity

4. High gypsum content:
   - possible subsidence from irrigation

5. Shallow to bedrock (lithic):
   low water-holding capacity and shallow rooting depth

6. Topographic limitations as related to erosion hazard or mechanization problems:
   mountainous, steep-- severe problem
   undulating-- moderate problem
   flat-- no problem

7. Flooding hazard:
   soils found on active wadis or floodplains

8. Sodic features:
   high Na content imposes limitations for irrigation use

9. Terraced, mountain soils:
   mountain terraces may restrict many conventional mechanical tillage operations; also rock-walled terraces are more susceptible to erosion and collapse

10. Soil temperature regime limitations:
    isomesic-- periods of frost are restrictive
    isothermic-- some cool temperature restrictions
    hyperthermic-- some seasonal or diurnal cool temperature restrictions; may also be too hot for some crops
    isohyperthermic-- some crop restrictions due to prolonged high temperatures

11. Wind erosion hazard:
    blowing and drifting, resulting in the formation of dunes and hummocks

12. Vertic properties:
    formation of cracks; shrinking and swelling

THE PRODUCTION OF SELECTED CROPS AND SOME IMPORTANT RELATED SOIL LIMITING FACTORS

Twelve crops presently or potentially important to Yemeni agriculture were studied. These crops are maize, sorghum, cotton, millet, citrus, date palms, bananas, wheat, chick peas, potatoes, coffee, and alfalfa. Crop soil requirements and soil limiting properties are given for each crop (ILACO B. V., 1981).

1. Maize (*Zea mays*)

moisture	--600 to 900mm rain, well distributed; at least ustic soil moisture regime
temperature	--if isohyperthermic, grown only in winter
	--if isomesic or isothermic, grown in summer
soil properties	--ECe* not > 5 mmhos/cm

2. Sorghum (*Sorghum vulgare*)

moisture	--at least 250mm rainfall; possible in aridic soil moisture regime but better in ustic
temperature	--isohyperthermic optimum --isothermic possible in summer
soil properties	--fairly resistant to ECe up to 6 mmhos/cm

3. Cotton (*Gossypium* spp.)

moisture	--best grown in an aridic moisture regime with irrigation; if rainfed need at least 450mm or an ustic regime without irrigation
temperature	--isohyperthermic optimum --not possible in isomesic
soil properties	--needs good drainage, no aquic regimes; salt-tolerant, ECe up to 10 mmhos/cm

4. Bulrush Millet (*Pennisetum typhoides*)

moisture	--needs 200 to 300mm; can be grown in an aridic regime
temperature	--isohyperthermic regime optimum; possible for summer in isothermic regime
soil properties	--tolerates poor soils but must be well drained, no aquic moisture regimes; fairly salt tolerant

5. Citrus (*Citrus* spp.)

moisture	--minimum rainfall of 1,100mm preferably supplemented to an optimum of 1,800 to 2,000mm; udic regime optimum but possibly ustic or aridic with irrigation
temperature	--not suitable for isomesic or isohyperthermic regimes
soil properties	--needs deep, well drained soils, not suitable in aquic regimes; sensitive to ECe > 2.5 mmhos/cm

6. Date Palms (*Phoenix dactylifera*)

moisture	--aridic suitable with no rainfall from flowering to ripening but 2,000mm of moisture is needed from groundwater and/or irrigation
temperature	--isohyperthermic regime is optimum, hyperthermic is possible
soil properties	--prefers sandy soils with groundwater < 3m depth, aquic regime preferable; fairly salt tolerant with ECe < 8 mmhos/cm

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*Electrical conductivity of the saturation extract.

7. Banana (*Musa* spp.)

moisture	--udic regime required for 1,500 to 2,000mm water or intense irrigation
temperature	--isohyperthermic regime is optimum; marginal in isothermic; not suitable for isomesic or hyperthermic regimes
soil properties	--light, fertile soils with high organic matter and good internal drainage are optimum, not adequate for aquic regimes

8. Wheat (*Triticum aestivum*)

moisture	--a minimum of 250mm is needed; optimum for the wetter end of the aridic and the drier end of ustic
temperature	--not suitable for isohyperthermic
soil properties	--best suited to medium to relatively heavy soils, not suited for coarse loamy families; not suited to aquic regimes; relatively resistant to salinites < 7 mmhos/cm

9. Chick Peas (*Cicer arietinum*)

moisture	--suitable for aridic and ustic regimes, not suited for udic regime
temperature	--not suitable for isohyperthermic or hyperthermic, suited to summers in isomesic or isothermic regimes
soil properties	--needs well drained soils, no aquic regimes; prefers heavy soils, not suited to coarse loamy families; very tolerant to salinity (no ECe limit given)

10. Potatoes (*Solanum tuberosum*)

moisture	--100 mm/month needed; no short periods of drought tolerated, udic regime is optimum
temperature	--not suited to isohyperthermic or hyperthermic regimes, better suited to isomesic or isothermic (borderline) in the summer
soil properties	--not suited to heavy soils or aquic regimes; susceptible to high salinity (no ECe limit given)

11. Coffee (*Coffea arabica*)

moisture	--best suited to dry end of udic regime (udic with short dry seasons)
temperature	--not suited to isohyperthermic, hyperthermic, or isomesic regimes, best in isothermic regime
soil properties	--needs good drainage and high organic matter (especially suited to Mollisols); aquic regime not tolerated

12. Alfalfa (Medicago sativa)

moisture	--best suited to udic but will tolerate others with irrigation
temperature	--not suited to isomesic, isohyperthermic, or hyperthermic (perhaps borderline) regimes, well suited to isothermic
soil properties	--suited to well drained soils, no aquic regimes; not suited to heavy soils, clayey families; not tolerant to ECe > 3 mmhos/cm; moderately tolerant to pH's > 6.5

SPECIFIC SOIL LIMITATIONS OF SOIL SUBGROUPS INCLUDED IN THE SOIL MAP LEGEND AND SOIL FAMILIES FROM APPENDIX I.

As an aid to making useful agricultural interpretations, the limiting soil properties for each soil family listed on the soil map legend (Table 5.1, Chapter 5) is given. These limiting soil properties form the basis for interpreting the suitability of the twelve crops (given above) for the different soil subgroups and families (Table 7.1). This list of limiting soil properties can also form the basis for future interpretations for other crops not cited in this report.

1. Typic Calciorthid, Coarse Loamy, Mixed, Isohyperthermic; Typic Calciorthid, Loamy Skeletal, Mixed, Isohyperthermic; Typic Calciorthid, Coarse Loamy, Mixed, Calcareous, Hyperthermic; Typic Calciorthid, Fine Loamy, Mixed, Isothermic; and Typic Calciorthid, Coarse Loamy, Mixed, Isothermic Families

   --Aridic soil moisture regime; needs irrigation
   --Isohyperthermic temperature regime; may be too hot for some crops
   --Highly calcareous; implying a high potential for micronutrient deficiencies and possible low availabe P
   --Coarse loamy textural class; low water-holding capacity and some possible impediments to mechanical cultivation

2. Typic Torrifluvent, Coarse Loamy, Mixed, Calcareous, Hyperthermic; Typic Torrifluvent, Coarse Loamy, Mixed, Isomegathermic; Typic Torrifluvent, Sandy, Mixed, Calcareous, Isomegathermic; Typic Torrifluvent, Coarse Loamy, Mixed, Calcareous, Isohyperthermic; and Typic Torrifluvent, Coarse Loamy, Mixed Hyperthermic Families

   --Aridic soil moisture regime; needs irrigation
   --Isomegathermic, isohyperthermic and hyperthermic temperature regimes may be too hot for some crops
   --Calcareous; may have some micronutrient deficiencies
   --Low organic matter content
   --Coarse loamy and sandy textural classes; low waterholding capacity and some possible impediments to mechanical cultivation

3. Typic Torriorthent, Sandy Skeletal, Mixed, Isohyperthermic; Typic Torriorthent, Coarse Loamy, Mixed, Calcareous, Isohyperthermic; Typic Torriorthent, Coarse Loamy, Mixed, Isothermic; Typic Torriorthent, Loamy Skeletal, Mixed, Calcareous, Hyperthermic; Typic Torriorthent, Coarse Loamy, Mixed, Hyperthermic; Typic Torriorthent, Coarse Loamy, Mixed, Isohyperthermic; Typic Torriorthent, Fine Loamy, Mixed, Isohyperthermic; Typic Torriorthent, Coarse Loamy, Mixed, Calcareous, Hyperthermic Families

   --Aridic soil moisture regime; needs irrigation
   --Isohyperthermic and hyperthermic temperature regimes may be too hot for some crops
   --Calcareous; may have some micronutrient deficiencies
   --Low organic matter content
   --Sandy skeletal and coarse loamy textural classes; very low water-holding capacity and some possible impediments to mechanical cultivation

4. Typic Gypsiorthid, Coarse Loamy, Mixed, Isohyperthermic Family

   --Aridic moisture regime -needs irrigation <u>but</u> soil will subside with irrigation
   --Isohyperthermic temperature regime is too hot for some crops
   --Highly gypsiferous; subsidence with irrigation
   --Low organic matter content
   --Coarse loamy textural class; low water-holding capacity and some possible impediments to mechanical cultivation
   --Mountainous; highly erodable and not easily cultivated mechanically

5. Lithic Torriorthents, Coarse Loamy, Mixed, Calcareous, Hyperthermic Family

   --Aridic soil moisture regime; needs irrigation
   --Isohyperthermic temperature regime is too hot for some crops; isomesic is too cold for others
   --Calcareous; may have some micronutrient deficiencies
   --Low organic matter content
   --Coarse loamy textural class; low water-holding capacity and some possible impediments to mechanical cultivation
   --Shallow to bedrock (lithic contact < 50cm); highly erodable and major impediments to mechanical cultivation

6. Typic Salorthid, Sandy, Mixed, Isohyperthermic; Typic Salorthid, Coarse Loamy, Mixed, Isonyperthermic; and Typic Salorthid, Coarse Loamy, Mixed, Hyperthermic Families

--Aquic moisture regime; very wet, needs drainage
--Isohyperthermic and hyperthermic temperature regimes may be too hot for some crops
--Very salty; high ECe
--Generally not suitable for any uses presently envisaged, except perhaps extensive grazing

7. Tropic Fluvaquent, Coarse Loamy, Calcareous, Mixed Isomegathermic Family

--Aquic or peraquic soil moisture regime; very wet needs drainage
--Isomegathermic (presently included in isohyperthermic) regime is too hot for some crops
--Some risk of flooding during rainy seasons

8. Tropaquent, Coarse Loamy, Mixed, Isomegathermic Family

--Aquic or peraquic soil moisture regime; very wet needs drainage
--Isomegathermic (presently included in isohyperthermic) regime is too hot for some crops
--Some risk of flooding during rainy seasons

9. Typic Udifluvent, Coarse Loamy, Calcareous, Mixed, Hyperthermic Family

--Hyperthermic temperature regime is too hot for some crops
--Calcareous; may have some micronutrient deficiencies
--Coarse loamy textural class; low water-holding capacity and some possible impediments to mechanical cultivation
--Some risk of flooding during rainy seasons

10. Typic Torripsamment, Mixed, Calcareous, Isomegathermic; and Typic Torripsamment, Mixed, Hyperthermic Families

--Aridic moisture-regime; needs some irrigation
--Isomegathermic and hyperthermic temperature regimes may be too hot for many crops
--Calcareous; may have some micronutrient deficiencies
--Texture implies low water-holding capacity
--Subject to blowing and drifting, formation of shifting dunes

11. Typic Ustifluvent, Coarse Loamy, Mixed, Isothermic; Typic Ustifluvent, Fine Loamy, Mixed, Isothermic; Typic Ustifluvent, Coarse Loamy, Mixed, Isohyperthermic; Typic Ustifluvent, Fine Loamy, Mixed, Isohyperthermic; and Typic Ustifluvent, Coarse Loamy, Mixed, Calcareous, Hyperthermic Families

--Ustic moisture regime; may need supplemental irrigation
--Calcareous; may have some micronutrient deficiencies
--Coarse loamy textural class; low water-holding capacity and some possible impediments to mechanical cultivation
--Terraced areas also impose some restrictions on certain types of mechanical cultivation
--Slight flooding hazard during rainy seasons
--Isohyperthermic and hyperthermic temperature regimes may be too hot for some crops

12. Typic Haplargid, Fine Loamy, Mixed, Hyperthermic Family

--Aridic moisture regime; needs irrigation
--Hyperthermic temperature regime may be too hot for some crops
--Calcareous; may have some micronutrient deficiencies

13. Typic Ustorthent, Sandy Skeletal, Mixed, Isothermic; Typic Ustorthent, Coarse Loamy, Mixed, Isothermic; Typic Ustorthent, Fine Silty, Mixed, Isothermic; Typic Ustorthent, Coarse Loamy, Calcareous, Mixed, Isomesic; and Typic Ustorthent, Fine Loamy, Mixed, Isothermic Families

--Ustic moisture regime; may need supplemental irrigation
--Calcareous; may have some micronutrient deficiences
--Sandy skeletal and coarse loamy textural classes; low water-holding capacity and some possible impediments to mechanical cultivation
--Isomesic temperature regime may have frosts in winter

14. Typic Camborthid, Loamy Skeletal, Mixed, Isothermic Family

--Aridic moisture regime; needs irrigation
--Calcareous; may have some micronutrient deficiencies
--Loamy skeletal textural class; low water-holding capacity and some possible impediments to mechanical cultivation
--Mountainous; highly erodable and not easily cultivated mechanically

15. Aquollic Salorthid, Fine Clayey, Mixed, Isothermic Family

--Aquic moisture regime; very wet, needs drainage
--Very salty; high ECe
--Generally not suitable for any uses envisaged, except perhaps extensive grazing

16. Typic Fluvaquent, Fine Clayey, Mixed, Isohyperthermic Family

--Aquic moisture regime; very wet, needs drainage
--Isohyperthermic temperature regime; may be too hot for some crops
--Calcareous; may have some micronutrient deficiencies
--Some risk of flooding during rainy seasons

17. Typic Ustipsamments, Mixed, Isohyperthermic Family

--Ustic moisture regime; may need supplemental irrigation
--Hyperthermic and isohyperthermic temperature regimes are too hot for many crops
--Calcareous; may have some micronutrient deficiencies
--Texture implies low water-holding capacity
--Subject to blowing and drifting, formation of sand dunes

18. Tropofluvents (Isohyperthermic)

--Somewhat calcareous; may have potential micronutrient deficiencies
--Isohyperthermic temperature regime may be too hot for some crops; isomesic regime may have frosts in winter
--Some risk of flooding during rainy seasons

19. Typic Natrustalf, Fine Clayey, Mixed, Isothermic Family

--Ustic moisture regime; may need supplemental irrigation
--Somewhat calcareous; may have potential micronutrient deficiencies
--Natric horizon; clay may deflocculate with the application of irrigation water

20. Entic Haplustoll, Coarse Loamy, Mixed, Isomesic Family

--Ustic moisture regime; may need supplemental irrigation
--Calcareous; may have some micronutrient deficiencies
--Isomesic temperature regime may have frosts in winter
--Mountainous; highly erodable and not easily cultivated mechanically

21. Typic Argiudoll, Sandy Skeletal, Mixed, Isomesic Family

--Somewhat calcareous; may have potential micronutrient deficiencies
--Isomesic temperature regime may have frosts in winter
--Mountainous; highly erodable and not easily cultivated mechanically
--Sandy skeletal textural class; low water-holding capacity and some possible impediments to mechanical cultivation

22. Lithic Ustorthent, Sandy Skeletal, Mixed, Isomesic Family

--Ustic moisture regime; may need supplemental irrigation
--Somewhat calcareous; may have potential micronutrient deficiencies
--Isomesic temperature regime may have frosts in winter
--Sandy skeletal textural class; low water-holding capacity and some possible impediments to mechanical cultivation
--Shallow to bedrock (lithic contact < 50cm); highly erodable and major impediments to mechanical cultivation

23. Ustic Torriorthent, Fine Loamy, Mixed, Isothermic Family

--Aridic bordering on ustic moisture regime; will need some supplemental irrigation
--Calcareous; may have some micronutrient deficiencies
--Rolling topography; moderate to high erosion potential

24. Udic Haplustoll, Loamy Skeletal, Mixed, Isothermic; and Udic Haplustoll, Fine Silty, Mixed, Isothermic Families

--Ustic bordering on udic moisture regime; may need some supplemental irrigation
--Calcareous; may have some micronutrient deficiencies
--Mountainous; highly erodable and not easily cultivated mechanically
--Loamy skeletal textural class; low water-holding capacity and possible impediments to mechanical cultivation
--Terraced areas also impose some restrictions on certain types of mechanical cultivation
--Isomesic temperature regime may have frosts in winter

25. Entic Ustropepts (Isomesic)

--Ustic moisture regime; may need supplemental irrigation
--Calcareous; may have some micronutrient deficiencies
--Isomesic temperature regime may have frosts in winter
--Mountainous; highly erodable and not easily cultivated mechanically

26. Petrocalcic Calciustoll, Fine Loamy, Mixed, Isothermic Family

--Ustic moisture regime; may need supplemental irrigation
--Calcareous; may have some micronutrient deficiencies
--Low water-holding capacity due to petrocalcic horizon
--Lithic property; shallow to petrocalcic horizon
--Mountainous; highly erodable and not easily cultivated mechanically

27. Typic Calciustoll, Fine Silty, Mixed, Isothermic; and Typic Calciustoll, Coarse Loamy, Mixed, Isothermic Families

--Ustic moisture regime; may need supplemental irrigation
--Calcareous; may have some micronutrient deficiencies

28. Typic Ustropept, Fine Silty, Mixed, Isothermic; and Typic Ustropept, Fine Loamy, Mixed, Isothermic Families

--Ustic moisture regime; may need supplemenal irrigation
--Calcareous; may have some micronutrient deficiencies
--Mountainous; highly erodable and not easily cultivated mechanically
--Terraced areas also impose some restrictions on certain types of mechanical cultivation

29. Ustollic Calciorthid, Fine Loamy, Mixed, Isothermic Family

--Aridic bordering on ustic soil moisture regime; will need supplemental irrigation
--Calcareous; may have some micronutrient deficiencies

30. Vertic Haplustoll, Fine Loamy, Mixed, Isothermic; Vertic Haplustoll, Coarse Silty, Mixed, Isothermic; and Vertic Haplustoll, Fine Loamy, Mixed, Isomesic Families

--Ustic moisture regime; may need supplemental irrigation
--Calcareous; may have some micronutrient deficiencies
--Vertic properties; cracking may make it difficult to apply irrigation water evenly
--Isomesic temperature regime may have frosts in winter

31. Udic Pellustert, Fine Clayey, Montmorillonitic, Isothermic Family

--Ustic moisture regime; may need supplemental irrigation
--Calcareous; may have some micronutrient deficiencies
--Fine clayey textural class; restricted water-holding capacity
--Vertic properties; cracking may make it difficult to apply irrigation water evenly

32. Typic Torrert, Fine Clayey, Montmorillonitic, Isothermic Family

--Aridic moisture regime; needs irrigation
--Calcareous; may have some micronutrient deficiencies
--Fine clayey textural class; restricted water-holding capacity
--Vertic properties; cracking may make it difficult to apply irrigation water evenly

33. Ustollic Camborthid, Coarse Loamy, Mixed, Isothermic Family

--Aridic bordering on ustic moisture regime; needs some irrigation
--Very calcareous; may have some micronutrient deficiencies

34. Ustic Torripsamment, Coarse Loamy, Mixed, Isothermic Family

--Aridic bordering on ustic soil moisture regime; needs supplemental irrigation
--Coarse loamy textural class; low water-holding capacity and possible impediments to mechanical cultivation
--Subject to blowing and drifting, formation of sand dunes
--Calcareous; may have some micronutrient deficiencies

35. Typic Haplustoll, Coarse Loamy, Mixed, Isothermic Family

--Ustic soil moisture regime; some supplemental irrigation may be needed
--Calcareous; may have some micronutrient deficiencies

36. Typic Hapludoll, Coarse Loamy, Mixed, Isothermic Family

--Calcareous; may have some micronutrient deficiencies
--Mountainous; highly erodable and not easily cultivated mechanically
--Coarse loamy textural class; low water-holding capacity and possible impediments to mechanical cultivation

37. Entic Hapludoll, Coarse Loamy, Mixed, Isothermic Family

--Calcareous; may have some micronutrient deficiencies
--Mountainous; highly erodable and not easily cultivated mechanically
--Coarse loamy textural class; low water-holding capacity and possible impediments to mechanical cultivation

38. Aridic Haplustolls (Isothermic)

--Ustic bordering on aridic soil moisture regime; will need supplemental irrigation
--Calcareous; may have some micronutrient deficiencies

39. Lithic Calciorthids (Isohyperthermic, Isothermic)

--Aridic soil moisture regime; needs irrigation
--Highly calcareous; may have some micronutrient deficiencies
--Isohyperthermic temperature regime may be too hot for some crops
--Lithic character and stoniness; low water-holding capacity and possible impediments to mechanical cultivation
--Mountainous; highly erodable and not easily cultivated mechanically

40. Rock outcrops or Basalt Flows

--These areas are usually unsuitable for any agriculture except perhaps for very extensive grazing.

THE SUITABILITY OF MAJOR SOIL FAMILIES IN YEMEN FOR TWELVE IMPORTANT CROPS

The ranges of climatic and soil properties optimum for twelve crops have been listed above. Limiting soil properties have also been listed for each soil subgroup and family described in the legend and soil profile descriptions, respectively. Each soil family, and hence subgroup, can now be rated as to its suitability for the cultivation of each of these twelve crops. (A moderate level of inputs--fertilizers, irrigation, pest control, etc.--and management is assumed.) There are three ratings possible. That is, a particular soil (as conceived by the soil family) is either 1) suitable, 2) moderately unsuitable, or 3) unsuitable for a particular crop.

Table 7.1 Suitability Ratings of Major Soil Families in the Yemen Arab Republic for Selected Crops

Key

1: suitable
2: moderately unsuitable
3: unsuitable

	Soil Family Name	Maize	Sorgum	Cotton	Bulrush Millet	Citrus	Date Palms	Banana	Wheat	Chick Peas	Potatoes	Coffee	Alfalfa
		Crops and Ratings											
1.	Typic Calciorthid, Coarse Loamy, Mixed, Isohyperthermic	2	1	1	1	3	1	2	3	3	3	3	3
2.	Typic Calciorthid, Loamy Skeletal, Mixed, Isohyperthermic	3	1	2	1	3	2	3	3	3	3	3	3
3.	Typic Calciorthid, Coarse Loamy, Mixed, Calcareous, Hyperthermic	2	1	1	1	2	2	3	3	3	3	3	2
4.	Typic Calciorthid, Fine Loamy, Mixed, Isothermic	2	2	2	2	2	2	2	1	1	2	2	2
5.	Typic Calciorthid, Coarse Loamy, Mixed, Isothermic	2	2	2	2	2	2	2	3	3	2	2	1
6.	Typic Torrifluvent, Coarse Loamy, Mixed, Calcareous, Hyperthermic	2	1	1	1	2	2	3	3	3	3	3	2
7.	Typic Torrifluvent, Coarse Loamy, Mixed, Isomegathermic	2	1	1	1	3	1	2	3	3	3	3	3
8.	Typic Torrifluvent, Sandy, Mixed, Calcareous, Isomegathermic	2	1	1	1	3	1	2	3	3	3	3	3
9.	Typic Torrifluvent, Coarse Loamy, Mixed, Calcareous, Isohyperthermic	2	1	1	1	3	1	2	3	3	3	3	3
10.	Typic Torrifluvent, Coarse Loamy, Mixed, Hyperthermic	2	1	1	1	2	2	3	3	3	3	3	2
11.	Typic Torriorthent, Sandy Skeletal, Mixed, Isohyperthermic	3	2	2	2	3	2	3	3	3	3	3	3
12.	Typic Torriorthent, Coarse Loamy, Mixed, Calcareous, Isohyperthermic	2	1	1	1	3	1	2	3	3	3	3	3
13.	Typic Torriorthent, Coarse Loamy, Mixed, Isothermic	2	2	2	2	2	2	2	3	3	2	2	1
14.	Typic Torriorthent, Loamy Skeletal, Mixed, Calcareous, Hyperthermic	3	2	2	2	3	2	3	3	3	3	3	3

15. Typic Torriorthent, Coarse Loamy, Mixed, Hyperthermic	2	1	1	1	3	1	2	3	3	3	3	3
16. Typic Torriorthent, Coarse Loamy, Mixed, Isohyperthermic	2	1	1	1	3	1	2	3	3	3	3	3
17. Typic Torriorthent, Fine Loamy, Mixed, Isohyperthermic	2	1	1	1	3	1	1	3	3	3	3	3
18. Typic Torriorthent, Coarse Loamy, Mixed, Calcareous, Hyperthermic	2	1	1	1	3	1	2	3	3	3	3	3
19. Typic Gypsiorthid, Coarse Loamy, Mixed, Isohyperthermic	3	2	3	2	3	3	3	3	3	3	3	3
20. Lithic Torriorthent, Coarse Loamy, Mixed, Calcareous, Hyperthermic	3	2	3	2	3	3	3	3	3	3	3	3
21. Typic Salorthid, Sandy, Mixed, Isohyperthermic	3	3	3	3	3	1	3	3	3	3	3	3
22. Typic Salorthid, Coarse Loamy, Mixed, Isohyperthermic	3	3	3	3	3	1	3	3	3	3	3	3
23. Typic Salorthid, Coarse Loamy, Mixed, Hyperthermic	3	3	3	3	3	1	3	3	3	3	3	3
24. Tropic Fluvaquent, Coarse Loamy, Calcareous, Mixed, Isomegathermic	2	2	3	3	3	1	3	3	3	3	3	3
25. Tropaquent, Coarse Loamy, Mixed, Isomegathermic	2	2	3	3	3	1	3	3	3	3	3	3
26. Typic Udifluvent, Coarse Loamy, Calcareous, Mixed, Hyperthermic	1	1	1	1	2	1	3	2	3	3	3	2
27. Typic Torripsamment, Mixed, Calcareous, Isomegathermic	3	2	2	1	3	2	3	3	3	3	3	3
28. Typic Torripsamment, Mixed, Hyperthermic	3	2	2	1	3	2	3	3	3	3	3	3
29. Typic Ustifluvent, Coarse Loamy, Mixed, Isothermic	1	2	2	2	1	3	2	2	2	1	1	1
30. Typic Ustifluvent, Fine Loamy, Mixed, Isothermic	1	2	2	2	1	3	2	1	1	1	1	1
31. Typic Ustifluvent, Coarse Loamy, Mixed, Isohyperthermic	2	1	1	1	3	1	1	3	3	3	3	3
32. Typic Ustifluvent, Fine Loamy, Mixed, Isohyperthermic	2	1	1	1	3	1	1	3	3	3	3	3

33. Typic Ustifluvent, Coarse Loamy, Mixed, Hyperthermic	2	1	1	1	2	2	2	3	3	3	3	3
34. Typic Haplargid, Fine Loamy, Mixed, Hyperthermic	2	1	1	1	2	3	3	2	3	3	3	3
35. Typic Ustorthent, Sandy Skeletal, Mixed, Isothermic	2	1	2	1	1	3	3	3	3	1	2	1
36. Typic Ustorthent, Coarse Loamy, Mixed, Isothermic	2	1	2	1	1	3	3	3	3	1	1	1
37. Typic Ustorthent, Fine Silty, Mixed, Isothermic	1	1	2	1	1	3	2	1	1	2	1	2
38. Typic Ustorthent, Coarse Loamy, Calcareous, Mixed, Isomesic	1	3	3	3	3	3	3	2	2	1	3	3
39. Typic Ustorthent, Fine Loamy, Mixed, Isothermic	1	1	2	1	1	3	2	1	1	2	1	2
40. Typic Camborthid, Loamy Skeletal, Mixed, Isothermic	3	2	2	2	2	3	3	3	3	3	2	2
41. Aquollic Salorthid, Fine Clayey, Mixed, Isothermic	3	3	3	3	3	3	3	3	3	3	3	3
42. Typic Fluvaquent, Fine Clayey, Mixed, Isohyperthermic	3	2	3	3	3	1	3	3	3	3	3	3
43. Typic Ustipsamments, Mixed, Isohyperthermic	2	1	1	1	3	1	1	3	3	3	3	3
44. Tropofluvents (Isohyperthermic)	2	1	1	1	3	1	1	3	3	3	3	3
45. Typic Natrustalf, Fine Clayey, Mixed, Isothermic	2	2	2	2	3	3	2	1	1	2	1	2
46. Entic Haplustoll, Coarse Loamy, Mixed, Isomesic	2	2	3	3	3	3	3	3	3	1	3	3
47. Typic Argiudoll, Sandy Skeletal, Mixed, Isomesic	2	3	3	3	3	3	3	3	3	2	3	3
48. Lithic Ustorthent, Sandy Skeletal, Mixed, Isomesic	3	3	3	3	3	3	3	3	3	3	3	3
49. Ustic Torriorthent, Fine Loamy, Mixed, Isothermic	1	2	2	2	1	3	2	1	1	2	1	1
50. Udic Haplustoll, Loamy Skeletal, Mixed, Isothermic	1	2	2	2	1	3	2	3	3	2	1	1

51. Udic Haplustoll, Fine Silty, Mixed, Isothermic	1	2	2	2	1	3	2	1	1	2	1	1
52. Entic Ustropepts (Isomesic)	2	3	3	3	3	3	3	2	2	2	3	3
53. Petrocalcic Calciustoll, Fine Loamy, Mixed, Isothermic	2	2	3	2	3	3	3	2	2	3	1	2
54. Typic Calciustoll, Fine Silty, Mixed, Isothermic	1	2	2	2	2	3	2	1	1	2	1	1
55. Typic Calciustoll, Coarse Loamy, Mixed, Isothermic	1	2	2	2	2	3	3	3	3	2	1	1
56. Typic Ustropept, Fine Silty, Mixed, Isothermic	1	2	2	2	1	3	2	1	1	2	1	1
57. Typic Ustropept, Fine Loamy, Mixed, Isothermic	1	2	2	2	1	3	2	1	1	2	1	1
58. Ustollic Calciorthid, Fine Loamy, Mixed, Isothermic	2	2	2	2	1	3	2	1	1	2	2	2
59. Vertic Haplustoll, Fine Loamy, Mixed, Isothermic	1	2	2	2	1	3	3	1	1	2	1	1
60. Vertic Haplustoll, Coarse Silty, Mixed, Isothermic	1	2	2	2	1	3	3	2	2	2	1	1
61. Vertic Haplustoll, Fine Loamy, Mixed, Isomesic	1	3	3	3	3	3	3	1	1	1	3	3
62. Udic Pellustert, Fine Clayey, Montmorillonitic, Isothermic	1	2	2	2	2	3	3	1	1	3	2	3
63. Typic Torrert, Fine Clayey, Montmorillonitic, Isothermic	1	2	2	2	3	3	3	1	1	3	3	3
64. Ustollic Camborthid, Coarse Loamy, Mixed, Isothermic	2	2	2	2	3	3	3	3	3	3	3	3
65. Ustic Torripsamment, Coarse Loamy, Mixed, Isothermic	2	2	2	2	3	3	3	3	3	3	3	3
66. Typic Haplustoll, Coarse Loamy, Mixed, Isothermic	1	2	2	2	1	3	2	3	3	2	1	1
67. Typic Hapludoll, Coarse Loamy, Mixed, Isothermic	1	2	2	2	1	3	1	3	3	2	1	1
68. Entic Hapludoll, Coarse Loamy, Mixed, Isothermic	1	2	2	2	1	3	1	3	3	2	1	1

69. Aridic Haplustalls (Isothermic)	1	2	2	2	1	3	2	2	2	2	1	1
70. Lithic Calciorthids (Isohyperthermic)	3	2	3	2	3	3	3	3	3	3	3	3
71. Lithic Calciorthids (Isothermic)	3	2	3	2	3	3	3	2	3	3	3	3
72. Rock Outcrops and Basalt Flows	3	3	3	3	3	3	3	3	3	3	3	3

MANAGING THE SOILS OF NORTH YEMEN

SOIL AND WATER CONSERVATION

The need for highly developed soil and water conservation practices in Yemen is based on two pervasive factors in Yemeni agriculture. Moisture is most often the limiting factor in crop production and farming is usually practical where there is at least a noticeable gradient and often where slopes are extreme.

Given these conditions there are three soil and moisture conservation methods which Yemeni farmers have practiced for centuries and which have resulted in the presence of deep, well drained, loamy soils in every region of the country. These methods are spate irrigation, water harvesting, and terracing.

In practice these three methods are often used in numerous modifications and combinations, but the net effect is the same. Water runoff is conserved and collected, and with it comes transported soil material, primarily fine sand, silt, and clay. This phenomenon is of great importance in spate irrigation. It is also present in water harvesting and to a lesser extent in terraced agriculture.

Spate Irrigation

Spate irrigation is a system which exploits the seasonally abundant but erratic water resources of the wadis. Because of the gradient which is characteristic of the mountain wadis and the Tihama Piedmont it is possible by means of simple earthen diversion structures and ancillary canals to divert streams--especially at fullflow or "spate" stage--to fields by using gravity. Typically a canal will conduct silty water from the stream to a series of fields surrounded by bunds. The water is impounded in the Piedmont Tihama, where extensive tracts of land are topographically suited for cultivation and access. Irrigation water is transported several kilometers from the stream by this method. In the mountain wadis the bunds are often only about 50cm high. On the Tihama, where often there is little rainfall to

supplement the water obtained by spate irrigation, bunds are sometimes two or more meters high. These soils are deep and have an excellent capacity for moisture storage. A thorough inundation saturates the profile and provides moisture for a crop over a sustained period of time.

Water Harvesting

Throughout North Yemen runoff is collected from bare rocky areas and directed by means of low dikes to cultivated fields. The most impressive examples of water harvesting occur in the Central and Northern Highlands. In the Central Highlands arable land is sometimes left fallow for the express purpose of directing the rain water it collects to an adjacent field.

Terracing

The primary purpose of terracing is to retain, build up, or extend arable lands situated on slopes. It also has the effect of increasing effective rainfall with the result that in many areas of North Yemen where one would expect to find aridic soil moisture regimes, ustic moisture regimes are found instead. There are four types of terraces in North Yemen: steep slope terraces, gentle slope terraces, perched terraces, and basalt flow terraces.

Steep Slope Terraces: For the purposes of this study steep slope terraces are defined as those where the slope between terraces is greater than 25%.

Many steep and gentle slope terraces are positioned to harvest water from surrounding slopes. However, in steep slope terraces this takes on special significance. The presence and positioning of terraces on steep slopes can be grouped in four general classes which, in the absence of climatic data in many areas of the country, serve as indicators of the quantity of effective rainfall.

Class I: No moisture constraint. Terraces extend out of ravines on mountain ridges and high on mountain slopes. The terraces cover the entire face of the mountain, excluding only areas of rock outcrops.

Class II: Moderate moisture constraint. Terraces continue high up on mountain slopes but are limited in extent to the contours of the slope's watershed.

Class III: Serious moisture constraint. Terraces are only at the base of a mountain slope watershed.

Class IV: Severe moisture constraint. No terraces on mountainsides or footslopes.

In high mountains, where there is a wide variation in rainfall and air temperature, the lower slopes of a mountain may be class III or class IV while its upper slopes are class I or class II.

Gentle Slope Terraces: The use of terms like Western Plains, Mountain Plains, and Eastern Plains implies that there are significant amounts of level farm land in North Yemen. In fact this is not the case. Virtually all farm land in North Yemen is situated on topography with a visible slope. This fact, combined with the need to impound water to improve the moisture status of cultivated fields, accounts for the fact that even on the plains virtually all cropped land is terraced. The gentle slope terraces are not as dramatic as steep slope terraces but they do match them in extent.

Gentle slope terraces are the generally broad terraces of footslopes, mountain plains, wadis, and the Piedmont Tihama. With the major exception of some footslope soils, the soils of the gentle slope terraces tend to be deep; some are many meters in depth. In the wadis and the Piedmont Tihama these terraces are usually spate irrigated. By definition the slope of gentle slope terraces is less than 25%. In practice it tends to be much less than that.

An important difference between gentle slope terraces and steep slope terraces is the distances to rock outcrops, which determines the amount of coarse materials in the soil. Gentle slope terraces, as a general rule, are more silty and less sandy and gravelly than steep slope terraces. The presence or absence of rocks to reinforce terraces often serves as an indicator of the dominance of silt in a soil (see section on soil genesis, Chapter 2). Terraced soils with a high silt content often do not need stone reinforcement. Good examples of this are the terraces in the high silt content soils of Ibb, where, in some instances, even steep slope terraces are not reinforced with stone.

Perched Terraces: In terms of slope, perched terraces would also qualify as gentle slope terraces. However, they are different in that they are typical of the extensive exposed bedrock terrain of the Northern Highlands. The name is derived from the fact that the soil of these terraces is seldom more than one-and-a-half meters deep and it is "perched" on bedrock. Often a rock wall is built around a perimeter of bedrock and the inside of the perimeter is filled with transported soil materials.

Perched terraces are also formed by building low rock walls across small ravines and streams--sometimes only a meter or two wide--which are a part of the bedrock topography. Soil is often transported to these terraces, but the entrapment of silt, which is present in the runoff impounded, is also an important constituent of these soils.

Despite their proximity to parent rocks, these terraced soils are predominantly silt with comparatively small amounts of sand or coarser materials.

Basalt Flow Terraces: Again, these are gentle slope terraces in terms of slope. They are the small terraces of widely diverse shapes which have been formed in basalt flows by the combination of picking rocks to clear favorably situated land for cultivation and building walls

around the land to preserve it. These terraces are common in large areas of the Central Highlands. The soils of basalt flow terraces are loams and silt loams, but stones and gravel are common. These soils tend to be very strongly calcareous.

MANAGEMENT CONSIDERATIONS OF IMPORTANT SOIL PROPERTIES

Specific limiting soil properties are reviewed below in terms of their amenability to improved management. Some of these properties were also discussed earlier in relation to specific soil families.

Soil Permeability and Moisture Retention Characteristics

The Fluvents and Orthents which are prevalent in the wadis and terraces of North Yemen are mostly loams which have both good permeability and good moisture retention characteristics. It is these qualities of the soils of Yemen which make agriculture possible in areas of erratic water availability. There are soils with restricted permeability on the highland plains and in the wadis around Taizz but these are of limited extent. More common are sandy and coarse-textured soils which are droughty because of poor moisture retention characteristics. Many of the abandoned terraces in the highlands are more gravelly than those still maintained. The Psamments of the plains also have less favorable water retention characteristics than the Fluvents of the wadis. However, as shown by the widespread presence of dune culture on the Tihama, crops with a vigorous and deep root system can exploit the limited rainfall which percolates quickly and then is stored in the dunes of the Piedmont and mid-Tihama.

Drainage

The soils of North Yemen are generally well drained. The only notable exceptions observed are the restricted drainage soils of the coastal Tihama and Wadi Jawf.

Salinity and Alkalinity

Except for some areas along the Red Sea, in Wadi Jawf, and in a very few areas in the highlands where salts collect in basins and locally the water is abnormally saline, salinity or alkalinity are not problems.

Crusting

Although not extremely serious, crusting does exist as a result of the soils' low organic matter content and high silt content. It was particularly noticed that on farms on the Tihama where machinery has been used extensively for four to ten years, poor soil structure and crusting is a problem. A rotation including several years of a sod crop would be the most obvious solution to this problem, if it is economically feasible.

Moisture Stress and Sediment Stratification

Random moisture stress, apparently resulting from restricted water penetration due to stratification, was observed, but it is not as widespread as one might expect with the extensive cropping of alluvial soils in North Yemen. Most of these soils are cropped and worked regularly while the sediments making up the soil are deposited. The result of this is apparently the obliteration of any significant stratification at the surface 50cm in most areas. If new lands on the western or eastern plains were brought into production, stratification would very likely be a problem.

Stoniness

The presence of stones in the soil is a limitation for mechanized agriculture on the plains near the mountains. Mountainous, colluvial soils are also typically very stony.

Hummocky Soils: Due to the effects of wind erosion and deposition, hummocks are common over large areas of the plains and would impede land leveling for bringing new lands under irrigation.

Micronutrient Deficiencies

Due to the high levels of $CaCO^3$ in the soils of North Yemen, deficiencies of iron, manganese, zinc, or copper would be likely with intensive culture of susceptible crops. However, such deficiences were not noted to be widespread under current agricultural practices.

GLOSSARY

Alluvium: A general term for clay, silt, sand, gravel, or other similar unconsolidated material deposited by a stream or other body of running water on the bed of the stream, its floodplain, or its deltas, or deposited as a cone or fan at the base of a mountain slope.

Argillic horizon: A mineral soil horizon that is characterized by the illuvial accumulation of layer-lattice silicate clays. The argillic horizon has a certain minimum thickness (depending on the thickness of the solum), a minimum quantity of clay in comparision with an overlying eluvial horizon (depending on the clay content of the eluvial horizon), and usually has coatings of oriented clay on the surface of pores, peds, or bridging sand grains. (Soil Sci. Soc. Am., 1978, p. 24).

Aridic: A soil moisture regime that has no moisture available for plants for more than half the cumulative time that the soil temperature at 50cm is above 5°C and has no period as long as 90 consecutive days when there is moisture for plants while the soil temperature is continously above 8°C. (Soil Sci. Soc. Am., 1978, p. 24).

Barchan: A moving, isolated, crescent-shaped sand dune which forms where sand supply is limited and wind is constant and moderate in speed.

Bunds: Any artificial embankment used to control the flow of water on a river or on irrigated land.

Calcic horizon: A mineral soil horizon of secondary carbonate enrichmont that is more than 15cm thick, has a calcium carbonate equivalent of more than 15%, and has at least 5% more calcium carbonate equivalent than the underlying C horizon. (Soil Sci. Soc. Am., 1978, p. 24)

Colluvium: A general term applied to any loose, heterogeneous, incoherent mass of soil material or rock fragments deposited chiefly by mass-wasting, usually at the base of a steep slope or cliff.

False-color infrared composite: Imagery produced from bands 4, 5, and 7 of digital multispectral scanner (MSS) data from the Landsat satellite.

Graben: An elongated, relatively depressed crustal block that is bounded by faults on its long sides.

Horst: An elongated, relatively uplifted crustal block that is bounded by faults on its long sides.

Laccolith: A lens-shaped concordant igneous intrusion less than eight kilometers in diameter.

Lacustrine sediments: Sediments deposited at the bottom of a lake.

Longitudinal dune: A long, narrow, usually symmetrical (in profile) sand dune, oriented parallel to the direction of the prevailing wind responsible for its construction.

Loess: Widespread, unconsolidated, commonly nonstratified deposit of fine-grained, highly calcareous material. Loess is generally believed to be windblown dust of Pleistocene age, but in Yemen loess deposition appears to be currently active. Loess in Yemen may be reworked by water sedimentation.

Marl: Unconsolidated deposits of a mixture of clay and calcium carbonate, formed under marine, or especially freshwater, conditions.

Mollic epipedon: A surface horizon of mineral soil that is dark colored and relatively thick; contains at least 0.58% organic carbon; is not massive and hard or very hard when dry, has a base saturation of more than 50% when measured at pH 7, has less than 250ppm P_2O_5 soluble in 1% citric acid, and is dominantly saturated with bivalent cations. (Soil Sci. Soc. Am., 1978, p. 27)

Petrocalcic horizon: A continous, indurated calcic horizon that is cemented with calcium carbonate and, in some places, with magnesium carbonate. It cannot be penetrated with a spade or auger when dry, it is impenetrable to roots, and its dry fragments do not slake in water. (Soil Sci. Soc. Am., 1978, p. 27)

Sabkhah: Coastal and inland salt flats or playas, built up by deposition of silt, clay, and muddy sand in shallow, sometimes extensive, depressions. The deposits are completely saturated with brine and are often salt encrusted.

Spate irrigation: Irrigation by diversion of water from a sudden flood on a river, caused by heavy rains higher up the valley.

Udic: A soil moisture regime that is neither dry for as long as ninety cumulative days nor for as long as sixty consecutive days in the ninety days following the summer solstice at periods when the soil temperature is above 5^0C. (Soil Sci. Soc. Am., 1978, p. 28).

Ustic: A soil moisture regime that is intermediate between the aridic and udic regimes and common in temperate subhumid or subarid regions, or in tropical or subtropical regions with a monsoon climate. A limited amount of moisture is available for plants, but occurs at times when the soil temperature is optimum for plant growth. (Soil Sci. Soc. Am., 1978, p. 28)

Wadi: A stream bed or channel, or a steep-sided bouldery ravine, that is usually dry except during the rainy season. Wadis often form oases. "Wadi" also refers to the stream that runs in the bed. In Arabic, "wadi" can refer to any stream channel, whether it is dry or not.

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Appendix I

SOIL PROFILE LOCATIONS, DESCRIPTIONS, AND ANALYTICAL DATA

CONTENTS

Map I.1: Sites of Profile Descriptions in Yemen. 174

Soil Profile Descriptions and Analytical Data
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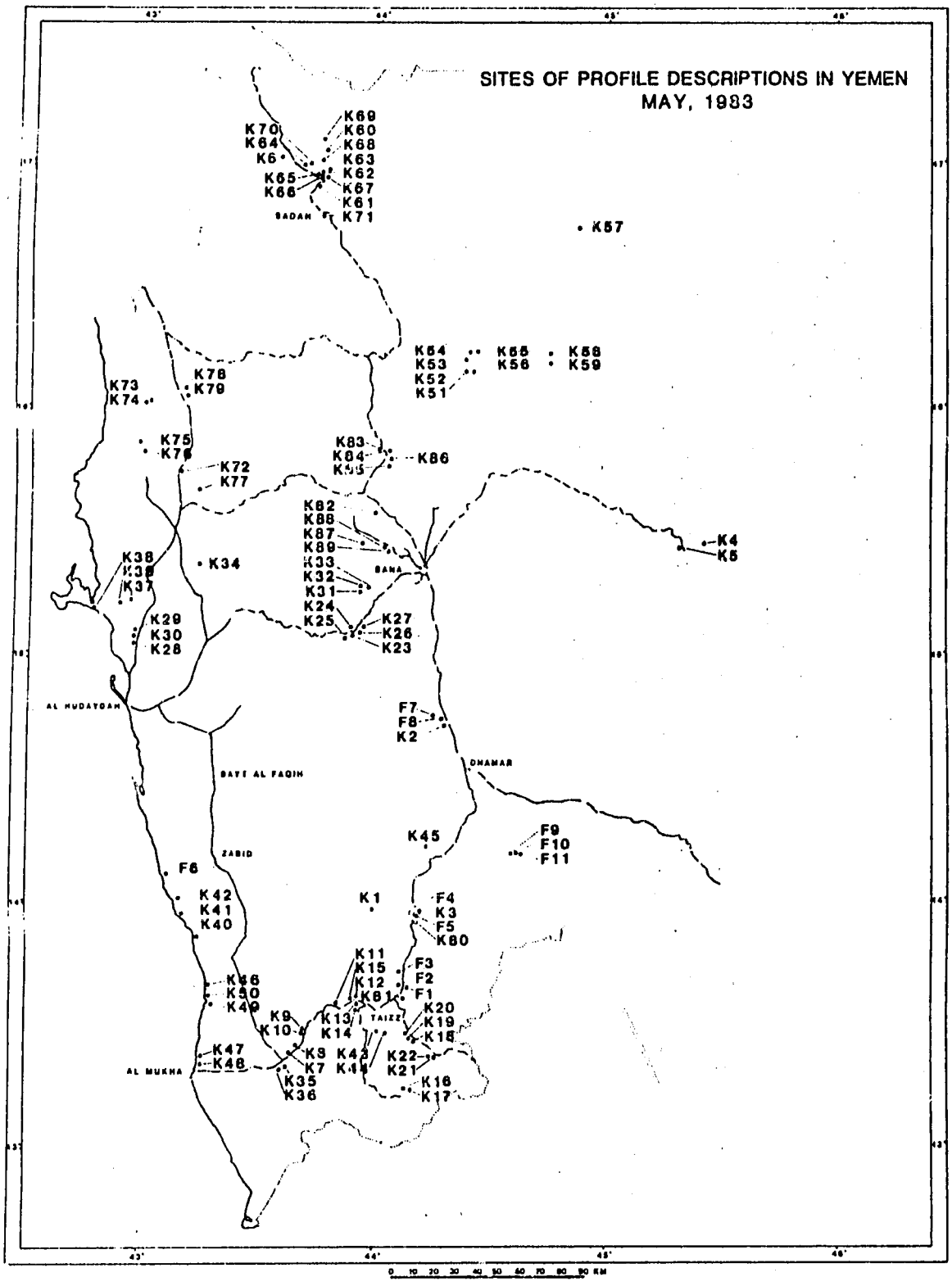
SITES OF PROFILE DESCRIPTIONS IN YEMEN
MAY, 1983
K70
K64
K6
K65
K66
K69
K60
K68
K63
K62
K67
K61
K71
BADAN
K57
K64
K53
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BANA
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K29
K30
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K26
K23
AL HUDAYDAH
F7
F8
K2
DHAMAR
BAYT AL FAQIH
K45
F9
F10
F11
ZABID
F6
K42
K41
K40
K1
F4
K3
F5
K80
K11
K15
K12
K81
F3
F2
F1
K46
K50
K49
K9
K10
K13
K14
TAIZZ
K20
K19
K18
K47
K48
AL MUKHA
K8
K7
K35
K36
K43
K44
K22
K21
K16
K17

SOIL PROFILE SITE F1

SITE INFORMATION

Classification: TYPIC TORRIORTHENT, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: April 13, 1981, 2 PM
Authors: T. Forbes and J. King
Location: 5km southwest of Al Ganed
Elevation: 1420m
Physiographic position: Convex slope, plain
Topography of surrounding country: Undulating
Microtopography: Gullies, tussacks
Slope: 4%
Land use: *Acacia arabica* present, surrounding areas used for sorghum, corn and wheat
Climate: Unknown (rainfall about 200mm/yr)

SOIL INFORMATION

Parent material: Alluvium and colluvium from volcanic rocks of hillcrest. Large addition of loess.
Drainage class: Well drained
Moisture conditions: Dry down to one meter, then slightly moist.
Depth to groundwater: Unknown
Surface stones or outcrops: Fine gravel partially covering surface; hillcrest very rocky.
Evidence of erosion: Severe sheet and gully erosion, possible wind erosion.
Salt content: No apparent salt or alkali
Human influence: Heavy grazing

Profile Description

C1 0-20cm F1	Light yellowish-brown 10YR 6/4 (dry); silt loam; weak coarse to fine subangular blocky structure; nonsticky, nonplastic, very friable (moist); soft (dry); common, very fine discontinous, horizontal, inped, tubular, closed pores; calcareous; common fine roots; clear, broken boundary.
IIC2 20-31cm F2	Brown, 10YR 5/3 (moist); slightly gravelly silt loam; weak coarse to fine subangular blocky structure; nonsticky, nonplastic, very friable (moist); few, very fine, discontinous, random, inped, tubular, closed pores; calcareous; frequent mineral fragments--basalt rock; few small roots; clear, broken boundary.

IIIC3 31-41cm F3	Yellowish-brown, 10YR 5/4 (moist); silt loam; weak to moderate, coarse to fine subangular blocky structure; slightly sticky (wet); slightly plastic, very friable (moist); few, micro, discontinous, random, inped, tubular, closed pores; calcareous; few fine to very fine roots; clear, wavy boundary.
IVC4 41-69cm F4	Yellowish-brown, 10YR 5/4 (moist); gravelly silt loam; moderate coarse to fine subangular, blocky structure; slightly sticky (wet); slightly plastic, very friable (moist); few very fine, discontinous, random, inped, tubular, closed pores; calcareous; few gravels, angular to subangular fresh basalt rock fragments; few ostracod shells; very few fine roots; clear, wavy boundary.
VC5 69+cm F5	Yellowish-brown 10YR 5/4 (moist); silt loam; weak to moderate, coarse to fine, subangular blocky structure; slightly plastic and slightly sticky (wet); very friable (moist); few, very fine, discontinous, random, inped, tubular, closed pores; calcareous; very few coarse and fine roots.

Note: Gravel layer thickness and depth is quite variable for polypedon.

ANALYTICAL DATA FOR SITE F1

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
F1	0-20	C1	vf	g	13.1	77.5	9.4	sil
F2	20-31	IIC2	fr	g	27.3	63.2	9.5	sil
F3	31-41	IIIC3	vf	-	11.6	77.1	11.3	sil
F4	41-69	IVC4	f	g	31.2	59.6	9.2	sil
F5	69+	VC5	vf	-	27.4	61.7	10.8	sil

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.5 mm	Medium Sand .5-.25 mm	Fine Sand .25-0.1mm	Very Fine Sand 0.1-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
F1	2.1	0.4	0.3	1.2	9.1	60.9	12.8	3.7
F2	11.2	3.2	1.5	3.6	7.8	50.6	9.2	3.4
F3	1.1	0.8	0.5	1.8	7.4	59.2	13.1	4.8
F4	13.5	3.4	4.2	2.5	7.6	50.0	6.2	3.3
F5	6.9	1.8	0.8	2.7	15.3	44.5	12.5	4.7

No.	pH 1:5	pH 1:1	EC mmhos	Avail. P (ppm)	CaCO3 (%)	Organic Matter (%)	Total N (%)	CEC meq/100g
F1	9.0	7.8	0.22	8.74	18.4	0.6	0.062	19.9
F2	8.8	7.75	0.87	8.51	20.6	0.38	0.056	17.2
F3	8.7	7.9	0.56	7.82	21.2	0.63	0.042	21.3
F4	9.0	7.9	0.9	7.82	17.8	0.21	0.0213	16.6
F5	9.0	7.9	0.8	3.7	17.6	0.30	0.018	18.8

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE F2

SITE INFORMATION

Classification: TYPIC CAMBORTHID, LOAMY-SKELETAL, MIXED, ISOTHERMIC FAMILY
Date and time described: April 14, 1981, 11 AM
Authors: T. Forbes and J. King
Location: Al Thhran--5 miles southeast of Al Ganed
Elevation: 1350m
Physiographic position: Colluvial footslope, convex slope
Topography of surrounding country: Steep, dissected slope
Microtopography: Layer of cobbles on slope surface
Slope: 43-44%
Land use: Not used for cultivation
Climate: Unknown

SOIL INFORMATION

Parent material: Colluvium from basalt and limestone
Drainage class: Well-drained
Moisture conditions: Surface moisture
Depth to groundwater: Unknown
Surface stones or outcrops: Stones, gravels and some boulders
Evidence of erosion: Some sheet erosion
Salt content: No alkali or calcium salts on rocks
Human influence: None

Profile Description

A1 0-13cm F6	Dark reddish-brown, 5YR 3/4 (moist); stony, slightly gravelly, loam; weak, coarse to fine subangular blocky structure; slightly sticky and slightly plastic (wet); loose to very friable (moist); many micro to medium, discontinuous, random, inped, interstitial open and closed pores; very frequent volcanic and limestone stones; strongly calcareous; many coarse medium and fine roots; clear, wavy boundary.
B 13-70cm F7	Reddish-brown, 5YR 4/4 (moist); stony and gravelly loam; very weak, medium to fine subangular blocky and crumb structure; very slightly sticky, slightly plastic (wet); loose to very friable (moist); many micro to some coarse discontinuous, random, interstitial, inped, open and closed pores; calcareous; many fine and some coarse roots; very frequent volcanic and limestone gravel; gradual, irregular boundary.

Cca 70+cm F8	Brown, 7.5YR 4/4 (dry); stony and gravelly loam; very weak, medium fine, subangular blocky and granular structure; slightly sticky and slightly plastic (wet); loose (dry); many micro to coarse, discontinuous, random, inped, interstitial, open and closed pores; very frequent volcanic and limestone stones and gravel; very few fine roots; strongly calcareous.

ANALYTICAL DATA FOR SITE F2

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
F6	0-13	A1	vfr	s	36.7	44.6	18.7	l
F7	14-70	B	vfr	g	46.7	36.2	17.1	l
F8	70+	Cca	vfr	s,g	44.5	37.7	17.8	l

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.5 mm	Medium Sand .5-.25 mm	Fine Sand .25-0.1mm	Very Fine Sand 0.1-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
F6	9.5	7.7	5.4	8.2	5.9	24.8	16.9	2.9
F7	13.1	10.3	7.5	10.9	4.8	19.3	14.2	2.7
F8	14.7	11.0	6.8	8.5	3.6	15.0	14.6	8.1

No.	pH 1:5	pH 1:1	EC mmhos	Avail. P	CaCO3 (%) (ppm)	Organic Matter	Total N (%)	CEC meq/100g (%)
F6	8.6	7.85	0.36	5.3	8.4	1.54	0.068	34.9
F7	8.5	7.6	2.3	5.8	10.8	1.18	0.058	29.6
F8	8.4	7.6	4.1	6.7	16.0	0.91	0.049	29.1

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE F1

SITE INFORMATION

Classification: TYPIC TORRIORTHENT, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: April 13, 1981, 2 PM
Authors: T. Forbes and J. King
Location: 5km southwest of Al Ganed
Elevation: 1420m
Physiographic position: Convex slope, plain
Topography of surrounding country: Undulating
Microtopography: Gullies, tussacks
Slope: 4%
Land use: Acacia arabica present, surrounding areas used for sorghum, corn and wheat
Climate: Unknown (rainfall about 200mm/yr)

SOIL INFORMATION

Parent material: Alluvium and colluvium from volcanic rocks of hillcrest. Large addition of loess.
Drainage class: Well drained
Moisture conditions: Dry down to one meter, then slightly moist.
Depth to groundwater: Unknown
Surface stones or outcrops: Fine gravel partially covering surface; hillcrest very rocky.
Evidence of erosion: Severe sheet and gully erosion, possible wind erosion.
Salt content: No apparent salt or alkali
Human influence: Heavy grazing

Profile Description

C1 0-20cm F1	Light yellowish-brown 10YR 6/4 (dry); silt loam; weak coarse to fine subangular blocky structure; nonsticky, nonplastic, very friable (moist); soft (dry); common, very fine discontinous, horizontal, inped, tubular, closed pores; calcareous; common fine roots; clear, broken boundary.
IIC2 20-31cm F2	Brown, 10YR 5/3 (moist); slightly gravelly silt loam; weak coarse to fine subangular blocky structure; nonsticky, nonplastic, very friable (moist); few, very fine, discontinous, random, inped, tubular, closed pores; calcareous; frequent mineral fragments--basalt rock; few small roots; clear, broken boundary.

IIIC3 31-41cm F3	Yellowish-brown, 10YR 5/4 (moist); silt loam; weak to moderate, coarse to fine subangular blocky structure; slightly sticky (wet); slightly plastic, very friable (moist); few, micro, discontinous, random, inped, tubular, closed pores; calcareous; few fine to very fine roots; clear, wavy boundary.
IVC4 41-69cm F4	Yellowish-brown, 10YR 5/4 (moist); gravelly silt loam; moderate coarse to fine subangular, blocky structure; slightly sticky (wet); slightly plastic, very friable (moist); few very fine, discontinous, random, inped, tubular, closed pores; calcareous; few gravels, angular to subangular fresh basalt rock fragments; few ostracod shells; very few fine roots; clear, wavy boundary.
VC5 69+cm F5	Yellowish-brown 10YR 5/4 (moist); silt loam; weak to moderate, coarse to fine, subangular blocky structure; slightly plastic and slightly sticky (wet); very friable (moist); few, very fine, discontinous, random, inped, tubular, closed pores; calcareous; very few coarse and fine roots.

Note: Gravel layer thickness and depth is quite variable for polypedon.

ANALYTICAL DATA FOR SITE F1

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
F1	0-20	C1	vf	g	13.1	77.5	9.4	sil
F2	20-31	IIC2	fr	g	27.3	63.2	9.5	sil
F3	31-41	IIIC3	vf	-	11.6	77.1	11.3	sil
F4	41-69	IVC4	f	g	31.2	59.6	9.2	sil
F5	69+	VC5	vf	-	27.4	61.7	10.8	sil

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.5 mm	Medium Sand .5-.25 mm	Fine Sand .25-0.1mm	Very Fine Sand 0.1-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
F1	2.1	0.4	0.3	1.2	9.1	60.9	12.8	3.7
F2	11.2	3.2	1.5	3.6	7.8	50.6	9.2	3.4
F3	1.1	0.8	0.5	1.8	7.4	59.2	13.1	4.8
F4	13.5	3.4	4.2	2.5	7.6	50.0	6.2	3.3
F5	6.9	1.8	0.8	2.7	15.3	44.5	12.5	4.7

No.	pH 1:5	pH 1:1	EC mmhos	Avail. P (ppm)	CaCO3 (%)	Organic Matter (%)	Total N (%)	CEC meq/100g
F1	9.0	7.8	0.22	8.74	18.4	0.6	0.062	19.9
F2	8.8	7.75	0.87	8.51	20.6	0.38	0.056	17.2
F3	8.7	7.9	0.56	7.82	21.2	0.63	0.042	21.3
F4	9.0	7.9	0.9	7.82	17.8	0.21	0.0213	16.6
F5	9.0	7.9	0.8	3.7	17.6	0.30	0.018	18.8

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE F2

SITE INFORMATION

Classification: TYPIC CAMBORTHID, LOAMY-SKELETAL, MIXED, ISOTHERMIC FAMILY
Date and time described: April 14, 1981, 11 AM
Authors: T. Forbes and J. King
Location: Al Thhran--5 miles southeast of Al Ganed
Elevation: 1350m
Physiographic position: Colluvial footslope, convex slope
Topography of surrounding country: Steep, dissected slope
Microtopography: Layer of cobbles on slope surface
Slope: 43-44%
Land use: Not used for cultivation
Climate: Unknown

SOIL INFORMATION

Parent material: Colluvium from basalt and limestone
Drainage class: Well-drained
Moisture conditions: Surface moisture
Depth to groundwater: Unknown
Surface stones or outcrops: Stones, gravels and some boulders
Evidence of erosion: Some sheet erosion
Salt content: No alkali or calcium salts on rocks
Human influence: None

Profile Description

A1 0-13cm F6	Dark reddish-brown, 5YR 3/4 (moist); stony, slightly gravelly, loam; weak, coarse to fine subangular blocky structure; slightly sticky and slightly plastic (wet); loose to very friable (moist); many micro to medium, discontinuous, random, inped, interstitial open and closed pores; very frequent volcanic and limestone stones; strongly calcareous; many coarse medium and fine roots; clear, wavy boundary.
B 13-70cm F7	Reddish-brown, 5YR 4/4 (moist); stony and gravelly loam; very weak, medium to fine subangular blocky and crumb structure; very slightly sticky, slightly plastic (wet); loose to very friable (moist); many micro to some coarse discontinuous, random, interstitial, inped, open and closed pores; calcareous; many fine and some coarse roots; very frequent volcanic and limestone gravel; gradual, irregular boundary.

Cca 70+cm F8	Brown, 7.5YR 4/4 (dry); stony and gravelly loam; very weak, medium fine, subangular blocky and granular structure; slightly sticky and slightly plastic (wet); loose (dry); many micro to coarse, discontinuous, random, inped, interstitial, open and closed pores; very frequent volcanic and limestone stones and gravel; very few fine roots; strongly calcareous.

ANALYTICAL DATA FOR SITE F2

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
F6	0-13	A1	vfr	s	36.7	44.6	18.7	l
F7	14-70	B	vfr	g	46.7	36.2	17.1	l
F8	70+	Cca	vfr	s,g	44.5	37.7	17.8	l

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.5 mm	Medium Sand .5-.25 mm	Fine Sand .25-0.1mm	Very Fine Sand 0.1-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
F6	9.5	7.7	5.4	8.2	5.9	24.8	16.9	2.9
F7	13.1	10.3	7.5	10.9	4.8	19.3	14.2	2.7
F8	14.7	11.0	6.8	8.5	3.6	15.0	14.6	8.1

No.	pH 1:5	pH 1:1	EC mmhos	Avail. P (ppm)	CaCO3 (%)	Organic Matter	Total N (%)	CEC meq/100g (%)
F6	8.6	7.85	0.36	5.3	8.4	1.54	0.068	34.9
F7	8.5	7.6	2.3	5.8	10.8	1.18	0.058	29.6
F8	8.4	7.6	4.1	6.7	16.0	0.91	0.049	29.1

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE F3

SITE INFORMATION

Classification: AQUOLLIC SALORTHID, FINE CLAYEY, MIXED, ISOTHERMIC FAMILY
Date and time described: April 14, 1981, 3:20 PM
Authors: T. Forbes and J. King
Location: 3 km south of Al Ganed airport, off main road
Elevation: Unknown
Physiographic position: Broad-based lowland
Topography of surrounding country: Flat or almost flat
Microtopography: Bare spots between tight cover of Bermuda grass
Slope: 2%
Land use: Grazing
Climate: Unknown

SOIL INFORMATION

Parent material: Alluvium from surrounding terraced areas
Drainage class: Imperfectly drained
Moisture conditions: Moist throughout, wet at water table
Depth to groundwater: Unknown
Surface stones or outcrops: No surface stones or outcrops
Evidence of erosion: Patches of bare eroded soil
Salt content: Class 2- salt crystals apparent on surface
Human influence: Grazing by ruminants

Profile Description

Alsa 0-36 cm F9	Dark brown, 10YR 4/3 (moist); common small white spots of salt crystals; silty clay loam; moderate very coarse to fine subangular blocky structure; slightly sticky, plastic (wet); firm (moist); common fine, discontinous, vertical inped, tubular, open pores; strongly calcareous due to presence of crystalline salt spots; common fine roots; clear, smooth boundary.
Bg 36+cm F10	Matrix- grey, 5YR 6/1 (wet); many, fine, distinct, clear, dark brown (7.5YR 4/4) mottles; silty clay; weak, coarse to fine subangular blocky structure; sticky and plastic (wet); friable (moist); common, fine, discontinous, vertical, inped, tubular, open pores; strongly calcareous; a few fine roots.

Note: Water table at 67cm.

ANALYTICAL DATA FOR SITE F3

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
F9	0-36	A1sa	vf	-	0.6	59.6	39.8	sicl
F10	36+	Bg	vf	-	1.2	48.3	50.4	sic

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.5 mm	Medium Sand .5-.25 mm	Fine Sand .25-0.1mm	Very Fine Sand 0.1-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine .005-.002mm
F9	0	0	0	0.3	0.3	10.2	28.5	20.9
F10	0	0.1	0.1	0.4	0.6	14.1	18.4	15.9

No.	pH 1:5	pH 1:1	EC mmhos	Total N (%)	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	CEC meq/100g
F9	8.9	8.2	7.7	3.0	25.2	1.91	0.119	39.1
F10	8.8	8.1	7.3	3.7	36.6	0.88	0.064	35.2

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE F4

SITE INFORMATION

Classification: TYPIC CALCIUSTOLL, FINE SILTY, MIXED, ISOTHERMIC FAMILY
Date and time described: April 16, 1981, 10:30 AM
Authors: T. Forbes
Location: Broad, flat surface adjacent to wadi deposit
Elevation: 1860m
Physiographic position: Upper terrace adjacent to wadi deposit
Topography of surrounding country: Nearly flat plateau
Microtopography: Some low disintegrating terrace walls
Slope: 1-3%
Land use: Grass pasture--left in pasture for about 800 years
Climate: Unknown

SOIL INFORMATION

Parent material: Silty clay alluvium over loess over deep gravel deposits (from wadi)
Drainage class: Well drained
Moisture conditions: Slightly moist surface to moist underneath
Depth to groundwater: Unknown
Surface stones or outcrops: No surface stones or outcrops
Evidence of erosion: No evidence of significant erosion
Salt content: Calcareous salts in deep horizons
Human influence: Some influence from disintegrating terraces nearby

GENERAL DESCRIPTION OF THE PROFILE: Soil has a deep dark profile with deep very dark A1. The profile becomes more calcareous with depth.

Profile Description

A1 0-49cm F11	Very dusky red 2.5YR 2.5/2 (moist); silty clay loam; strong coarse to fine subangular blocky and crumb structure; slightly sticky, slightly plastic (wet); firm (moist); hard (dry); common, micro to fine, discontinuous, random, inped, vesicular, closed pores; very few round to subangular stones; very slightly calcareous; abundant fine and medium roots; clear, wavy boundary.

Bca
49-77cm
F12

Dark reddish-grey, 5YR 4/2 (dry); common, fine, distinct, clear, white calcareous salt crystals (calcite); silty clay loam; moderate, coarse to fine, subangular blocky structure; slightly and very slightly plastic (wet); friable (moist); hard (dry); a few very fine and common fine discontinuous, random, inped, tubular and vesicular closed pores; very few rounded stones (noncalcareous); calcareous; common fine and a few medium roots; gradual, wavy boundary.

Cca
77+cm
F13

Dark brown, 7.5YR 4/2 (moist); silt loam; moderate coarse to fine subangular blocky structure; nonsticky and very slightly plastic (wet); friable (moist); hard (dry); a few micro and very fine, discontinuous, random and vertical, inped tubular closed pores; common fine and medium, distinct, clear, white, carbonate mycelia; a few fine roots.

ANALYTICAL DATA FOR SITE F4

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
F11	0-49	A1	vf	s	6.8	62.7	30.4	sicl
F12	49-77	Bca	vf	s	7.3	63.5	29.8	sicl
F13	77+	Cca	vf	-	18.3	59.1	22.6	sil

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.5 mm	Medium Sand .5-.25 mm	Fine Sand .25-0.1mm	Very Fine Sand 0.1-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
F11	0	1.1	0.9	2.6	2.1	25.0	23.4	14.4
F12	0	0.1	0.2	2.5	4.5	28.2	26.6	8.8
F13	0	0.1	0.5	7.7	10.0	29.9	23.5	5.7

No.	pH 1:5	pH 1:1	EC mmhos	Total N (%)	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	CEC meq/100g
F11	7.9	7.6	0.36	4.14	6.0	1.42	0.114	57.3
F12	8.4	7.8	0.29	4.7	7.2	1.08	0.088	51.5
F13	8.6	7.95	0.24	5.8	9.4	0.64	0.041	44.9

* vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE F5

SITE INFORMATION

Classification: TYPIC USTROPEPT, FINE SILTY, MIXED, ISOTHERMIC FAMILY
Date and time described: April 16, 1981, 12:50 PM
Authors: T. Forbes
Location: Agricultural Institute--Salaba Seda, Ibb
Elevation: 1860m
Physiographic position: Side of flat-bedded terrace
Topography of surrounding country: Rolling hill (terraced)
Microtopography: Microtopography evened out by terracing
Slope: 15%
Land use: Farmed for maize, sorghum, some beans
Climate: Probably ustic moisture regime

SOIL INFORMATION

Parent material: Loess over colluvial, alluvial clay/loess mixture
Drainage class: Well drained
Moisture conditions: Moist to dry
Depth to groundwater: Unknown
Surface stones or outcrops: Occasional stone on surface, no rock outcrop
Evidence of erosion: Some slumping along terrace edge, no significant erosion
Salt content: Calcarecus salt accumulation at depth
Human influence: Top material especially disturbed by terracing

GENERAL DESCRIPTION OF THE PROFILE: Deep silty to silt loam profile with calcarecus accumulation (nodules) at depth.

Profile Description

Ap 0-59cm F14	Yellowish-brown, 10YR 5/4 (slightly moist); slightly gravelly silt loam; moderate, medium to fine subangular, blocky structure; nonsticky and nonplastic (wet); very friable (slightly moist); hard (dry); a few fine and common very fine and micro, discontinuous, oblique and random, inped, tubular, closed pores; very few gravels and stones (noncalcareous); calcareous; abundant fine and medium roots; very few small, soft, carbonate nodules; gradual, wavy boundary.

C1ca 59-115cm F15	Dark yellowish-brown, 10YR 4/4 (moist); slightly gravelly silt loam; strong coarse to fine subangular blocky structure; nonsticky and nonplastic (wet); firm (slightly moist); hard (dry); a few medium and common very fine, discontinuous, vertical and oblique, inped, interstitial and tubular, closed pores; very few calcareous gravels; many medium, prominent, clear, white calcareous mycelia; very few small, hard, irregular, greyish white nodules; strongly calcareous; a few fine roots; gradual, wavy boundary.
C2ca 115+cm F16	Dark brown, 10 YR 4/3 (moist); many fine and medium, prominent, clear white, calcareous mycelia; silty clay loam (slightly gravelly); strong coarse to fine subangular blocky structure; slightly sticky and slightly plastic (wet); very firm (slightly moist); hard (dry); common micro and very fine, a few fine and medium, discontinuous, random, inped, tubular, closed pores; very few gravel fragments; very few small, hard calcareous nodules; strongly calcareous; a very few fine roots.

ANALYTICAL DATA FOR SITE F5

No.	Depth (cm.)	Horizon	Coarse Frag. >2 mm *	Size Course Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
F14	0-59	Ap	vf	g,s	12.5	72.7	14.8	sil
F15	59-115	C1ca	vf	g	7.4	63.6	29.0	sil
F16	115+	C2ca	vf	g	5.5	64.4	30.1	sicl

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.5 mm	Medium Sand .5-.25 mm	Fine Sand .25-0.1mm	Very Fine Sand 0.1-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
F14	3.2	1.6	0.8	1.4	5.5	60.2	8.6	3.9
F15	0.6	0.2	0.1	0.5	5.9	48.4	10.7	4.4
F16	0.9	0.5	0.2	0.2	3.5	44.0	16.4	4.0

No.	pH 1:5	pH 1:1	EC mmhos	Total N (%)	Organic Matter (%)	$CaCO_3$ (%)	Avail. P (ppm)	CEC meq/100g
F14	8.6	7.8	0.42	6.44	15.4	1.34	0.082	21.5
F15	8.6	7.95	0.23	5.8	15.2	0.73	0.075	25.2
F16	8.6	7.95	0.55	5.0	14.0	0.79	0.058	30.7

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE #6

SITE INFORMATION

Classification: TYPIC TORRIFLUVENT, COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY, STRONGLY SALINE PHASE
Date and time described: April 22, 1981, 12:15 PM
Authors: T. Forbes
Location: Wadi Zabid area, Bani Fathal, 5km from the Red Sea
Elevation: 50m
Physiographic position: Center of flat alluvial (aeolian) plain
Topography of surrounding country: Flat alluvial wadi, much disturbed in areas by building bunds
Microtopography: Many sand blow out areas and remanants of stabilized sand dunes
Slope: 0-1%
Land use: Not cultivated, some shrubs adapted to salty conditions
Climate: Unknown

SOIL INFORMATION

Parent material: Alluvial (wadi) and aeolian deposits
Drainage class: Well-drained
Moisture conditions: Soil moist below 10-20cm
Depth to groundwater: Unknown
Surface stones or outcrops: No surface stones or rock outcrops
Evidence of erosion: Some sheet and aeolian erosion
Salt content: Salt (Ca or Na) very apparent on soil surface; surface feels "spongy" when walking
Human influence: Appears undisturbed recently by humans, but may have been used intensively in the past

GENERAL DESCRIPTION OF THE PROFILE: Deep light to dark brown profile. Six sedimentary layers discerned. Sedimentation due to human, alluvial and aeolian processes.

Profile Description

A1ca 0-18cm #17	Brown, 7.5 YR 4/4 (moist); common, fine distinct, clear, white salt crystals; sandy loam (with fine sand); moderate to weak, medium to fine, subangular blocky structure; nonsticky and very slightly plastic (moist); very friable (moist); common micro and very fine, a few medium, discontinuous, horizontal and random, inped, tubular and vesicular, open and closed

pores; very few gravel; very few small soft calcareous nodules, and few very small white salt crystals; strongly calcareous; no artifacts; very few, very fine roots; clear, wavy boundary.

IC1
18-78cm
F18

Brown, 10YR 5/3 (slightly moist); very few, very fine distinct white salt crystals; silt loam (with very fine sand); moderate to weak, coarse to fine , subangular blocky structure; very slightly sticky and very slightly plastic, friable to very friable; common micro to very fine, few medium, discontinuous, random, inped, tubular, and vesicular, closed pores; very few basalt gravels; very few, very small, soft spherical, white salt crystals; strongly calcareous; frequent small to large (about 8 cm) orange pottery chips; a few small and very fine roots; gradual, wavy boundary.

IIC2
78-93cm
F19

Yellowish-brown, 10 YR 5/4 (moist); silt loam; moderate to weak coarse to fine subangular blocky structure; slightly sticky and slightly plastic (wet); very friable to friable (moist); segregation of light and dark material, some large pores contain what appear to be dried cutans, lighter material deposited by human influence illuviates into horizon beneath; common micro and very fine, a few fine and medium, discontinuous, random, inped tubular and vesicular, closed pores; very few basalt gravels; very few, very small, soft, spherical white salt nodules; very few, fine roots; strongly calcareous; no artifacts; gradual, wavy boundary.

IIIC3
93-118cm
F20

Dark, greyish-brown, 10YR 4/2 (moist); very few fine, distinct, white salt crystals (nodules); very fine sandy loam; weak coarse to fine subangular blocky structure; nonsticky, nonplastic (wet); very friable (moist); very few fine and a few micro, discontinuous, random, inped, tubular, closed pores; very few small, soft, spherical salt nodules; strongly calcareous; a very few fine roots; clear, wavy boundary.

IVC4
118-135cm
F21

Brown, 10YR 4/3 (moist); common, fine, distinct, grey salt nodules; loam; moderate, very coarse to fine subangular blocky structure; sticky and plastic (wet); friable (moist); lighter clay material segregated from coarser material (speckeled appearance)--resembles inactive old cutans; a few fine and medium, common micro, very fine, discontinuous, random, inped, tubular, closed pores; very few basalt gravel; frequent, small to large, soft, spherical (and

mycelia), white salt nodules and material; strongly calcareous; no artifacts; very few fine roots; clear, wavy boundary.

VC5
135+cm
F22

Brown, 10 YR 4/3 (moist); loamy fine sand; weak coarse to fine subangular blocky structure; nonsticky and nonplastic (wet); very friable to loose (moist); common, micro, random, discontinuous, inped, interstitial, closed pores; very rare basalt gravel; strongly calcareous; no roots; no artifacts.

ANALYTICAL DATA FOR SITE F6

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
F17	0-18	A1ca	vf	g	59.9	30.4	9.7	sl
F18	18-78	IC1	vf	g	44.2	50.6	5.3	sil
F19	78-93	IIC2	vf	g	9.6	76.6	13.9	sil
F20	93-118	IIIC3	vf	-	60.9	36.3	2.7	sl
F21	118-135	IVC4	vf	g	33.9	47.2	18.9	l
F22	135+	VC5	vf	g	78.1	20.8	4.3	ls

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.5 mm	Medium Sand .5-.25 mm	Fine Sand .25-0.1mm	Very Fine Sand 0.1-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
F17	0.1	1.0	5.2	28.7	24.9	17.0	10.8	2.5
F18	0.3	1.0	3.3	20.1	19.5	31.7	14.9	3.9
F19	0.1	0.4	1.2	4.6	3.3	28.3	38.1	10.2
F20	0.1	1.1	5.4	30.0	24.2	22.3	9.1	4.9
F21	0.1	0.5	2.9	16.4	13.9	21.9	19.6	6.1
F22	0.0	2.1	10.3	42.8	22.9	16.2	0.0	4.6

No.	pH 1:5	pH 1:1	EC mmhos	Total N (%)	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	CEC meq/100g
F17	9.4	8.4	6.1	8.6	11.2	0.45	0.044	18.3
F18	9.9	8.55	3.6	6.44	9.6	0.30	0.044	22.5
F19	8.6	8.05	3.15	6.0	9.6	0.30	0.037	27.8
F20	9.2	9.1	1.15	5.8	9.6	0.28	0.034	22.2
F21	10.2	9.1	1.15	5.21	13.8	0.27	0.021	32.1
F22	10.5	9.6	0.9	5.14	8.2	0.10	0.014	19.1

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE F7

SITE INFORMATION

Classification: TYPIC TORRERTS, FINE CLAYEY, MONTMORILLONITIC, ISOTHERMIC FAMILY, SILTY CAP PHASE
Date and time described: May 6, 1981, 9AM
Authors: T. Forbes
Location: Qa'Jahran, British experimental farm near Ma'bar, 70-75km south of Sana'a
Elevation: 2230m
Physiographic position: Wide, nearly flat plain; slightly convex middle footslope, 1km from rock outcrop
Topography of surrounding country: Nearly flat
Microtopography: Disturbance by human cultivation, formation of bunds
Slope: 1-2%
Land use: Not used, near garden area in front of housing project
Climate: Unknown

SOIL INFORMATION

Parent material: Lacustrine sediments (as reported previously) and alluvium-colluvium from rock outcrop and loess
Drainage class: Well-drained
Moisture conditions: Dry throughout
Depth to groundwater: Unknown
Surface stones or outcrops: No surface stones or rock outcrops
Evidence of erosion: No evidence of erosion at Site.
Salt content: Calcareous concretions present in the profile; no obvious evidence of alkali (Na) salt
Human influence: Area has been cultivated for centuries with some form of irrigation--as evidenced by the top disturbed layer

GENERAL DESCRIPTION OF THE PROFILE: Deep, tri-color profile. Light brown loose surface, dark brown buried layer, followed by brown layer with very prominent calcareous, white concretions.

Profile Description

Ap 0-25cm F23	Yellowish-brown, 10YR 5/4 (dry); very slightly gravelly silt loam; moderate coarse to fine subangular blocky structure; very slightly sticky and very slightly plastic (wet); friable to loose (dry); common micro and

few very fine, discontinuous, random, inped, interstitial and tubular open and closed pores; very few volcanic gravels and stones (fresh); common very fine to medium roots (and grass rhizomes); strongly calcareous; abrupt, wavy boundary.

A1b
25-58cm
F24

Dark grey 10YR 4/1 (dry); a few fine to medium, distinct, clear grey to white calcareous nodules; slightly gravelly silty clay loam; strong very coarse prismatic to very strong, medium blocky structure; sticky and plastic (wet); hard (dry); streak of brown, silty material seen in cracks; broken thick pressure faces (cutans or slickensides); a few micro and fine discontinuous, inped, interstitial and tubular, closed pores; very few small calcareous gravel (hard); very calcareous; a few fine and very fine roots; clear, irregular boundary.

Bbca
58-71cm
F25

Yellowish-brown, 10YR 5/4 (dry); common, medium to fine, distinct, clear to diffuse, white to greyish calcareous nodules; slightly gravelly silty clay loam; weak coarse prismatic to medium and fine subangular blocky structure; sticky and plastic (wet); hard (dry); thin, broken clay pressure coatings or slickensides; very few micro, common fine and a few fine discontinuous, random, inped, interstitial and tubular, closed pores; a very few volcanic gravel; frequent small, hard calcareous white nodules; strongly calcareous; very few fine and very fine roots; gradual, broken boundary.

Cbca
71+cm
F26

Brown, 10YR 4/3 (dry); common, medium, prominent, sharp, white to greyish calcareous nodules; slightly gravelly clay; strong medium prismatic to strong fine subangular blocky structure; sticky and plastic (wet); slightly hard (dry); broken, moderately thick clay pressure coatings and slickensides; very few micro, a few very fine discontinuous, random, inped, interstitial and tubular closed pores; a very few fresh volcanic gravels; frequent to very frequent , small and large, soft and hard, irregular white and grayish, calcareous nodules; very strongly calcareous; rare fine and very fine roots.

ANALYTICAL DATA FOR SITE F7

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
F23	0-25	Ap	vf	g,s	31.6	50.1	18.3	sil
F24	25-58	Alb	vf	g	12.2	38.8	49.1	sicl
F25	58-71	Bbca	vf	g	16.9	34.0	49.1	sicl
F26	71+	Cbca	vf	g	11.2	39.2	49.7	c

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.5 mm	Medium Sand .5-.25 mm	Fine Sand .25-0.1mm	Very Fine Sand 0.1-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
F23	1.4	2.1	1.9	3.1	23.0	28.4	13.1	8.6
F24	1.1	1.0	0.7	1.6	7.8	20.0	11.4	7.4
F25	2.8	2.2	1.1	1.6	9.1	19.4	14.6	0.0
F26	1.4	0.6	0.2	0.8	8.1	15.3	14.2	9.7

No.	pH 1:5	pH 1:1	EC mmhos (%)	Total N (%)	Organic Matter (ppm)	CaCO3 (%)	Avail. P	CEC meq/100g
F23	8.8	7.8	0.16	0.24	0.71	10.2	5.06	23.6
F24	8.9	7.8	0.23	0.20	1.03	11.8	3.68	41.0
F25	8.9	7.9	0.23	0.20	1.03	11.8	3.68	36.0
F26	9.0	8.1	0.38	0.10	0.20	17.4	3.68	46.6

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE F8

SITE INFORMATION

Classification: UDIC PELLUSTERT, FINE CLAYEY, MONTMORRILLONITIC, ISOTHERMIC FAMILY SILTY CAP PHASE
Date and time described: May 6, 1981, 12:15 PM
Authors: T. Forbes
Location: About 0.5km east of previous pit (FVII)
Elevation: 2230m
Physiographic position: Flat to concave slope
Topography of surrounding country: Edge of colluvial/alluvial toeslope and plain (Qa'Jahran proper)
Microtopography: Ridging by farmers
Slope: 2%
Land use: Barley trial on one side and forage trial on the other
Climate: Unknown

SOIL INFORMATION

Parent material: Lacustrine sediment mixed with alluvium/colluvium of volcanic rock outcrop and loess cap
Drainage class: Well drained with mottling starting at 108cm
Moisture conditions: Profile slightly moist at surface and moist with depth
Depth to groundwater: Unknown, but estimate that it may be within 2.5m
Surface stones or outcrops: A few surface stones; no rock outcrops
Evidence of erosion: No evidence of erosion
Salt content: No surface salt or alkali
Human influence: Very evident, have pulled up by plowing dark clayey layer into some parts of loess layer. Also have ridged and plowed for centuries

GENERAL DESCRIPTION OF THE PROFILE: Deep dark clayey profile with loess cap grading to gleyed clay at depth (about 140cm)

Profile Description

Ap 0-34cm F27	Dark yellowish-brown, 10YR 4/4 (moist); clay loam; moderate to weak, coarse to fine, subangular blocky structure; nonsticky and very slighly plastic (moist); common micro and a few fine and very fine, random, inped, discontinuous, interstitial and tubular, closed and open pores; very few volcanic gravel; strongly

calcareous; common fine and a few medium roots; abrupt, wavy to irregular boundary.

A1b
34-87cm
F28

Very dark grey 10YR 3/1 (moist); clay; weak prismatic to moderate medium to fine subangular blocky structure; nonsticky and slightly plastic (wet); friable (moist); patchy, thin, clay pressure coatings or slickensides; very few micro and a few fine, discontinuous, random, inped, interstitial and tubular, open and closed pores; very few volcanic gravel; calcareous; a few medium, fine and very fine roots; clear, wavy boundary.

IIC1ca
87-108cm
F29

Brown, 10YR 4/3 (moist); common, fine to medium, distinct clear, white to greyish calcareous nodules; clay loam; very slightly sticky and very slightly plastic (wet); very weak medium prismatic to moderate medium to fine subangular blocky structure; patchy, thin, clay pressure coatings or slickensides; a few micro, fine and very fine, discontinuous, random, inped, interstitial and tubular, closed and open pores; a few volcanic gravel and a few small mica flakes; frequent small to large, hard and soft, irregular white to grey calcareous nodules; strongly calcareous; very few very fine roots; gradual, wavy boundary.

IIC2ca
108-136cm
F30

Very dark greyish-brown, 10YR 3/2 matrix (moist) with light yellowish-brown 10YR 5/6 and yellowish-brown 10YR 5/4 limestone and decomposed limestone; clay loam; matrix with gravelly clay (decomposed rock); moderate coarse to fine subangular blocky structure; slightly sticky and slightly plastic matrix (wet) and sticky and plastic decomposed rock (wet); friable (moist) matrix) and firm (moist) decomposed rock); very thin and very patchy thin clay pressure coatings or slickensides in voids and pores; many micro and common fine discontinuous, random, inped, interstitial and tubular, closed and open pores; very frequent decomposed limestones and gravel and very few small mica flakes; very few small greyish calcareous nodules; strongly calcareous; a few fine roots; clear, wavy boundary.

IIICcag
136+cm
F31

Grey, 5YR 5/1 (moist) with common, medium, prominent, clear, yellowish-red 5YR 5/6 and 5YR 3/1 very dark grey mottles (stone remnants); clay; strong medium to fine subangular rock-like structure; sticky and plastic (wet); firm (moist); patchy thin clay pressure coatings or slickensides; common fine and medium discontinuous, random, inped, interstitial, closed pores; very strongly calcareous; no visible roots.

Note: Vertical cracks approximately 20cm deep and 2m long occasionally observed nearby.

ANALYTICAL DATA FOR SITE F8

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
F27	0-34	Ap	vf	g	29.8	43.8	26.4	cl
F28	34-87	A1b	vf	g	8.7	38.9	52.4	c
F29	87-108	IIC1ca	f	g	31.2	31.6	37.2	cl
F30	108-136	IIC2ca	vfr	s,g	31.5	29.3	36.3	cl
F31	136+	IIICcag	vf	-	5.1	36.8	58.1	c

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.5 mm	Medium Sand .5-.25 mm	Fine Sand .25-0.1mm	Very Fine Sand 0.1-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
F27	2.5	3.1	2.4	2.7	19.1	25.1	9.2	9.6
F28	.9	1.6	1.5	1.2	8.7	16.2	13.1	9.6
F29	4.3	8.8	7.4	4.0	6.8	18.4	10.3	3.0
F30	4.5	8.7	6.7	4.0	7.7	15.3	8.6	5.4
F31	0.3	0.5	0.4	1.1	2.9	18.6	14.1	4.1

No.	pH 1:5	pH 1:1	EC mmhos	Total N (%)	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	CEC meq/100g
F27	9.1	8.2	0.38	0.12	0.91	8.6	13.34	25.0
F28	8.5	7.9	2.4	0.06	0.88	6.2	32.2	47.9
F29	9.0	7.9	2.1	0.12	0.47	5.8	3.68	29.5
F30	8.7	7.9	2.1	0.10	0.37	5.8	5.52	34.2
F31	8.5	7.7	1.4	0.08	0.31	5.4	5.98	48.7

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE F9

SITE INFORMATION

Classification: TYPIC USTORTHENT, COARSE, LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: May 11, 1981 7:30 AM
Authors: T. Forbes
Location: Al Jabjab near Al Naderah Town (Wadi Bana); 300 m from secondary school stadium
Elevation: 2100m
Physiographic position: Terraced footslope of volcanic mountain
Topography of surrounding country: Sloping terraced land down to alluvial wadi bottom
Microtopography: Near washed-out gully; nearly level surface
Slope: Between terraces 29%; on terrace 10%
Land use: Previously cultivated for sorghum and lentil only, rainfed, never irrigated; now in fallow
Climate: Unknown

SOIL INFORMATION

Parent material: Colluvium from mountains and loess. Some water-transported sediments also from mountain and loess.
Drainage class: Well-drained
Moisture conditions: Profile slightly moist to dry throughout
Depth to groundwater: Unknown
Surface stones or outcrops: A few surface stones, no rock outcrops
Evidence of erosion: Profile intially exposed by gully erosion
Salt content: Calcareous material increases with depth
Human influence: Terrace-building

GENERAL DESCRIPTION OF THE PROFILE: Deep, well drained light brown silty then clay profile, calcareous mycelia increase with depth.

Profile Description

Ap 0-22cm F32	Dark yellowish-brown, 10YR 4/4 (moist); gravelly and slightly stony loam; weak medium to fine subangular blocky and crumb structure; nonsticky and slightly plastic (wet); very friable to loose (moist); many micro and common, very fine and fine discontinuous, random, inped, interstitial and tubular closed and open pores; frequent volcanic gravel and a few volcanic stones (fresh); calcareous; many medium and fine roots; gradual, wavy boundary.

C1
22-49cm
F33

Dark yellowish-brown, 10YR 4/4 (moist); with a few fine distinct, clear white calcareous mycelia; gravelly and stony loam; moderate coarse to fine subangular blocky and crumb structure; nonsticky and slightly plastic (wet); very friable (moist); common micro and a few very fine and fine, discontinuous, random, inped, interstitial and tubular, closed and open pores; frequent fresh volcanic gravel and a few fresh volcanic stones; calcareous; common medium and fine, and a few coarse roots; gradual, wavy boundary.

C2
49-115cm
F34

Yellowish-brown, 10YR 5/4 (moist); common, fine to medium, distinct clear, white, calcareous, mycelia; gravelly and stony, loam; moderate coarse to fine subangular blocky structure; nonsticky and nonplastic (wet); very friable (moist); soft (dry); many micro and common very fine and fine discontinuous, random, inped, interstitial and tubular, closed and open pores; frequent fresh volcanic gravel and stones; very few, small and some large, soft and spherical and irregular white calcareous nodules; strongly calcareous; a few medium and fine and some coarse roots; gradual, wavy boundary.

C3ca
115+cm
F35

Brown, 10YR 4/3 (moist); with many fine and medium distinct clear white calcareous mycelia; gravelly and stony clay loam; strong coarse to fine subangular blocky structure; slightly sticky and plastic (wet); friable (moist); slightly hard (dry); common very fine and fine discontinuous, random, inped, tubular, open and closed pores; frequent fresh volcanic gravel and stones; very few small and large soft, spherical and irregular, white calcareous nodules; strongly calcareous; very few medium and fine roots.

ANALYTICAL DATA FOR SITE F5

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
F32	0-22	Ap	fr	g,s	48.9	44.9	6.3	l
F33	22-49	C1	fr	g,s	51.9	36.8	11.3	l
F34	49-115	C2	fr	g,s	42.8	42.5	14.3	l
F35	115+	C3ca	fr	g,s	28.7	43.5	27.8	cl

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.5 mm	Medium Sand .5-.25 mm	Fine Sand .25-0.1mm	Very Fine Sand 0.1-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
F32	8.9	7.0	5.6	11.7	15.6	24.0	17.0	3.9
F33	10.5	7.6	6.2	12.4	14.8	21.3	11.6	3.9
F34	9.7	7.4	5.4	10.8	9.5	26.5	10.5	6.0
F35	9.6	4.7	2.9	6.1	5.5	35.6	1.6	6.3

No.	pH 1:5	pH 1:1	EC mmhos	Total N (%)	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	CEC meq/100/g
F32	8.4	7.8	0.19	0.12	1.34	150.8	2.3	0.0
F33	8.8	7.8	0.27	0.12	0.67	10.2	3.22	50.5
F34	8.7	7.9	0.95	0.10	0.47	10.2	3.22	50.0
F35	8.7	8.0	0.18	0.08	0.32	10.2	7.36	54.8

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE F10

SITE INFORMATION

Classification: TYPIC NATRUSTALF, FINE, CLAYEY, MIXED, ISOTHERMIC FAMILY
Date and time described: May 11, 1981, 7:30 AM
Authors: T. Forbes
Location: On secondary school sports field, Al Jabjab, Wadi Bana
Elevation: 2090m
Physiographic position: Terraced footslope of volcanic mountain
Topography of surrounding country: Sloping terraced land down to alluvial wadi bottom
Microtopography: Near washed-out gulley; nearly level surface
Slope: 7% between terraces, 4% on terraces
Land use: Previously cultivated for sorghum and lentil only, rainfed, never irrigated, now in fallow
Climate: Unknown

SOIL INFORMATION

Parent material: Mostly alluvium and volcanic colluvium from mountain with little loess cap on surface Drainage class: Well drained
Moisture conditions: Profile moist throughout
Depth to groundwater: Unknown (reported by locals to be about 3m)
Surface stones or outcrops: No surface stones or outcrops
Evidence of erosion: No evidence of erosion
Salt content: No alkali, shallow to calcareous zone
Human influence: Terrace constructed

GENERAL DESCRIPTION OF THE PROFILE: Deep, dark, clayey profile with silty surface. Calcareous accumulation in second horizon.

Profile Description

Ap 0-15cm F36	Brown, 10YR 4/3 (moist); very slightly gravelly silty clay (with some fine sand); moderate coarse to fine subangular blocky structure; non sticky and slightly plastic (wet); friable (moist); some evidence of clay movement in large pores (very few cutans); many micro and very few, fine and very fine, discontinuous, random, inped, interstitial and tubular, closed and open pores; very few fresh volcanic gravels and stones; calcareous; very few finer roots; clear, wavy boundary.

IIB21tca
15-91cm
F37

Very dark greyish-brown, 10YR 3/2 (moist); with common, medium, distinct, clear, white calcareous streaks; slightly stony and gravelly clay; very coarse to fine prismatic structure; sticky and plastic (wet); firm to friable (moist); continuous, moderately thick, clay cutans on peds and in large pores; a few fine and micro, discontinuous, random, inped, tubular and interstitial, open and closed pores; a few fresh volcanic gravels and rocks; strongly calcareous; very few very fine roots; abrupt, wavy boundary.

IIB22t
91+cm
F38

Black, 10YR 2.5/1 (moist); clay; very coarse to fine prismatic structure; sticky and plastic (wet); firm to friable (moist); continuous, thick, clay cutans on ped faces and in pores; very few micro and a few fine, discontinuous, random, inped, tubular and interstitial open and closed pores; very weakly calcareous.

Note: B2t appears to have become slowly calcareous by leaching of calcareous silty material above. Argillic horizon formed before the addition of calcareous loess material.

ANALYTICAL DATA FOR SITE F10

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
F36	0-15	Ap	vf	g,s	14.8	53.0	32.2	sicl
F37	15-91	IIB21tca		f	g,s	16.2	45.2	38.7
F38	91+	IIB22t	vf	-	4.4	49.7	45.9	sic

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.5 mm	Medium Sand .5-.25 mm	Fine Sand .25-0.1mm	Very Fine Sand 0.1-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
F36	3.5	2.3	1.5	3.3	4.3	30.6	13.9	8.5
F37	3.5	2.7	2.0	4.4	3.7	20.5	19.5	5.1
F38	0.3	0.5	0.4	1.1	2.2	22.9	19.0	7.8

No.	pH 1:5	pH 1:1	EC mmhos	Total N (%)	Organic Matter (%)	$CaCO_3$ (%)	Avail P (ppm)	CEC meq/100g
F36	8.6	7.9	0.28	0.12	0.75	12.4	7.82	44.3
F37	8.7	7.9	0.27	0.14	0.70	12.0	8.28	57.2
F38	8.8	7.9	0.21	0.22	0.70	11.0	6.9	61.9

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE F11

SITE INFORMATION

Classification: TYPIC TROPOFLUVENT, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: May 11, 1981, 11:45 AM
Authors: T. Forbes
Location: Wadi Al Mahmarah; 4km from Al Nadrah along Wadi Bana
Elevation: 2040m
Physiographic position: Alluvial terrace next to braided gravel, flowing wadi
Topography of surrounding country: Nearly flat alluvial terrace
Microtopography: Some ridging and construction of bunds made from boulders
Slope: 2-3%
Land use: Cropped under maize
Climate: Unknown

SOIL INFORMATION

Parent material: Alluvium mainly from volcanic rocks and calcareous loess in the drainage area
Drainage class: Well drained
Moisture conditions: Moist
Depth to groundwater: About 2.5m
Surface stones or outcrops: Some rounded boulders and stones
Evidence of erosion: Edge of terrace has been cut and eroded by flowing wadi
Salt content: No salt or alkali apparent
Human influence: Bund construction to trap wadi sediment and to prevent large-scale erosion

GENERAL DESCRIPTION OF THE PROFILE: Shallow silty/sandy, brown profile over rounded volcanic rock alluvium.

Profile Description

Ap 0-30cm F39	Brown, 10YR 4/3 (moist); loam (with fine sand) with a few rocks and gravel; weak coarse to fine subangular blocky and crumb structure; nonsticky and very slightly plastic; very friable to loose; many micro, common fine and medium, discontinuous, random, inped, interstitial and tubular, closed and open pores; very few, fresh, rounded volcanic, rocks and gravel; very slightly

calcareous; some small 2-3mm charcoal fragments; many fine, medium and coarse roots.

C1
30-60cm
P40

Dark greyish-brown, 10YR 4/2 (moist); fine sandy loam; weak coarse to fine subangular, blocky and crumb structure; nonsticky and nonplastic (wet); very friable (moist); many micro, common, fine and medium and a few coarse, discontinuous, random, inped, interstital and tubular, closed and open pores; a few fresh volcanic gravels; very slightly calcareous; common fine and medium roots; abrupt, wavy boundary.

C2
60+cm
P41

Dark brown, 10 YR 3/3 (moist); gravelly, very stony sandy loam; very weak medium to fine subangular blocky structure; nonsticky and nonplastic (wet); very friable (moist); common micro and a few fine, discontinuous, random, inped and interstitial, tubular, closed and open pores; many rounded fresh volcanic rocks and gravel; very slightly calcareous; one coarse and a few medium and fine roots.

ANALYTICAL DATA FOR SITE F11

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
F39	0-30	Ap	vf	s,g	39.9	43.0	17.1	l
F40	30-60	C1	f	g	54.2	31.3	14.5	sl
F41	60+	C2	fr	s,g	59.5	26.6	14.0	sl

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.5 mm	Medium Sand .5-.25 mm	Fine Sand .25-0.1mm	Very Fine Sand 0.1-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
F39	1.1	3.7	6.7	16.1	12.3	32.4	9.1	1.5
F40	1.3	7.2	12.3	22.7	10.7	22.7	7.6	1.1
F41	9.5	12.7	11.2	17.5	8.6	20.4	5.8	0.4

No.	pH 1:5	pH 1:1	EC mmhos	Total N (%)	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	CEC meq/100g
F39	8.6	7.6	0.35	0.32	1.86	10.0	8.74	32.2
F40	8.9	7.6	0.30	0.28	1.14	9.2	9.2	27.7
F41	8.6	7.8	0.30	0.28	1.07	8.6	11.5	25.5

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from .us Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K1

SITE INFORMATION

Classification: TYPIC TORRIORTHENT, COARSE LOAMY, MIXED, CALCAREOUS, ISOHYPERTHERMIC FAMILY
Date and time described: May 16, 1981
Authors: J. King and T. Forbes
Location: 14° 2' N 45° 9' E, 30km east of Ibb, just north of trail from Udayn to Hays (Tihama), 300m from Wadi Annah
Elevation: 1100m
Physiographic position: Convex footslope
Topography of surrounding country: Rolling
Microtopography: Nil
Slope: 15%
Land use: Range land, grazing. Similar soils in the immediate area are terraced but many of these terraces are longer farmed
Climate: 1. Annual rainfall: 450mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isohyperthermic

SOIL INFORMATION

Parent material: Calcareous loess, volcanic and metamorphic rocks
Drainage class: Well drained
Moisture conditions: Slightly moist throughout
Depth to groundwater: Unknown
Surface stones or outcrops: Class 1, Fairly stony but 60% of surface covered with gravel or stones
Evidence of erosion: Severe gully erosion
Salt content: Calcareous
Human influence: Nil

GENERAL DESCRIPTION OF THE PROFILE: Deep brown silt to loam profile with distinct layering of sedimentary deposits. Effect of reworked loess dominates soil characteristics.

Profile Description

C 0-15cm K1	Grayish-brown, 10YR 5/2 (moist); gravelly sandy loam; moderate to weak, medium to fine subangular blocky and crumb structure; nonsticky and slightly plastic (wet); very friable (moist); many micro, discontinuous, random, inped, interstitial, open and closed pores; few sharp volcanic and metamorphic fresh gravel; calcareous; common fine roots; abrupt, wavy boundary.

IIC
15-35cm
K2

Grayish-brown, 10YR 5/2 (moist); stony gravelly sandy loam; moderate to weak, medium to fine subangular blocky and crumb structure; nonsticky and slightly plastic (wet); very friable (moist); many micro, discontinuous, random, inped, interstitial, open and closed pores; few sharp volcanic and metamorphic fresh gravel; calcareous; common, fine roots; abrupt, wavy boundary.

IIIC
35-95cm
K3

Brown, 10 YR 5/3 (moist); slightly stony, gravelly loam; moderate, medium to fine, subangular blocky and crumb structure; nonsticky and nonplastic (wet); friable (moist); common micro and very fine, discontinuous, inped, interstitial, open pores; fresh, frequent, rounded volcanic and metamorphic stones and sharp gravel; common, medium to coarse, distinct, clear white calcareous nodules; calcareous; few fine roots; diffuse, wavy boundary.

IVC
95-191cm
K4

Light brownish-gray, 10YR 6/2 (moist); a few streaks of darker material resembling material above; slightly stony silt loam; moderate medium to fine, subangular blocky structure; nonsticky and very slightly plastic (wet); firm (moist); many very fine discontinuous, random, inped, tubular closed pores; frequent, large and small, soft and hard, irregular, calcareous, white nodules; strongly calcareous; very few coarse and fine roots; diffuse, wavy boundary.

VC
191+cm
K5

Brownish-yellow 10YR 6/6 (dry); common, coarse, distinct, clear, dark brown, 7.5YR 3/2 mottles; very slightly stony silty clay loam; strong, very coarse prismatic to strong subangular blocky structure; slightly sticky, slightly plastic (wet); hard (dry); common medium and many fine and very fine, discontinuous, vertical and random, inped, tubular, open and closed pores; frequent small to large, hard, irregular, white calcareous concretions; strongly calcareous; few fine and medium roots.

ANALYTICAL DATA FOR SITE K1

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K1	0-15	C	f	g	56.2	32.5	11.3	sl
K2	15-35	II	f	g	57.3	29.5	13.2	sl
K3	35-95	III	fr	s,g	25.5	48.6	25.9	l
K4	95-191	IV	f	s,g	8.8	69.1	22.1	sil
K5	191+	V	vf	s	3.8	62.2	34.0	sicl

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.05 mm	Medium Sand .5-.25 mm	Fine Sand .25-.01mm	Very Fine Sand .01-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
K1	14.3	13.3	9.7	13.6	5.3	23.8	8.7	0.0
K2	16.5	14.4	9.8	11.6	4.9	21.3	4.1	4.1
K3	5.8	4.6	3.9	6.2	4.9	30.3	15.4	2.9
K4	1.5	1.0	0.5	1.2	4.5	45.5	17.8	5.8
K5	0.6	0.5	0.3	0.8	1.6	37.7	17.5	7.0

No.	pH 1:5	pH 1:1	EC mmhos	Total N (%)	Organic Matter (%)	$CaCO_3$ (%)	Avail. P (ppm)	CEC meq/100g
K1	8.7	7.9	0.19	0.40	0.96	13.4	12.88	11.3
K2	8.9	7.9	0.18	0.22	0.55	10.5	8.28	15.6
K3	9.0	7.9	0.81	0.16	0.31	8.6	6.44	28.2
K4	9.3	8.0	0.85	0.16	0.18	7.2	5.52	34.0
K5	9.0	8.0	1.1	0.14	0.28	6.2	10.12	43.0

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K2

SITE INFORMATION

Classification: UDIC HAPLUSTOLL, FINE SILTY, MIXED, ISOTHERMIC FAMILY
Date and time described: May 17, 1981
Authors: J. King and T. Forbes
Location: One km northwest from Salaba Site at Ibb Agricultural School
Elevation: 1840m
Physiographic position: Terraced convex slope
Topography of surrounding country: Hilly
Microtopography: Terraced, flat with walls about 1 meter high
Slope: 25% between terraces; 1% on terraces
Land use: Sorghum and maize on terraces
Climate: 1. Annual rianfall: 950mm, 2. Soil moisture regime: Ustic-Udic, 3. Soil temperature regime: Isothermic

SOIL INFORMATION

Parent material: Loess deposit with reworked surface modified by farmers to build terraces
Drainage class: Well drained
Moisture conditions: Slightly moist down to 20cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: No significant erosion
Salt content: Calcareous throughout
Human influence: Terraced farming has significantly modified upper 30 to 150cm

GENERAL DESCRIPTION OF THE PROFILE: Deep dark calcareous silty profile with prismatic structure over light brown loess deposit.

Profile Description

Ap 0-20cm K6	Dark brown, 10YR 3/2 very dark greyish-brown (moist), 10YR 4/3 dark brown (dry rubbed); silty clay loam; moderate medium to fine subangular blocky and crumb structure; nonsticky and slightly plastic (wet); firm (moist); a few fine and many micro, discontinuous, random, inped, tubular and interstitial open pores; slightly calcareous; many fine and medium roots; clear, wavy boundary.

B 20-60cm K7	Dark brown, 10YR 3/2 very dark greyish-brown (moist); 10YR 4/2 dark greyish-brown (dry rubbed); silty clay loam; slightly sticky and slightly plastic (wet); very hard (dry); very strong coarse columnar to strong medium subangular blocky structure; a few fine and common micro, inped, discontinuous, random, tubular and interstitial open pores; calcareous; common fine and medium roots; gradual and wavy boundary.
C1 60-140cm K8	Dark brown, 7.5YR 3/2 (moist); silty clay loam; sticky and plastic (wet); very firm (moist); very strong coarse columnar to coarse subangular blocky structure; common fine and very fine discontinuous, random, inped, tubular, and vesicular, open and closed pores; a few small, soft, irregular calcareous nodules; many, fine, distinct, diffuse, white calcareous mycelia on peds; strongly calcareous; very few pieces of pottery; a few fine roots; a few fresh, volcanic gravels; diffuse, irregular boundary.
CIIca 140-170cm K9	Light yellowish-brown, 10YR 6/4 matrix with dark brown 10YR 4/3 material in cracks and former pores; silt loam; firm (moist); slightly sticky and slightly plastic (wet); common fine and many micro, discontinuous, random, inped, tubular open pores; many fine, distinct, diffuse calcareous mycelia; very few small, hard, angular, yellowish calcareous nodules; very strongly calcareous; a few fine roots; clear, wavy boundary.
CIIIca 170+cm K10	Very pale brown, 10YR 7/4 (dry); common, medium, distinct, clear, brownish material in tubular pores; very slightly gravelly silty clay loam; slightly plastic and nonsticky (wet); slightly hard (dry); common fine and many micro, discontinuous, random, inped, tubular, open pores; very few small hard, greyish, angular, calcareous nodules; few, fine, faint, clear, white calcareous mycelia; strongly calcareous; a few fine roots.

ANALYTICAL DATA FOR SITE K2

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K6	0-20	Ap	vf	g	5.2	63.1	31.7	sicl
K7	20-60	B	vf	g	3.9	64.2	31.9	sicl
K8	60-140	C1	f	g	4.8	59.0	36.2	sicl
K9	140-170	IICca	vf	g	3.7	66.8	29.5	sil
K10	170+	IIICca	vf	g	4.4	65.5	30.0	sicl

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.05 mm	Medium Sand .5-.25 mm	Fine Sand .25-.01mm	Very Fine Sand .01-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
K6	0.6	0.5	0.3	1.0	2.9	41.0	15.4	6.8
K7	0.2	0.3	0.3	0.9	2.2	35.5	15.4	15.3
K8	0.2	0.2	0.2	0.6	3.6	36.2	11.8	11.1
K9	0.1	0.2	0.2	0.4	2.9	47.3	14.7	4.9
K10	0.5	0.3	0.1	0.2	3.4	42.0	3.7	19.9

No.	pH 1:5	pH 1:1	EC mmhos	Total N (%)	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	CEC meq/100g
K6	8.2	7.7	0.21	0.38	2.79	6.8	0.92	39.2
K7	8.4	7.7	0.21	0.32	3.05	8.4	0.46	41.9
K8	8.3	7.7	0.22	0.20	2.23	10.8	0.46	42.9
K9	8.6	7.9	0.27	0.12	0.77	15.6	0.92	28.8
K10	9.0	7.7	0.27	0.18	0.56	23.0	0.92	28.9

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K3

SITE INFORMATION

Classification: UDIC HAPLUSTOLL, LOAMY-SKELETAL, MIXED, ISOTHERMIC FAMILY
Date and time described: May 17, 1981
Authors: J. King
Location: About 1km south of Ibb on gravel road 300m east of and parallel to Ibb-Taizz road.
Elevation: 1860m
Physiographic position: Terraced (formerly convex) colluvial footslope
Topography of surrounding country: Steep to rolling topography, footslope of volcanic mountain
Microtopography: Land has been terraced
Slope: 15% between terraces, 0.5% on terrace
Land use: Mostly sorghum and maize
Climate: 1. Annual rainfall: 1000mm, 2. Soil moisture regime: Ustic-Udic, 3. Soil temperature regime: Isothermic

SOIL INFORMATION

Parent material: Volcanic angular and some rounded gravels and stones, probably mixed with some loess
Drainage class: Well drained
Moisture conditions: Moist throughout
Depth to groundwater: No effect on profile
Surface stones or outcrops: Some loose stones on surface resembles desert pavement
Evidence of erosion: No significant erosion
Salt content: No alkali; some calcareous material with depth
Human influence: Terraced

GENERAL DESCRIPTION OF THE PROFILE: Deep, dark colluvial material of volcanic origin. Profile becomes increasingly calcareous with depth.

Profile Description

Ap 0-27cm K11	Dark brown, 10YR 3/2 (moist); slightly stony and gravelly silt loam; slightly sticky and slightly plastic (wet); friable (moist); weak medium to fine subangular blocky and crumb structure; many micro and very fine discontinuous, random, inped, tubular, open pores; a few fresh volcanic stones and gravel

(resembling desert pavement on surface); slightly calcareous; common fine and medium roots; clear, wavy boundary.

IIB
27-54cm
K12

Very dark greyish-brown, 10YR 3/2 (moist); very stony clay loam; slightly sticky and slightly plastic (wet); friable (moist); moderate medium subangular blocky to crumb structure; many fine and micro discontinuous, random, inped, tubular and interstitial, open pores; very frequent fresh volcanic stones and gravel; many fine, distinct, clear, white calcareous mycelia; strongly calcareous; common fine and a few medium roots; clear, wavy boundary.

IIIB
54-84cm
K13

Very dark greyish-brown, 10YR 3/2 (moist); gravelly loam; slightly sticky and slightly plastic (wet); friable (moist); moderate medium subangular blocky to crumb structure; many micro and very fine, discontinuous, random, inped, tubular, open pores; very frequent fresh volcanic gravel and a few fresh volcanic stones; many fine, distinct, clear, white, calcareous mycelia; a few fine and medium roots; strongly calcareous; clear, wavy boundary.

IVC
84-224cm
K14

Dark brown, 7.5 YR 3/2; gravelly, stony silty clay loam; slightly sticky and slightly plastic (wet); friable (moist); many micro and common fine, discontinuous, random, inped, interstitial and tubular pores; very frequent fresh volcanic gravel and stones; many fine, distinct, clear, white, calcareous mycelia; strongly calcareous; a few fine roots; clear, wavy boundary.

ANALYTICAL DATA FOR SITE K3

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K11	0-27	Ap	f	s,g	27.7	51.9	20.4	sil
K12	27-54	IIB	vfr	s,g	29.7	33.5	30.8	cl
K13	54-84	IIIB	vfr	g,s	41.5	36.5	21.4	l
K14	84-224	IVC	vfr	g,s	54.0	23.9	22.1	scl

No.	Very Coarse Sand 2-1mm	Coarse Sand 1-.05 mm	Medium Sand .5-.25 mm	Fine Sand .25-.01mm	Very Fine Sand .01-.05mm	Coarse Silt .05-.02mm	Medium Silt .02-.005mm	Fine Silt .005-.002mm
K11	6.9	4.4	3.0	5.6	7.8	36.1	13.5	5.3
K12	12.0	4.9	3.5	5.2	4.1	22.4	10.6	6.5
K13	14.3	9.1	5.1	6.9	6.1	19.4	12.8	4.4
K14	18.1	13.2	7.7	9.6	5.5	16.2	6.3	1.5

No.	pH 1:5	pH 1:1	EC mmhos	Total N (%)	Organic Matter (%)	CaCO3 (%) (ppm)	Avail. P	CEC meq/100g
K11	8.7	7.7	0.21	0.28	1.66	8.8	6.44	32.9
K12	8.7	7.8	0.23	0.24	1.02	8.8	2.76	42.6
K13	8.6	7.8	0.23	0.14	0.95	9.2	3.22	38.0
K14	8.6	7.6	0.28	0.12	0.26	9.4	4.6	34.8

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam sl-silt

SOIL PROFILE SITE K4

SITE INFORMATION

Classification: TYPIC TORRIORTHENT, COARSE LOAMY, MIXED, HYPERTHERMIC FAMILY, IRRIGATED PHASE
Date and time described: May 24, 1981
Authors: J. King
Location: Just across the Wadi Abida from the village of Al Hussan Al Ghujlah on the farm of Mr. M. Ahmet Ben-Ghlal in the Mareb governate 15° 29' N, 45° 25' E
Elevation: 1025m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: Field 20m x 20m between bunds 50cm high
Slope: Almost flat (2% slope)
Land use: Winter wheat stubble; winter wheat, barley or sorghum on a four-year rotation with alfalfa; the exact time of rotation determined by alfalfa yields
Climate: Annual rainfall is 50-100mm/yr. Rain comes in irregular showers in two distinct seasons: March-May and July-August. In winter, temperatures range from freezing to 37°C. In summer, from 17°C to 41°C. (page 9-11 in Electrowatt). Climate: 1. Annual Rainfall: >200 mm, 2. Soil Moisture Regime: Aridic, 3. Soil Temperature Regime: Hyperthermic

SOIL INFORMATION

Parent material: Recent alluvium
Drainage class: Well drained
Moisture conditions: Dry 0-55cm, slightly moist 55-105cm, moist 105-150cm
Depth to groundwater: 30m in nearby well
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: Calcareous
Human influence: Irrigated land surrounded by bunds 50cm high. Goat and sheep manure added to field in small quantities just prior to cropping

GENERAL DESCRIPTION OF THE PROFILE: Evidence of profile development is limited to concretions of fine textured material which have the same color as the matrix. These concretions are small (about 2mm), but present in the 10-55cm horizon and increase in size (to about 5mm) with depth until the 105-125cm horizon, below which they are not present.

Profile Description

A2 0-10cm K15	Very pale brown, 10YR 7/3 (dry); loam; moderate medium to fine subangular blocky to crumb structure; nonsticky, slightly plastic; soft (dry); many fine tubular pores; strongly calcareous; common medium to fine roots; clear, wavy boundary.
B21 10-55cm K16	Very pale brown, 10YR 7/3 (dry); silt loam; moderate coarse to medium subangular blocky structure; slightly sticky, slightly plastic; soft (dry); few fine tubular pores; frequent small soft, angular pale brown, nodules of fine materials same color as matrix; strongly calcareous; few micro to fine roots; gradual, wavy boundary.
B22 55-105cm K17	Brown, 10YR 5/3 (moist); silt loam; moderate coarse to fine subangular blocky structure; slightly sticky, slightly plastic; friable (moist); common fine tubular pores; frequent medium soft angular pale brown, nodules of fine materials the same color as the matrix; strongly calcareous; few medium to fine roots; abrupt, smooth boundary.
B23 105-125cm K18	Yellow brown, 10YR 5/4 (moist); silt loam; moderate coarse to fine subangular blocky and platy structure; slightly sticky, plastic; firm (moist); common fine tubular pores; strongly calcareous; few micro to fine roots; abrupt, smooth boundary.
C 125-150cm K19	Light yellowish-brown, 10YR 6/4 (moist); silt loam; moderate coarse to fine subangular blocky and platy structure; nonsticky, nonplastic, very friable (moist); strongly calcareous; tubular pores; few micro and fine roots; abrupt, smooth boundary.
IIC 150+cm K20	Very pale brown, 10YR 7/3 (moist); sand; structureless; nonsticky, nonplastic; loose non-coherent moist (dry); strongly calcareous; no roots.

ANALYTICAL DATA FOR SITE K4

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K15	0-10	A2	-	-	38	48	14	l
K16	10-55	B21	-	-	38	54	8	sil
K17	55-105	B22	-	-	30	56	14	sil
K18	105-125	B23	-	-	32	54	14	sil
K19	125-150	C	-	-	32	56	12	sil
K20	150+	IIC	-	-	90	6	4	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	Total N (%)
K15	7.6	0.97	0.77	15.2	2.30	0.20
K16	8.0	0.40	0.66	11.4	1.84	0.22
K17	8.1	0.39	0.59	10.8	3.22	0.12
K18	8.2	0.39	0.51	9.5	1.84	0.10
K19	8.2	0.32	0.33	8.2	1.84	0.16
K20	8.3	0.15	0.10	6.8	1.84	0.08

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K5

SITE INFORMATION

Classification: TYPIC TORRIFLUVENT, COARSE LOAMY, MIXED, HYPERTHERMIC FAMILY
Date and time described: May 25, 1981
Authors: J. King and A.E. Abu Ghanem
Location: 200m south of main road 2.5km west of Ma'rib, 15° 25' N, 45° 20' E
Elevation: 1100m
Physiographic position: On flat surface of deeply dissected terrace
Topography of surrounding country: Badlands
Microtopography: Severely eroded ancient abandoned terraces
Slope: 3° or 5%
Land use: Low intensity grazing
Climate: 1. Annual Rainfall: >200mm, 2. Soil Moisture Regime: Aridic, 3. Soil Temperature Regime: Hyperthermic.

SOIL INFORMATION

Parent material: Alluvium transported by water diverted by ancient Sabean dam
Drainage class: Well drained
Moisture conditions: Dry
Depth to groundwater: About 50m
Surface stones or outcrops: None
Evidence of erosion: Extensive gully erosion
Salt content: None, calcareous
Human influence: Originally accumulated because of ancient Sabean irrigation system.

GENERAL DESCRIPTION OF THE PROFILE: Uniform, pale brown appearance throughout.

Profile Description

C 0-45cm K21	Light yellowish-brown, 10YR 6/4 (dry); silt loam; moderate medium to very fine subangular blocky structure; slightly sticky, slightly plastic (wet); hard (dry); few fine tubular pores; few micro to fine roots; strongly calcareous; clear wavy, boundary.

IIC 45-67cm K22	Pale brown, 10YR 6/3 (dry); sandy loam; weak coarse to very fine subangular blocky structure; nonsticky, nonplastic, soft (dry); common fine tubular pores; strongly calcareous; no roots; gradual, irregular boundary.
IIIC 67-85cm K23	Light yellowish-brown, 10YR 6/4; (dry) silt loam; moderate coarse to fine subangular blocky structure; slightly sticky, slightly plastic (wet); hard (dry); few fine tubular pores; strongly calcareous; no roots; clear, wavy boundary.
IVC 85+cm K24	Light yellowish-brown, 10YR 6/4 (dry); loam to sandy loam; weak medium to fine subangular blocky structure; nonsticky, nonplastic (wet); slightly hard (dry); few fine tubular pores; strongly calcareous; no roots.

ANALYTICAL DATA FOR SITE K5

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K21	0-45	C	-	-	22	64	14	sil
K22	45-67	IIC	-	-	72	22	6	sl
K23	67-85	IIIC	-	-	28	68	4	sil
K24	85+	IVC	-	-	48	44	8	l-sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	$CaCO_3$ (%)	Avail. P (ppm)	Total N (%)
K21	7.5	5.0	0.38	20.8	4.18	0.14
K22	7.4	5.3	0.16	16.5	1.38	0.10
K23	7.4	13.0	0.59	13.2	5.58	0.26
K24	7.4	2.6	0.26	12.4	3.28	0.24

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K6

SITE INFORMATION

Classification: TYPIC TORRIORTHENT, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: May 29, 1981
Authors: J. King
Location: At new experiment farm 17 km northwest of Sadah, west of main road to Saudi Arabia
Elevation: 1910 m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: 1^{0}, 2%
Land use: Sparse, low native grasses and broadleaves
Climate: 1. Annual Rainfall: 200 mm, 2. Soil Moisture Regime: Aridic, 3. Soil Temperature Regime: Isothermic.

SOIL INFORMATION

Parent material: Alluvial and colluvial material from sandstone and granitic outcrops in mountains, loess
Drainage class: Well drained
Moisture conditions: Dry throughout
Depth to groundwater: Unknown, but no effect on profile
Surface stones or outcrops: None
Evidence of erosion: None at site--gully erosion in region
Salt content: Calcareous
Human influence: Nil

GENERAL DESCRIPTION OF THE PROFILE: Light colored silt cap over a burried A horizon. Beneath the burried A horizon there is a horizon which is lighter than the argillic horizon, but still darker than the IIC material beneath. A lithologic discontinuity with sandier texture is observed beneath the IIC horizon.

Profile Description

C 0-5cm K25	Light yellowish-brown, 10YR 6/4 (dry); slightly gravelly sandy loam; moderate thin platy in the surface 1cm then moderate to medium to very fine subangular blocky structure; nonsticky, nonplastic (wet); slightly hard dry; few medium tubular pores; few angular gravel fragments; strongly calcareous; common very fine roots; clear, smooth boundary.

IIA 5-16cm K26	Dark brown, 10YR 3/3 (dry); slightly gravelly sandy loam; moderate coarse to fine subangular blocky structure; nonsticky, nonplastic (wet); slightly hard (dry); few fine tubular pores; few angular weathered stones and gravel; strongly calcareous; common very fine roots; clear, wavy boundary.
IIB2 16-47cm K27	Dark yellowish-brown, 10YR 4/4 (dry); slightly gravelly sandy loam; moderate coarse to fine subangular blocky structure; nonsticky, slightly plastic (wet); slightly hard (dry); few fine tubular pores; few weathered angular gravel fragments; common calcium mycelia; strongly calcareous; common very fine roots; clear, irregular boundary.
IIC 47-90cm K28	Light yellowish-brown, 10YR 6/4 (dry); slightly stony and gravelly sandy loam; moderate medium to fine subangular blocky structure; nonsticky, nonplastic (wet); slightly hard (dry); few fine tubular pores; few angular weathered stones and gravel; strongly calcareous; common very fine roots; clear wavy boundary.
IIIC 90-150cm K29	Reddish-yellow, 5YR 6/6 (dry); slightly stony and gravelly sand; structureless; nonsticky, nonplastic (wet); loose, noncoherent (dry); few angular weathered stones and gravel; strongly calcareous; common very fine roots.

ANALYTICAL DATA FOR SITE K6

No.	Depth (cm.)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K25	0-5	C	f	g	72	16	12	sl
K26	5-16	IIA	f	s,g	60	28	12	sl
K27	16-47	IIB2	f	g	64	24	12	sl
K28	47-90	IIC	f	s,g	78	12	10	sl
K29	90-150	IIIC	f	s,g	91	1	8	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	Total N (%)
K25	8.1	0.15	0.38	6.8	2.76	0.14
K26	8.1	0.15	1.12	6.4	3.68	0.44
K27	8.2	0.19	0.64	6.4	2.30	0.16
K28	8.2	0.51	0.21	5.8	2.46	0.20
K29	8.4	0.56	0.18	5.6	3.68	0.12

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K7

SITE INFORMATION

Classification: TYPIC CALCIORTHID, COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: July 12, 1981
Authors: J. King
Location: One km south of Souk Al Uraysh, roadcut on west side of Taizz-Hudaydah road. 13° 23' N, 43° 38' E
Elevation: 445m
Physiographic position: Gently convex slope near summit of rise
Topography of surrounding country: Alluvial plain with scattered low hills with volcanic outcrops
Microtopography: None
Slope: 12% or 5°
Land use: Low intensity grazing
Climate: No accurate data, but rainfall more similar to Tihama than Taizz. Probably in the neighborhood of 400 mm coming in erratic storms during the summer months. With the use of bunds, poor crops of millet--apparently mainly for forage rather than grain--are grown in this region on the flat land.

1. Annual Rainfall: 300mm
2. Soil Moisture Regime: Aridic
3. Soil Temperature Regime: Isohyperthermic

SOIL INFORMATION

Parent material: Predominantly derived from granite and basalt alluvium
Drainage class: Well drained (Class 4)
Moisture conditions: Dry throughout
Depth to groundwater: Unknown, but probably 50+m. No effect on profile.
Surface stones or outcrops: Gravelly to stony desert pavement, class 2
Evidence of erosion: Moderate gully erosion in the immediate area
Salt content: Calcareous
Human influence: Nil

GENERAL DESCRIPTION OF THE PROFILE: Strongly calcareous in very gravelly, slightly stony alluvium. 0-15cm no visible carbonates, 15-45cm powdery calcite also calcite plating out on rocks; 45-70cm calcareous horizon; 70-200cm very few fine carbonate nodules. Some of the alluvial rocks and gravel showed advanced weathering.

Profile Description

A 0-15cm K30	Dark brown, 10YR 3/3 (moist) and light yellowish-brown, 10YR 6/4 (dry); gravelly, slightly stony silty clay loam; moderate medium to fine subangular, blocky structure; nonsticky, slightly plastic, very friable (moist); loose noncoherent (dry); few, fine tubular pores; strongly calcareous; few fine, common very fine roots; clear, wavy boundary.
IIBca 15-45cm K31	Pale brown, 10YR 4/3 (moist and dry); very gravelly, slightly stony sandy clay; moderate medium to fine subangular blocky structure; slightly sticky, slightly plastic (wet); very friable (moist); slightly hard (dry); very few fine tubular pores; strongly calcareous; common fine, a few very fine roots; abrupt, wavy boundary.
IICca 45-70cm K32	Pale brown, 10YR 6/3 (moist), white, 10YR 8/1 (dry); very gravelly, slightly stony sandy loam; moderate medium to fine subangular blocky structure; slightly sticky, slightly plastic; very friable (moist); slightly hard (dry); strongly calcareous; very few very fine roots; abrupt, smooth boundary.
IIIC 70-200cm K33	Grayish brown, 10YR 5/2 (moist) and light grey, 10YR 7/1 (dry); very gravelly, slightly stony sandy loam; weak medium to fine subangular blocky structure; nonsticky, slightly plastic (wet); very friable (moist); soft (dry); very few fine tubular pores; strongly calcareous; no roots.

ANALYTICAL DATA FOR SITE K7

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K30	0-15	A	f	g,s	15	58	27	sicl
K31	15-45	BIIca	fr	s,g	52	19	29	scl
K32	45-70	CIIca	fr	g,s	55	30	15	sl
K33	70-200	IIIC	fr	g,s	75	16	9	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	$CaCO^3$ (%)	Avail P (ppm)
K30	7.7	0.2	0.90	9.6	3.68
K31	7.4	7.7	0.57	13.8	1.92
K32	7.4	5.7	0.63	40.2	1.84
K33	7.5	4.9	0.63	11.0	1.22

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K8

SITE INFORMATION

Classification: TYPIC CALCIORTHID, LOAMY SKELETAL, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: July 13, 1981
Authors: J. King and A.E. Abu Ghanem
Location: 6km northeast of Souk Al Uraysh 40m east of Taizz-Hudaydah Rd , 13° 9' N 43° 41' E
Elevation: 495m
Physiographic position: Gently concave slope near foot of a low hill
Topography of surrounding country: Alluvial plain with scattered low hills with volcanic outcrops
Microtopography: Bank of shallow erosion gully
Slope: Sloping 9% or 5°
Land use: Low intensity grazing
Climate: No accurate data, but rainfall more similar to Tihama than to Taizz. Probably in the neighborhood of 400mm coming in erratic storms during the summer months. With the use of bunds, poor crops of millet, mainly apparently for forage rather than grain, are grown in this region on the flat land.
1. Annual rainfall: 300mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isohyperthermic

SOIL INFORMATION

Parent material: Basalt rocks and calcareous loess
Drainage class: Class 4, well drained
Moisture conditions: Slightly moist 15-40cm depth
Depth to groundwater: Unknown, but probably more than 50m, no effect on profile
Surface stones or outcrops: Class 2, stony. Gravel and stones cover the entire surface of the soil. Desert pavement.
Evidence of erosion: Slight gully erosion
Salt content: Calcareous
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Strongly calcareous throughout, but no visible carbonates 0-8cm. Carbonates forming mycellia and plating out on rocks 8-38cm; carbonate nodules very common at 38+cm.

Profile Description

C1 0-8cm K34	Very dark greyish-brown, 10YR 3/2 (moist) and brown, 10YR 5/3 (dry); very gravelly loam; weak fine to very fine subangular blocky structure; slightly sticky, slightly plastic (wet); very friable (moist); soft (dry); strongly calcareous; few micro roots; clear, wavy boundary.
C2ca 8-38cm K35	Brown, 10YR 4/3 (moist) and yellowish-brown, 10YR 5/3 (dry); very gravelly, slightly stony silt loam; weak fine to very fine, subangular, blocky structure; slightly sticky and slightly plastic (wet); very friable (moist); soft (dry); very few very fine tubular pores; carbonate mycelia and pebble coatings; strongly calcareous; no roots; clear, wavy boundary.
C3ca 38+cm K36	Dark yellowish-brown, 10YR 4/4 (moist) and yellowish-brown, 10YR 5/4 (dry); very gravelly , slightly stony silt loam; moderate, medium to very fine subangular blocky structure; slightly sticky, slightly plastic, very friable (moist); soft (dry); few, very fine tubular pores; very frequent small to large soft irregular, white, calcareous nodules; strongly calcareous; no roots.

ANALYTICAL DATA FOR SITE K8

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K34	0-8	C1	vfr	g	41	42	17	l
K35	8-38	C2ca	vfr	g,s	47	46	7	sl
K36	38+	C3ca	vfr	g,s	55	38	7	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	$CaCO_3$ (%)	Avail. P (ppm)
K34	7.6	1.6	1.05	15.6	3.22
K35	7.4	10.0	0.85	17.8	0.96
K36	7.2	7.4	1.05	35.4	0.32

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K5

SITE INFORMATION

Classification: TYPIC CALCIORTHID, LOAMY SKELETAL, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: July 16, 1981
Authors: J. King
Location: One km north of Al Barh on the Taizz-Hudaydah road at the site of the new hatchery east of the road just south of the village
Elevation: 710m
Physiographic position: Alluvial plain
Topography of surrounding country: Plain deeply dissected by wadis, scattered low hills in the plain
Microtopography: None
Slope: 2% or 1^0
Land use: Low intensity rangeland pasture
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isohyperthermic

SOIL INFORMATION

Parent material: Primarily calcareous loess and alluvium with granitic and basaltic rocks
Drainage class: Well drained
Moisture conditions: Dry
Depth to groundwater: 50-80m
Surface stones or outcrops: Class 2, desert pavement-gravelly to stony
Evidence of erosion: Moderate gully erosion
Salt content: Calcareous
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: This profile consists of the top 160cm of a freshly dug pit about 4m deep. There were visible carbonates -consisting of some plating on rocks and occasional soft nodules- in the top 15cm. Carbonates became more common from 15 to 30cm - resulting in a gradual boundary between the two horizons of this profile - and then are uniform to 160cm. Except for an irregular sand horizon which marked the end of the calcic horizon at 160cm and extended to about 210cm, the entire 4 meters of the soil exposed by this pit were made up of pale brown alluvium with dominant round weathered gravel and stones with a few round boulders.

Profile Description

C1ca
0-30cm
K37

Light yellowish-brown, 10YR 6/4 (dry), brown, 10YR 4/3 (moist); very gravelly and stony silt; moderate very fine subangular blocky to very fine crumb structure; very friable (moist); slightly sticky, slightly plastic, slightly hard (dry); few fine tubular pores; very frequent rounded, weathered gravel and stones; few micro roots; strongly calcareous; gradual, wavy boundary.

C2ca
30-160cm
K38

Dark yellowish-brown, 10YR 4/4 (moist) and light yellowish-brown, 10YR 6/4 (dry); very gravelly and very stony loam; moderate fine subangular blocky to very fine crumb structure; slightly sticky, plastic; very friable (moist); slightly hard (dry); very few fine pores; very frequent rounded weathered gravel and stones; strongly calcareous; very few micro roots.

ANALYTICAL DATA FOR SITE K9

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K37	0-30	C1ca	vfr	g,s	43	50	7	si
K38	30-160	C2ca	vfr	g,s	49	30	21	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K37	7.3	7.7	1.13	24.6	3.68
K38	7.5	2.2	0.63	36.6	3.22

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K10

SITE INFORMATION

Classification: TYPIC USTIFLUVENT, COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: July 19, 1981
Authors: J. King
Location: 1km north of Al Bahr on west side of wadi Bahr, 13° 28' N 43° 42' E
Elevation: 585m
Physiographic position: Alluvial plain
Topography of surrounding country: Flat
Microtopography: Small fields 0.1-0.75m; bunds and terraces 0.50 to 1.25m high
Slope: 1° or 2%
Land use: Irrigated millet, sorghum and date palm
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isohyperthermic

SOIL INFORMATION

Parent material: Fine alluvium
Drainage class: Well drained
Moisture conditions: Moist throughout
Depth to groundwater: 10m--no effect on profile
Surface stones or outcrops: None
Evidence of erosion: Undercutting of bank by stream
Salt content: Strongly calcareous
Human influence: Terraces, bunds, irrigation, cropping

GENERAL DESCRIPTION OF THE PROFILE: The profile is pale brown throughout with no layering or horizon development to a depth of two meters, below which is a layer of sand and gravel. These soils are dominant in the wadis of the region.

Profile Description

C 0-160cm K39(0-10cm) K40(50-60cm) K41(150-160cm)	Brown, 7.5YR 5/3 (moist), and pale brown, 10YR 6/3 (dry); silt loam; moderately strong coarse to very coarse prismatic breaking to coarse subangular blocky structure; sticky, plastic; friable (moist); slightly hard (dry); very few, coarse, discontinous, horizontal,

inped, ellipsodial, vesicular pores; strongly calcareous throughout; common very fine, and few medium roots.

ANALYTICAL DATA FOR SITE K10

No.	Depth (cm)	Horizon	Coarse Frag. >2mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2mm ***
K39	0-10	-	-	-	16	63	21	sil
K40	50-60	-	-	-	24	67	9	sil
K41	150-160	-	-	-	34	57	9	sil

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K39	8.1	0.39	0.75	18.0	2.30
K40	8.2	0.32	1.23	15.6	1.84
K41	8.2	0.38	0.88	12.4	1.84

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K11

SITE INFORMATION

Classification: TYPIC TORRIORTHENT, SANDY SKELETAL, CALCAREOUS, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: July 20, 1981
Authors: J. King and A. E. Abu Ghanem
Location: Northwest side of Taizz--Hudaydah Road at village of Al Gopeh, 1.4 km northeast of Hajdah, 13° 35 'N 43° 50' E
Elevation: 1000 m
Physiographic position: Terrace at foot of gently concave ravine between two peaks rising to 180m above profile site
Topography of surrounding country: Steeply dissected
Microtopography: Terraced
Slope: 40%, 18 degrees between terraces
Land use: Sorghum and millet
Climate: 1. Annual rainfall: 400mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isonyperthermic

SOIL INFORMATION

Parent material: Basaltic colluvium with some loess
Drainage class: Class 4, well drained
Moisture conditions: Slightly moist below 120 cm
Depth to groundwater: Unknown, but no effect on profile
Surface stones or outcrops: Class 1, fairly stony; 15% of surface covered
Evidence of erosion: Slight gully erosion
Salt content: Calcareous
Human influence: Terracing, millet cropping

GENERAL DESCRIPTION OF THE PROFILE: A terraced soil with uniform color and texture throughout, with gravel or stones. Mineral fragments in all horizons are sharply angular and fresh.

Profile Description

Ap 0-25cm K42	Dark brown, 10YR 3/3 (moist), and yellowish-brown, 10YR 5/4 (dry); very gravelly sandy loam; moderate, medium subangular blocky to granular structure; nonsticky, slightly to nonplastic (wet); very friable (moist); soft (dry); common very fine roots; very frequent angular fresh gravel; calcareous; clear, wavy boundary.

C1
25-99cm
K43

Very dark greyish-brown, 10YR 3/2 (moist) and yellowish-brown, 10YR 5/4 (dry); gravelly, stony silt loam; moderate fine to medium subangular blocky structure; nonsticky, slightly to nonplastic (wet); very friable (moist); soft (dry); few fine tubular pores; very frequent angular, fresh gravel and stones; calcareous; common fine roots; clear, wavy boundary.

C2ca
99-220cm
K44

Very dark brown, 10YR 3/3 (moist), and yellowish-brown, 10YR 5/4 (dry); sandy loam; moderate fine to medium subangular blocky structure; nonsticky, slightly to nonplastic (wet); very friable (moist); soft (dry); few fine tubular pores; free carbonates in soil and coating rocks; few very fine roots; clear, wavy boundary.

ANALYTICAL DATA FOR SITE K11

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K42	0-25	Ap	vfr	g	64	25	11	sl
K43	25-99	C1	fr	g,s	68	21	11	sl
K44	99-210	C2ca	-	-	66	23	11	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K42	8.2	0.14	0.56	11.4	3.22
K43	8.1	0.17	0.30	10.2	3.68
K44	7.8	0.38	0.30	12.8	3.68

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K12

SITE INFORMATION

Classification: TYPIC TORRIORTHENT, COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: July 26, 1981
Authors: J. King and A. E. Abu Ghanem
Location: 1/2 km northwest of old Taizz airport; 100m east of the Taizz-Hudaydah road, 13° 36' N 43° 57' E
Elevation: 1128m
Physiographic position: Narrow alluvial valley between old alluvial terraces
Topography of surrounding country: Steeply dissected alluvial terraces
Microtopography: Flat because of agricultural terracing
Slope: 3° or 5% between terraces; 1% on terrace
Land use: Rainfed sorghum
Climate: 1. Annual rainfall: 600mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isohyperthermic

SOIL INFORMATION

Parent material: Fine calcareous alluvium
Drainage class: Well drained
Moisture conditions: Slightly moist at 70-120cm.
Depth to groundwater: Unknown-no effect on profile
Surface stones or outcrops: Class 0, very few stones
Evidence of erosion: Slight gully erosion
Salt content: Calcareous.
Human influence: Terracing, bunding, cropping.

GENERAL DESCRIPTION OF THE PROFILE: Two strata of fine alluvium.

Profile Description

Ap 0-18cm K45	Dark yellowish-brown, 10YR 4/4 (moist); pale brown, 10YR 6/3 (dry); sandy loam; surface 1cm fine platy, the next weak medium to fine subangular blocky structure; slightly sticky, plastic (wet), firm (moist), slightly hard (dry); few fine tubular pores, strongly calcareous; very frequent very fine and very few medium roots; clear, irregular boundary.

IIC 18-150cm K46	Brown, 7.5 YR 5/4 (dry) and strong brown, 7.5 YR 3/4 (moist); clay loam; moderate medium to coarse prismatic structure; sticky, plastic; friable (moist); very hard (dry); few fine tubular pores; strongly calcareous; few fine to very fine roots.

ANALYTICAL DATA FOR SITE K12

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K45	0-18	Ap	-	-	25	51	24	sl
K46	18-150	IIC	-	-	23	45	32	cl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K45	7.9	0.49	1.12	10.0	4.14
K46	7.6	0.63	0.63	12.4	3.68

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from .ce Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K13

SITE INFORMATION

Classification: TYPIC HAPLARGID, FINE LOAMY, MIXED, HYPERTHERMIC FAMILY
Date and time described: July 27, 1981
Authors: J. King and A. E. Abu Ghanem
Location: 100m south of the west end of the old Taizz airport landing strip. West of Taizz on the Taizz-Hudaydah road, 13° 36' N 43° 57' E.
Elevation: 1120m
Physiographic position: Convex slope 20m from crest of alluvial terrace
Topography of surrounding country: Hilly
Microtopography: None
Slope: 12° or 22%
Land use: Scattered cactus, low grass, low intensity grazing
Climate: 1. Annual rainfall: 600mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Hyperthermic

SOIL INFORMATION

Parent material: Dominantly coarse, granitic alluvium and calcareous loess
Drainage class: Class 4, well drained
Moisture conditions: Dry throughout
Depth to groundwater: Not known, no effect on profile
Surface stones or outcrops: Class 4, exceedingly stony and gravelly
Evidence of erosion: Severe gully erosion
Salt content: Calcareous
Human influence: Nil

GENERAL DESCRIPTION OF THE PROFILE: Four distinct horizons are very apparent in the profile. A light-colored, finely textured surface horizon, a pale brown horizon which proved upon closer examination to have three strata, a light-colored horizon and under that a dark reddish-brown buried soil. This last horizon is of particular interest because it is not calcareous and has large nodules of yellowish-white crystalline material in it. Some similar nodules can also be found in the overlying calcic horizon.

Profile Description

IIA2
0-10cm
K47

White, 2.5YR 8/2 (dry) and light yellowish-brown, 10YR 6/4 (moist); gravelly sandy loam; structureless; nonsticky and nonplastic (wet); very friable (moist); loose, noncoherent (dry); weathered gravel; strongly calcareous; very frequent, very fine and very few medium roots; clear, wavy boundary.

A2
10-28cm
K48

Brown, 10YR 4/3 (moist) and brown, 10YR 4/3 (dry); slightly gravelly loam; nonsticky and nonplastic (wet); very friable (moist) and soft (dry); few very fine tubular pores; weathered gravel; strongly calcareous; very frequent very fine and very few medium roots; gradual, wavy boundary.

IIBtca
28-43cm
K49

Brown, 10YR 4/3 (moist) and dark yellowish-brown, 10YR 4/4 (dry); slightly gravelly clay loam; weak medium prismatic structure; nonsticky and very slightly plastic (wet); very friable (moist); soft (dry); few very fine tubular pores; weathered gravel; strongly calcareous; frequent very fine and very few medium roots; clear, wavy boundary.

IIIBtca
43-55cm
K50

Dark yellowish-brown, 10YR 4/4 (moist), light yellowish-brown, 10YR6/4 (dry); slightly gravelly clay loam; moderate medium prismatic structure; sticky, slightly plastic (wet); very friable (moist); slightly hard (dry); weathered gravel; frequent large sphereical, white, soft, calcareous nodules; common very fine roots; abrupt, smooth boundary.

IIIC
55-93cm
K51

Light yellowish-brown, 10YR 6/4 (moist), white 10YR 8/2 (dry); slightly gravelly sandy loam; weak medium and fine subangular blocky structure; nonsticky and nonplastic (wet); very friable (moist); soft (dry); weathered gravel; frequent, large, irregular, white, calcareous nodules; few, very fine roots; clear, wavy boundary.

IVC
93-150+cm
K52

Brown, 10YR 4/3 (moist), pale brown, 10YR 6/3 (dry); slightly gravelly silt loam; moderately strong subangular blocky structure; slightly sticky and very slightly plastic (wet); very friable (moist); soft (dry); frequent vertically elongated large white nodules; noncalcareous; very few fine roots.

ANALYTICAL DATA FOR SITE K13

No.	Depth (cm) 2 mm	Horizon Frag.	Coarse Frag. 2-.05 *	Size Coarse .05- **	Total Sand <.002 mm	Total Silt <2 mm .002mm	Total Clay mm	Texture ***
K47	0-10	A2	fr	g	59	31	10	sl
K48	10-28	A2	f	g	43	33	24	l
K39	28-43	Btca	f	g	35	35	30	cl
K40	43-55	Btca	f	g	29	37	34	cl
K41	55-93	C	f	g	53	39	8	sl
K42	93-150+	IIC	f	g	35	55	10	sil

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K47	7.6	1.80	2.05	8.8	2.30
K48	7.6	1.95	2.00	10.0	5.52
K49	7.7	2.00	1.63	14.6	3.68
K50	7.6	2.10	1.12	14.8	4.60
K51	7.6	2.80	0.63	8.0	2.22
K52	7.5	3.10	0.33	4.0	1.38

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K14

SITE INFORMATION

Classification: TYPIC TORRIORTHENT, COARSE LOAMY, MIXED, HYPERTHERMIC FAMILY
Date and time described: July 28, 1981
Authors: J. King and A. E. Abu Ghanem
Location: 125m south if the west end of the old Taizz airport landing strip. West of Taizz on the Taizz-Hudaydah raod, 13° 36' N, 43° 57' E
Elevation: 1100m
Physiographic position: Within 30m of base of alluvial terrace, slightly concave slope
Topography of surrounding country: Hilly
Microtopography: None
Slope: 13° or 23%
Land use: Scattered cactus, low grass, and low intensity grazing
Climate: 1. Annual rainfall: 600mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Hyperthermic

SOIL INFORMATION

Parent material: Granitic alluvium and calcareous loess
Drainage class: Well drained
Moisture conditions: Moist below 43cm
Depth to groundwater: Not known - no effect
Surface stones or outcrops: Exceedingly stony and gravelly
Evidence of erosion: Gully erosion
Salt content: Calcareous
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: A pale brown soil with frequent gravel and a few stones.

Profile Description

A 0-13cm K53	Dark brown, 10YR 4/3 (moist) and pale brown, 10YR 6/3 (dry); gravelly and slightly stony loam; weak medium subangular blocky structure; nonsticky and slightly plastic (wet); very friable (moist); soft (dry); few fine tubular pores; few stones, frequent gravel, weathered and somewhat rounded; strongly calcareous; very frequent very fine roots; clear, wavy boundary.

B11 13-30cm K54	Dark brown, 10YR 4/3 (moist), and pale brown, 10YR 6/3 (dry); slightly gravelly, slightly stony loam; weak medium prismatic and subangular blocky structure; slightly sticky and slightly plastic (wet); very friable (moist); slightly hard (dry); few fine tubular pores; few somewhat rounded, weathered stones and gravel; strongly calcareous; frequent very fine roots; clear, wavy boundary.
B12ca 30-122cm K55	Dark yellowish-brown, 10YR 4/4 (moist) and pale brown, 10YR 6/3 (dry); gravelly and stony loam; weak, medium subangular blocky structure; nonsticky and slightly plastic (wet); very friable (moist); slightly hard (dry); few fine tubular pores; frequent somewhat rounded, weathered gravel and stones; common very fine roots; clear, wavy boundary.
C 122-184cm K56	Dark brown, 7.5YR 4/4 (wet) and pale brown, 10YR 6/3 (dry); gravelly loam; moderate medium subangular blocky structure; nonsticky and slightly plastic (wet); very friable (moist); somewhat hard (dry); few fine tubular pores; frequent somewhat rounded weathered gravel; strongly calcareous; few very fine roots; clear, wavy boundary.
IIC 184+cm K57	Dark yellowish-brown 10YR 4/6 (moist) and light yellowish-brown, 10YR 6/4 (dry); clay loam; moderate coarse subangular blocky structure; nonsticky and slightly plastic (wet); very friable (moist); somewhat hard (dry); few fine tubular pores; strongly calcareous; few very fine roots.

ANALYTICAL DATA FOR SITE K14

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K53	0-13	A	fr	s,g	34	46	20	l
K54	13-30	B11	f	s,g	42	40	18	l
K55	30-122	B12ca	fr	s,g	40	34	26	l
K56	122-184	C	fr	g	32	34	34	cl
K57	184+	IIC	-	-	38	38	28	cl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K53	7.9	0.35	1.55	12.2	5.52
K54	8.0	0.32	1.50	14.0	6.14
K55	8.0	0.26	0.88	16.8	6.44
K56	8.0	0.62	0.75	18.6	5.06
K57	8.1	0.75	0.25	19.2	5.52

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K15

SITE INFORMATION

Classification: TYPIC FLUVAQUENT, FINE CLAYEY, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: July 28, 1981
Authors: J. King and A. E. Abu Ghanem
Location: 150m north of Taizz-Hudaydah Road in Wadi Hathran, 12km west of Taizz
Elevation: 1040m
Physiographic position: Valley
Topography of surrounding country: Flat, but steeply dissected in immediate area
Microtopography: Nil
Slope: 1^0 or 2%
Land use: Short tubular, grasslike sedges; used for intensive grazing.
Climate: 1. Annual rainfall: 600mm, 2. Soil moisture regime: Aridic region, but specific site is poorly drained and therefore aquic moisture regime, 3. Soil temperature regime: Isohyperthermic

SOIL INFORMATION

Parent material: Fine alluvium
Drainage class: Poorly drained
Moisture conditions: Profile moist throughout
Depth to groundwater: 43cm
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: Calcareous
Human influence: Formerly irrigated

GENERAL DESCRIPTION OF THE PROFILE: A shallow brown surface horizon separated by a grey horizon from the water table which is at 43cm.

Profile Description

I- IIA1 0-12cm K58	Greyish-brown, 10YR 5/2 (dry), dark greyish-brown, 10YR 4/2 (moist); silty clay; strong medium subangular blocky structure; slightly sticky, plastic friable (moist); hard (dry); strongly calcareous; common medium roots; irregular, gradual boundary.

IIC 12-43cm K59	Grey, 10YR 6/1 (dry); grey, 10YR 5/1, (wet); clay; strong, coarse subangular blocky structure; slightly sticky; plastic (wet); friable (moist); extremely hard (dry); strongly calcareous; few fine roots.

ANALYTICAL DATA FOR SITE K15

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K58	0-12	I-IIA1	-	-	8	46	46	sic
K59	12-43	IIC	-	-	2	34	64	c

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K58	7.2	1.10	2.50	24.3	6.10
K59	7.6	0.45	1.25	25.1	5.06

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K16

SITE INFORMATION

Classification: TYPIC USTORTHENT, FINE SILTY, MIXED, ISOTHERMIC FAMILY
Date and time described: August 11, 1981
Authors: J. King and A.E. Abu Ghanem
Location: 1km northeast of the village of Sabaran north of the town of Al Turbah 13° 14' N 44° 8' E
Elevation: 2050m
Physiographic position: Terraced convex slope
Topography of surrounding country: Rolling
Microtopography: Flat because of terracing
Slope: 3.5° or 6%
Land use: Sorghum and beans, intercropped
Climate: 1. Annual rainfall: 375mm(?), 2. Soil moisture regime: Aridic?, 3. Soil temperture regime: Isothermic

SOIL INFORMATION

Parent material: Loess - soil stable enough that no stone wall required to maintain terrace
Drainage class: Class 4, well drained
Moisture conditions: Slightly moist below 30cm
Depth to groundwater: Unknown, no effect on profile
Surface stones or outcrops: None
Evidence of erosion: Slight sheet erosion
Salt content: Calcareous
Human influence: Terraced, cropped

GENERAL DESCRIPTION OF THE PROFILE: Uniform light brown silty soil.

Profile Description

Ap 0-25cm K60	Dark brown, 10YR 3/3 (moist) and light yellowish-brown, 10YR 6/4 (dry); silt loam; moderate coarse subangular blocky to crumb structure; sticky and plastic (wet); friable (moist); soft (dry); few very fine tubular pores; strongly calcareous; frequent very fine and fine, few medium, very few coarse roots; clear, smooth boundary.

C 25-150+cm K61	Brown, 10YR 5/3 (moist) and pale brown, 10YR 6/3 (dry); silt loam; moderately strong coarse prismatic structure; sticky and slightly plastic (wet); firm (moist); hard (dry); patchy, moderately thick cutans, possibly of clay materials in pores and on ped faces; common very fine tubular pores; strongly calcareous; few, medium roots.

ANALYTICAL DATA FOR SITE K16

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K60	0-25	Ap	-	-	16	68	16	sil
K61	25-150+	C	-	-	14	60	26	sil

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K60	7.8	0.25	1.15	20.4	6.90
K61	7.9	0.23	0.43	24.0	5.06

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K17

SITE INFORMATION

Classification: TYPIC USTORTHENT, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: August 11, 1981
Authors: J. King and A.E. Abu Ghanem
Location: 1/2 km south of the village of Sabaran near the town of Turbah, 13° 13' N 44° 8' E
Elevation: 1995m
Physiographic position: Valley
Topography of surrounding country: Hilly
Microtopography: Man-made terraces
Slope: 3° or 5%
Land use: Currently fallow used for light grazing, surrounding fields planted with sorghum and beans
Climate (estimated): 1. Annual rainfall: 375mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isothermic

SOIL INFORMATION

Parent material: Fine calcareous alluvium and volcanic colluvium
Drainage class: Class 4, well drained
Moisture conditions: Dry throughout
Depth to groundwater: Unknown, no effect on profile
Surface stones or outcrops: Fairly stony, very gravelly
Evidence of erosion: Slight rill erosion
Salt content: Calcareous
Human influence: Terraced, cropped

GENERAL DESCRIPTION OF THE PROFILE: Uniform reddish-brown gravelly silty soil throughout.

Profile Description

Ap 0-5cm K62	Dark brown, 7.5YR 3/4 (moist), and brown, 7.5YR 5/4 (dry); slightly gravelly and stony sandy loam; weak crumb structure; nonsticky and slightly plastic (wet); very friable (moist); loose, noncoherent (dry); few fresh angular gravel and stones; strongly calcareous; common very fine and few fine roots; clear, smooth boundary.

C 5-25cm K63	Dark reddish-brown, 7.5YR 3/3 (moist) and brown, 7.5YR 4/4 (dry); slightly gravelly and stony loam; moderate coarse subangular blocky structure; slightly sticky and slightly plastic (wet); friable (moist); slightly hard (dry); few fine tubular pores; few fresh angular stones and gravel; strongly calcareous; few fine and very fine roots; diffuse, wavy boundary.
IIC 25-150+cm K64	Dark reddish-brown, 7.5YR 3/3 (moist) and reddish-brown, 5YR 4/4 (dry); slightly gravelly and stony sandy loam; strong coarse subangular blocky structure; slightly sticky and slightly plastic (wet); friable (moist); hard (dry); few fine tubular pores; few fresh angular gravel and stones; common calcareous mycelia; few very fine roots.

ANALYTICAL DATA FOR SITE K17

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K62	0-5	Ap	f	g,s	54	30	16	sl
K63	5-25	C	f	s,g	46	39	15	l
K64	25-150+	IIC	f	g,s	54	33	13	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K62	7.8	0.15	0.30	9.8	4.60
K63	7.8	0.21	0.30	12.6	3.68
K64	7.8	0.30	0.25	13.8	3.60

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K18

SITE INFORMATION

Classification: TYPIC CALCIORTHID, LOAMY SKELETAL, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: August 12, 1981
Authors: J. King and A. E. Abu Ahaum
Location: Hill immediately southeast of SURDUP Nursery at Warazan, 13° 25' N 44° 14' E
Elevation: 1109m
Physiographic position: Convex slope
Topography of surrounding country: Steeply dissected alluvial terraces
Microtopography: None
Slope: 30% or 16.5°
Land use: Scattered low bushes and very few grasses or broadleaves used for low intensity grazing
Climate: 1. Annual rainfall: 425 mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isohyperthermic

SOIL INFORMATION

Parent material: Coarse granitic alluvium and calcareous loess
Drainage class: Well drained
Moisture conditions: Moist below 87cm
Depth to groundwater: Not known, no effect in profile
Surface stones or outcrops: Class 4, exceedingly stony
Evidence of erosion: None
Salt content: Calcareous
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: This profile is dominated by rounded weathered alluvial gravel and stones with visible calcium in the two lower horizons and the two upper horizons differentiated by easily apparent differences in color, structure, and the related factor of root quantity.

Profile Description

A1 0-9cm K65	Brown, 10YR 4/3 (moist); brown, 10YR 5/4 (dry); gravelly stony loam; moderate crumb structure; sticky nonplastic, very friable (moist); soft (dry); frequent rounded weathered gravel and stones; very frequent fine and common coarse roots; clear, wavy boundary.

B 9-48cm K66	Dark yellowish-brown, 10YR 4/4 (moist); pale brown, 10YR 6/3 (dry); gravelly stony loam; weak crumb structure; nonsticky, nonplastic, very friable (moist); soft (dry); few, coarse, discontinuous horizontal inped vesicular pores; frequent rounded weathered gravel and stones; strongly calcareous; common fine roots; diffuse, wavy boundary.
Cca 48-87cm K67	Dark yellowish-brown, 10YR 4/4 (moist); very pale brown, 10YR 7/4 (dry); gravelly, stony loam; moderate, medium subangular blocky structure; nonsticky, nonplastic, friable (moist); slightly hard (dry); few medium to coarse discontinous horizontal inped vesicular frequent gravel and stones, few boulders, rounded weathered; strongly calcareous; few very fine roots; diffuse, wavy boundary.
C 87-200+cm K68	Strong brown, 7.5YR 5/6 (moist); yellowish-brown, 10YR 5/4 (dry); gravelly, stony loam; weak moderate subangular blocky structure; nonsticky, nonplastic (wet); very friable (moist); soft (dry); frequent gravel and stones, few boulders, weathered rounded; few large, soft irregular white calcareous nodules; strongly calcareous; very fine roots.

ANALYTICAL DATA FOR SITE K18

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K65	0-9	A1	fr	g.s	56	35	9	sl
K66	9-48	B	fr	g,s	56	35	9	sl
K67	48-87	Cca	fr	g,s	46	39	15	l
K68	87-200+	C	fr	g,s,b	76	17	17	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K65	7.7	0.23	2.13	21.0	17.48
K66	7.5	1.40	1.63	28.6	8.74
K67	7.5	4.50	0.50	42.4	6.60
K68	7.5	1.50	0.13	11.6	5.52

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K19

SITE INFORMATION

Classification: TYPIC USTORTHENT, SANDY SKELETAL, MIXED, ISOTHERMIC FAMILY
Date and time described: August 13, 1981
Authors: J. King and A.E. Abu Ghanem
Location: In Wadi Wazaran 250m northeast of SURDUP nursery, 13° 25' N, 44° 14' E
Elevation: 1061m
Physiographic position: Valley bottom
Topography of surrounding country: Steeply dissected
Microtopography: None
Slope: 3° or 5%
Land use: Scattered low bushes and broadleaves, very scattered clumps of grass
Climate: 1. Annual rainfall: 375mm, 2. Soil moisture regime: aridic for region but because of location of this soil near the bottom of the wadi it has at least an ustic and possibly a udic moisture regime, 3. Soil temperature regime: Isothermic.

SOIL INFORMATION

Parent material: Fresh sandy skeletal alluvium
Drainage class: Class 5, somewhat excessively drained
Moisture conditions: Moist throughout
Depth to groundwater: 2.5m to level of flowing stream
Surface stones or outcrops: Stony
Evidence of erosion: Undercutting of stream bank
Salt content: Slightly calcareous
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Gray, sandy skeletal, stratified fresh alluvium with a very apparent horizon at 50cm where rocks and gravel are dominant.

Profile Description

C 0-50cm K69	Very dark greyish-brown, 10YR 3/2 (moist) and light greyish-brown, 10YR 6/2 (dry); gravelly, stony sand; structureless; nonsticky and nonplastic (wet); loose, noncoherent (moist); loose noncoherent (dry); frequent rounded fresh gravel and stones; slightly calcareous; few very fine roots; clear, smooth boundary.

IIC 50-63cm K70	No soil - just gravel and stones.
IIIC 63-130+cm K71	Dark yellowish-brown, 10YR 4/2 (moist) and grey, 10YR 5/1 (dry); gravelly, stony sand; structureless; nonsticky and nonplastic (wet); loose, noncoherent (moist); loose, noncoherent (dry); frequent gravel and stones, few boulders, fresh and rounded; strongly calcareous; very few fine to medium roots.

ANALYTICAL DATA FOR SITE K19

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K69	0-50	C	fr	g,s	90	5	5	s
K70	50-63	IIC	fr	g,s	-	-	-	-
K71	63-130+	IIIC	fr	g,s	94	1	5	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K69	7.8	0.35	0.30	9	4.60
K70	-	-	-	-	-
K71	7.9	0.34	0.38	2.76	7.2

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K20

SITE INFORMATION

Classification: TYPIC USTIFLUVENT, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: August 13, 1981
Authors: J. King and A. E. Abu Ghanem
Location: In Wadi Wazaran 500m northeast of SURDUP nursery 13° 25' N, 49° 14' E
Elevation: 1072m
Physiographic position: Valley bottom
Topography of surrounding country: Steeply dissected
Microtopography: Terraced
Slope: 2° or 4%
Land use: Sorghum and beans
Climate: 1. Annual rainfall: 375mm, 2. Soil moisture regime: Aridic for region but because of location of this soil near the bottom of the wadi it has at least a ustic and possibly a udic moisture regime, 3. Soil temperature regime: Isothermic.

SOIL INFORMATION

Parent material: Fine alluvium
Drainage class: Class 4, well drained
Moisture conditions: Moist throughout
Depth to groundwater: 6-10m
Surface stones or outcrops: Class 0, very few stones
Evidence of erosion: Moderate rill erosion at edges of terraces
Salt content: Calcareous
Human influence: Terraces 75cm high

GENERAL DESCRIPTION OF THE PROFILE: Ap horizon is more vivid due to light rainfall the previous night; otherwise pale brown throughout with the only horizon differentiation due to crumb structure in the Ap.

Profile Description

Ap 0-25cm K72	Dark brown, 10YR 3/3 (moist) and brown, 10YR 5/3 (dry); sandy loam; coarse moderate subangular blocky to crumb structure; nonsticky and nonplastic (wet); friable (moist); slightly hard (dry); very few fine tubular pores; common worm casts; strongly calcareous; common fine to medium roots; clear, wavy boundary.

C 25-75cm K73	Brown, 10YR 4/3 (moist) and pale brown, 10YR 6/3 (dry); loam; coarse moderate prismatic structure; nonsticky and nonplastic (wet); firm (moist); slightly hard (dry); very few fine tubular pores; very few rounded and weathered gravel; strongly calcareous; common fine and few medium to coarse roots.
C 75-125cm K74	Same description as above, only sampled to test for fluvent classification

ANALYTICAL DATA FOR SITE K20

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K72	0-25	Ap	-	-	62	25	13	sl
K73	25-75	C	vf	g	50	37	13	l
K74	75-125	C	vf	g	36	44	20	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K72	7.7	0.30	1.00	14.0	5.98
K73	8.0	0.40	0.63	16.4	3.46
K74	8.0	0.45	0.55	20.8	7.22

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K21

SITE INFORMATION

Classification: TYPIC USTIFLUVENT, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: August 18, 1981
Authors: J. King and A. E. Abu Ghanem
Location: In Jabe region southeast of Taizz 200m northeast of village of Habub in Al Masrah subgovernate (farm of Abul Ghani Gaid Noman) 13° 28' N, 44° 2' E
Elevation: 1330m
Physiographic position: Convex slope
Topography of surrounding country: Rolling
Microtopography: Contour terracing
Slope: 6° or 12%
Land use: Scattered Aelb trees, irrigated corn
Climate: 1. Annual rainfall: 600mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isothermic.

SOIL INFORMATION

Parent material: Loess and alluvium from mountain with granitic outcrops
Drainage class: Class 4, well drained
Moisture conditions: Moist below 60cm
Depth to groundwater: 20m--no effect on profile
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: None
Human influence: Cropped terraces

GENERAL DESCRIPTION OF THE PROFILE: This spate irrigated soil has an overlying horizon of lighter material which accumulated for several years to a depth of about 25cm at which point it is removed as 'dead' soil. Alluvium is unique to 63cm at which point it becomes mixed with colluvium.

Profile Description

C 0-18cm K35	Very dark greyish-brown, 10YR 3/2 (moist) and brown, 10YR 5/3 (dry); silt loam; weak crumb structure; slightly sticky and slightly plastic (wet); very friable (moist); soft (dry); strongly calcareous; frequent very fine roots; clear, irregular boundary.

IIC 19-38cm K76	Very dark greyish-brown, 10YR 3/2 (moist) and brown, 10YR 5/3 (dry); silt loam; weak coarse subangular blocky structure; slightly sticky and slightly plastic (wet); very friable (moist); soft (dry); strongly calcareous; common fine roots; clear, wavy boundary.
IIC 38-63cm K77	Dark brown, 10YR 3/3 (moist) and greyish-brown, 10YR 5/2 (dry); silt loam; moderate coarse subangular blocky structure; sticky and plastic (wet); very friable (moist); slightly hard (dry); few fine tubular pores; strongly calcareous; common fine roots; clear, wavy boundary.
II-IIIC 63-90cm K78	Dark brown, 10YR 3/3 (moist) and brown, 10YR 5/3 (dry); slightly gravelly loam; strong coarse prismatic to coarse subangular blocky structure; sticky and slightly plastic (wet); firm (moist); slightly hard (dry); few fine tubular pores; few angular fresh gravel; strongly calcareous; few fine roots; clear, wavy boundary.
IIIC 90-124cm K79	Very dark greyish-brown, 10YR 3/2 (moist) and brown, 10YR 5/3 (dry); slightly gravelly silt loam; strong coarse prismatic to subangular blocky structure; slightly sticky and nonplastic (wet); firm (moist); slightly hard (dry); few fine tubular pores; continuous thin clay cutans in pores; few angular fresh gravel; strongly calcareous; very few fine roots; clear, wavy boundary.
IVC 124-155+cm K80	Very dark greyish-brown, 10YR 3/2 (moist) and brown, 10YR 4/3 (dry); slightly gravelly loam; strong coarse prismatic to subangular blocky structure; slightly sticky and nonplastic (wet); firm (moist); slightly hard (dry); few very fine tubular pores; patchy thin clay cutans in pores; few fresh angular gravel; few fine calcareous mycelia.

ANALYTICAL DATA FOR SITE K21

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K75	0-19	C	-	-	34	52	14	sil
K76	19-38	IIC	-	-	32	54	14	sil
K77	38-63	IIC	-	-	24	56	20	sil
K78	63-90	II-IIIC	f	g	36	48	16	l
K79	90-124	IIIC	f	g	26	52	22	sil
K80	124+	IVC	f	g	36	40	24	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	$CaCO_3$ (%)	Avail. P (ppm)
K75	7.7	0.91	1.55	7.8	6.90
K76	7.6	0.89	1.25	8.0	5.52
K77	7.6	0.36	1.23	8.8	4.54
K78	7.8	0.35	1.19	6.4	4.60
K79	7.8	0.33	1.12	7.0	4.60
K80	7.6	0.33	1.12	8.8	4.14

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K22

SITE INFORMATION

Classification: TYPIC USTIFLUVENT, FINE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: August 18, 1981
Authors: J. King and A. E. Abu Ghanem
Location: Southeast of Taizz, governate of Al Masrah, Bani Ali Alhadj, 1/2km east of village of Habab 13° 28' N, 44° 2' E
Elevation: 1320m
Physiographic position: Convex slope
Topography of surrounding country: Hilly
Microtopography: Flat, terraced
Slope: 7° or 14%
Land use: Corn
Climate: 1. Annual rainfall: 600mm, 2. Soil moisture regime: Aridic. 3. Soil temperature regime: Isothermic.

SOIL INFORMATION

Parent material: Loess, colluvium and alluvium from volcanic mountains
Drainage class: Class 4, well drained
Moisture conditions: Moist below 42cm
Depth to groundwater: 20m--no effect on profile
Surface stones or outcrops: Class 1, fairly stony
Evidence of erosion: None
Salt content: Calcareous
Human influence: Cropped terraces

GENERAL DESCRIPTION OF THE PROFILE: The profile has two dominant features: the surface materials which are fine and were deposited by spate irrigation, and the deepest horizon of colluvium. There are two transition zones between these major features.

Profile Description

A1 0-23cm E81	Very dark greyish-brown, 10YR 3/2 (moist) and light yellowish-brown, 2.5YR 6/4 (dry); silty clay loam; moderate coarse to medium subangular blocky structure; slightly sticky and plastic (wet); friable (moist); slightly hard (dry); strongly calcareous; common very fine roots; clear, irregular boundary.

C 23-107cm K82	Very dark brown, 10YR 2/2 (moist) and brown, 10YR 5/3 (dry); silty clay loam; strong coarse prismatic to subangular blocky structure; slightly sticky, plastic (wet); very firm (moist); hard (dry); few fine tubular pores; very few angular weathered gravel, few pieces of pottery; strongly calcareous; few very fine to coarse roots; diffuse, wavy boundary.
IIC 107-150+cm K83	Very dark greyish-brown, 10YR 3/2 (moist) and brown, 10YR 5/3 (dry); clay loam; strong coarse prismatic to subangular blocky structure; slightly sticky and plastic (wet); friable (moist); hard (dry); very few angular weathered gravel; few pieces of charcoal; common calcareous mycelia; few fine to coarse roots.

ANALYTICAL DATA FOR SITE K22

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K81	0-23	A1	-	-	16	56	28	sicl
K82	23-107	C	vf	g	18	48	34	sicl
K82	107+	IIC	vf	g	32	40	28	cl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K81	7.6	0.30	2.14	10.4	5.06
K82	7.8	0.30	1.22	13.0	4.60
K83	7.4	0.18	1.16	15.4	4.52

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K23

SITE INFORMATION

Classification: TYPIC USTIFLUVENT, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: October 21, 1981
Authors: J. King and A. E. Abu Ghanem
Location: On road between Sana-Hudaydah road and Jabal Al Nabi Sharib 1km from the main road 15° 14' N, 43° 59' E
Elevation: 2980m
Physiographic position: Man-made terrace on convex slope
Topography of surrounding country: Mountainous
Microtopography: Contour terracing
Slope: Moderately steep between terraces, flat (1%) on terrace
Land use: Grain legumes, primarily lentils--barley, wheat
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Ustic, 3. Soil temperature regime: Isothermic.

SOIL INFORMATION

Parent material: Colluvial material derived from volcanic rocks mixed with calcareous loess.
Drainage class: Class 4, well drained
Moisture conditions: Profile moist throughout except for top 8cm which was recently plowed. Local people claim the last rain here came in mid-August. If that is true this soil has excellent moisture retention capabilities.
Depth to groundwater: No effect on profile
Surface stones or outcrops: Class 1, fairly gravelly
Evidence of erosion: Severe deterioration of terrace walls accompanied by sheet erosion
Salt content: Calcareous
Human influence: Cropping and contour plowing

GENERAL DESCRIPTION OF THE PROFILE: The profile is pale brown throughout with the only variations in color being the calcium mycelia in horizon 86 and 87. There is no strongly expressed horizon development.

Profile Description

Ap 0-8cm K84	Dark brown, 10YR 3/3 (moist) and light yellowish-brown, 10YR 6/4 (dry); slightly gravelly loam; weak medium to coarse subangular blocky structure; nonsticky,

nonplastic, (wet); friable (moist); mixture of slightly hard and noncoherent (dry); common very fine tubular pores; fresh slightly rounded fine to coarse volcanic gravel; slightly calcareous; few very fine roots; abrupt, smooth boundary.

Ap2
8-19cm
K85

Dark yellowish-brown 10YR 3/4 (moist) and yellowish-brown, 10YR 5/4 (dry); slightly gravelly loam; moderate medium to coarse subangular blocky structure; nonsticky, nonplastic (wet); friable (moist); mixture of slightly hard and noncoherent (dry); common very fine tubular pores; fresh slightly rounded fine to coarse volcanic gravel; slightly calcareous; very few, very fine roots; gradual, smooth boundary.

IIC
19-48cm
K86

Dark yellowish-brown 10YR 3/4 (moist) and yellowish-brown, 10YR 5/4 (dry); slightly gravelly sandy loam; moderate coarse prismatic to coarse subangular blocky structure; nonsticky, nonplastic (wet); friable (moist); mixture of slightly hard and noncoherent (dry); common very fine tubular pores; fresh slightly rounded fine to coarse volcanic gravel; slightly calcareous; very few, very fine roots; clear, smooth boundary.

IIIC
48-111cm
K87

Dark brown, 10YR 3/3 (moist) and yellowish-brown, 10YR 5/4 (dry); slightly gravelly sandy loam; moderate coarse prismatic to coarse subangular blocky structure; nonsticky, nonplastic (wet); friable (moist); mixture of slightly hard and noncoherent (dry); common very fine tubular pores; fresh slightly rounded fine to coarse volcanic gravel; slightly calcareous; very few, very fine roots; clear, smooth boundary.

IVC
111-149cm
K88

Dark brown 10YR 3/3 (moist) and yellowish-brown 10YR 5/4 (dry); slightly gravelly sandy loam; moderate coarse prismatic to coarse subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); mixture of slightly hard and noncoherent (dry); few very fine tubular pores; fresh slightly rounded fine to coarse volcanic gravel; strongly calcareous; no roots; clear smooth boundary.

VC
149-190+cm
K89

Dark brown 10YR 3/3 (moist) and yellowish-brown 10YR 5/4 (dry); slightly gravelly loam; moderate medium to coarse subangular structure; slightly sticky, slightly plastic (wet); friable (moist); mixture of slightly hard and noncoherent (dry); common very fine tubular

pores; fresh slightly rounded fine to coarse volcanic gravel; moderately calcareous; no roots.

ANALYTICAL DATA FOR SITE K23

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K84	0-8	Ap	f	g	39	49	24	l
K85	8-19	Ap2	f	g	31	47	22	l
K86	19-48	IIC	f	g	57	31	12	sl
K87	48-111	IIC	f	g	57	29	14	sl
K88	111-149	IIC	f	g	57	29	12	sl
K89	149+	IIIC	f	g	47	39	14	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K84	7.7	0.27	0.41	6.8	7.33
K85	7.7	0.26	0.34	6.6	7.33
K86	7.9	0.24	0.19	6.3	7.33
K87	7.9	0.24	0.19	6.3	7.33
K88	7.7	0.36	0.41	5.3	8.99
K89	7.7	0.39	0.27	5.3	9.16

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K24

SITE INFORMATION

Classification: TYPIC USTIFLUVENT, FINE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: October 21, 1981
Authors: J. King and A. E. Abu Ghanem
Location: One-half kilometer southeast of Bait Shabi, 1km northwest of Sana-Hudaydah Road, in field belonging to Hassen Ali Al Shabi, 15° 15' N, 44° 01' E
Elevation: 2685m
Physiographic position: Convex slope (terraced)
Topography of surrounding country: Hilly
Microtopography: Terrain
Slope: Class 3, sloping between terraces (10%), flat (2%) on terraces
Land use: Sorghum
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Ustic, 3. Soil Temperature regime: Isothermic.

SOIL INFORMATION

Parent material: Volcanic colluvium and calcareous loess
Drainage class: Class 4, well drained
Moisture conditions: Moist below second horizon
Depth to groundwater: No effect on profile
Surface stones or outcrops: Fairly gravelly
Evidence of erosion: None
Salt content: Calcareous
Human influence: Terracing, cropping

GENERAL DESCRIPTION OF THE PROFILE: Plow layer silty, then clay with calcium, then rocks, bottom of C no calcium

Profile Description

C 0-9cm K90	Dark yellowish-brown 10YR 4/4 (moist) and light yellowish-brown 10YR 6/4 (dry); slightly gravelly sandy loam; weak, fine subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); loose, with some slightly hard (dry); few volcanic gravel and very few stones; strongly calcareous; few very fine roots; abrupt, smooth boundary.

IIC 9-19cm K91	Dark yellowish-brown 10YR 3/4 (moist) and yellowish-brown 10YR 5/4 (dry); slightly gravelly loam; moderate medium subangular blocky structure; slightly sticky, nonplastic (wet); friable (moist); hard (dry); few very fine tubular pores; slightly weathered, slightly rounded few volcanic gravel and very few stones; strongly calcareous; few very fine to fine roots; clear, wavy boundary.
IIIC 19-30cm K92	Dark yellowish-brown 10YR 4.4 (moist) and brownish-yellow 10YR 6/6 (dry); slightly gravelly silt loam, moderate coarse prismatic to medium subangular blocky structure; slightly sticky, slightly plastic (wet); firm (moist); hard (dry); few, very fine tubular pores; slightly rounded and slightly weathered few volcanic gravel and very few stones; strongly calcareous; few very fine to fine roots; clear, irregular boundary.
IVC 30-127cm K93	Dark yellowish-brown 10YR 4.4 (moist) and brownish-yellow 10YR 6/6 (dry); sandy loam; moderate medium to coarse subangular blocky structure; slightly sticky, slightly plastic (wet); firm, hard (dry); few, very fine tubular pores; slightly rounded and slightly weathered few volcanic gravel and very few stones; strongly calcareous; very few fine roots; clear, smooth boundary.
HOR 127-150cm K94	Dark yellowish-brown 10YR 3/4 (moist) and light yellowish-brown 10YR 6/4 (dry); sandy loam; slightly sticky, nonplastic (wet); friable (moist); few very fine tubular pores; very few slightly rounded somewhat weathered volcanic stones; strongly calcareous; no roots; clear, smooth boundary.
VIC 150+cm K95	Rocks Dominant

ANALYTICAL DATA FOR SITE K24

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K90	0-9	-	f	g,s	77	15	8	sl
K91	9-19	-	f	g,s	48	30	22	l
K92	19-30	-	f	g,s	24	54	22	sil
K93	30-127	-	f	g,s	52	28	20	sl
K94	127-150	-	vf	s	74	10	16	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K90	7.7	0.33	0.65	8.3	7.33
K91	7.9	0.28	0.58	9.5	5.49
K92	7.8	0.30	0.82	11.2	9.16
K93	7.8	0.30	0.72	11.0	6.66
K94	7.8	0.25	0.22	10.6	5.49

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K25

SITE INFORMATION

Classification: ENTIC HAPLUSTOLL, COARSE LOAMY, MIXED, ISOMESIC FAMILY
Date and time described: October 22, 1981
Authors: J. King and A. E. Abu Ghanem
Location: Left side of trail to summit of Jabal Al Nabi Shahib at 3390m, 15° 16' N, 43° 58' E
Elevation: 3390m
Physiographic position: Convex slope
Topography of surrounding country: Mountainous
Microtopography: Terraced soil
Slope: 29% or 16° (steep) between terraces, 2% (flat) on terraces
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Ustic, 3. Soil temperature regime: Isomesic.

SOIL INFORMATION

Parent material: Volcanic colluvium, calcareous loess.
Drainage class: Class 4, well drained
Moisture conditions: Moist below 36cm
Depth to groundwater: No effect on profile--deep
Surface stones or outcrops: Class 1, fairly stony
Evidence of erosion: Terrace walls deteriorated; some sheet and slight gully erosion
Salt content: Calcareous
Human influence: Terraced, no cropping, abandoned.

GENERAL DESCRIPTION OF THE PROFILE: Change in color or parent material from pale brown to brown at 118cm. Darkening effect of organic matter on surface materials visible in profile to 55cm.

Profile Description

A11 0-11cm K96	Very dark brown 10YR 2/2 (moist) and brown 10YR 5/3 (dry); slightly stony silt loam; weak crumb to structureless structure; nonsticky, slightly plastic (wet); friable (moist); slightly hard (dry); common very fine tubular pores; frequent, smooth, soft, irregular, small, white, nodules; moderately calcareous; frequent very fine to fine roots; clear, smooth boundary.

A12 0-11cm K96	Very dark brown 10YR 2/2 (moist) and brown 10YR 5/3 (dry); slightly stony silt loam; crumb structure; nonsticky, nonplastic (wet); friable (moist); slightly hard (dry); many fine tubular pores; frequent smooth soft small irregular white nodules; noncalcareous; very frequent very fine to fine roots; clear, smooth boundary.
IIA1 11-21cm K98	Brown 10YR 4/3 (moist) and pale brown 10YR 6/3 (dry); slightly gravelly loam; moderate coarse prismatic structure; sticky, plastic (wet); friable (moist); slightly hard (dry); common very fine tubular pores; frequent smooth soft small irregular white nodules; noncalcareous; common very fine to fine roots; diffuse, smooth boundary.
IIC 55-118cm K99	Brown 10YR 4/3 (moist) and pale brown 10YR 6/3 (dry); gravelly to stony sandy loam; moderate coarse subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard (dry); common very fine tubular pores; frequent smooth soft small irregular white nodules; few very fine to medium roots; diffuse, smooth boundary.
IIIC 118-155cm K100	Dark brown 7.5YR 4/3 (moist) and brown 7.5YR 5/4 (dry); gravelly to stony silt loam; moderate medium subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard (dry); common very fine tubular pores; frequent smooth soft small irregular white nodules; noncalcareous; few very fine to medium roots; clear, smooth boundary.
IVC 155-170+cm K101	Dark yellowish-brown 10YR 4/4 (moist) and brown 7.5YR 5/4 (dry); gravelly to stony loam; moderate medium subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard (dry); common very fine tubular pores; frequent smooth soft small irregular white nodules; slightly calcareous;

ANALYTICAL DATA FOR SITE K25

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K96	0-11	A11	f	s	39	52	14	sil
K97	11-21	A12	f	g	40	56	14	sil
K98	21-55	IIA1	f	g,s	50	34	16	l
K99	55-118	IIC	fr	g,s	52	34	14	sl
K100	118-155	IIIC	fr	g,s	26	54	20	sil
K101	155+	IVC	fr	g,s	36	46	18	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K96	7.3	0.55	5.60	6.7	5.49
K97	7.2	0.37	5.50	5.3	5.48
K98	7.6	0.19	1.49	4.2	5.49
K99	7.8	0.17	1.10	8.2	3.66
K100	7.7	0.21	1.03	8.7	3.66
K101	7.8	0.21	0.54	8.7	3.66

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K26

SITE INFORMATION

Classification: USTOLLIC CAMBORTHID, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: October 29, 1981
Authors: J. King and A. E. Abu Ghanem
Location: 500m southwest of village of Matnah which is east of Sana on the Sana-Hudaydah Rd. 15° 15' N, 44° 01' E
Elevation: 2664m
Physiographic position: Convex slope
Topography of surrounding country: Rolling plain in mountainous region
Microtopography: Countour terracing
Slope: 15%, 8.5° between terraces, flat (1%) on terraces
Land use: Barley, wheat, grain legumes
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Ustic, 3. Soil temperature regime: Isothermic.

SOIL INFORMATION

Parent material: Volcanic alluvium
Drainage class: Class 4, well drained
Moisture conditions: Slightly moist below 12cm
Depth to groundwater: Not known--no effect on profile
Surface stones or outcrops: Class 4, exceedingly stony
Evidence of erosion: Some sheet erosion in front of the walls between terraces
Salt content: Calcareous
Human influence: Terracing, cropping

GENERAL DESCRIPTION OF THE PROFILE:

Profile Description

A11 0-15cm K102	Dark brown, 10YR 4.3 (moist) and yellowish-brown, 10YR 5/4 (dry); gravelly sandy loam; weak crumb structure; nonsticky, slightly plastic (wet); very friable (moist); soft (dry); frequent round fresh gravel of volcanic origin; slightly calcareous; very frequent fine roots; clear, smooth boundary.
A12 15-34cm	Dark brown, 10YR 4.3 (moist) and yellowish-brown, 10YR 5/4 (dry); slightly gravelly sandy loam; moderate

K103 medium subangular blocky structure; nonsticky, slightly plastic (wet); very friable (moist); slightly hard (dry); very few round fresh gravel of volcanic origin; noncalcareous; frequent fine roots; clear, wavy boundary.

B & A
34-51cm
K104 Dark yellowish-brown, 10YR 4/4 (moist) and yellowish-brown, 10YR 5/4 (dry); slightly gravelly sandy loam; moderate coarse prismatic to subangular blocky structure; nonsticky, nonplastic (wet); very friable (moist); hard (dry); few very fine tubular pores; very few round fresh gravel of volcanic origin; noncalcareous; few very fine roots; gradual, wavy boundary.

B
51-81cm
K105 Brown 10YR 5.3 (moist) and very pale brown, 10YR 7/4 (dry); gravelly sandy loam; moderate coarse prismatic to subangular blocky structure; nonsticky, nonplastic (wet); very friable (moist); slightly hard (dry); few fine interstitial pores; few rounded fresh gravel and stones of volcanic origin; strongly calcareous with very common calcium mycellium and coatings on rocks; few very fine roots; gradual, wavy boundary.

C
81-127cm
K106 Dark yellowish-brown, 10YR 4/4 (moist) and very pale brown, 10YR 7/4 (dry); very gravelly to stony sandy loam; moderate medium to fine subangular blocky structure; nonsticky, nonplastic (wet); friable (moist); slightly hard (dry): few round fresh gravel and stones of volcanic origin; strongly calcareous with very common calcium mycelia; very few, very fine roots; abrupt, smooth boundary.

Cca
127-153cm
K107 Dark yellowish-brown, 10YR 4/4 (moist) and very pale brown, 10YR 7/4 (dry); slightly gravelly sandy loam; moderate, medium, platy structure; nonsticky, nonplastic (wet); firm (moist); hard (dry); few very fine tubular pores; moderately calcareous with few calcium mycelia; abrupt, wavy boundary.

IIC
153-183cm
K108 Dark brown, 10YR 4/3 (moist) and strong brown, 7.5YR 5/6 (dry); very gravelly to stony sandy loam; moderate medium to fine subangular blocky structure; nonsticky, nonplastic (wet); firm (moist); slightly hard (dry); very frequent, rounded, weathered to strongly weathered gravel to boulders of volcanic origin; moderately calcareous with few calcium mycelia; no roots.

ANALYTICAL DATA FOR SITE K26

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K102	0-15	A11	fr	g	68	27	5	sl
K103	15-34	A12	vf	g	58	33	9	sl
K104	34-51	B & A	vf	g	58	33	9	sl
K105	51-81	B	B	g,s	64	31	5	sl
K106	81-127	C	f	g,s	68	27	5	sl
K107	127-153	Cca	f	g	58	35	7	sl
K108	153-183	IIC	vfr	g,s,b	58	35	7	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K102	7.7	0.17	1.24	3.0	3.66
K103	7.7	0.23	1.20	2.4	5.49
K104	7.9	0.19	0.74	2.7	5.49
K105	7.9	0.24	0.37	9.5	3.66
K106	7.9	0.23	0.20	9.9	5.49
K107	7.8	0.31	0.18	14.7	5.49
K108	7.9	0.23	0.17	4.0	9.16

*vf-very few (<5% by volume) ** g-gravel (2-75mm)
f-few (5-15% by volume) s-stones (75-250mm)
fr-frequent (15-40% by volume) b-boulders (>250mm)
vfr-very frequent (40-80% by volume)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K27

SITE INFORMATION

Classification: TYPIC USTROPEPT, FINE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: October 29, 1981
Authors: J. King and A. E. Abu Ghanem
Location: One kilometer southeast of the Sana-Al Hudaydah road, 1.5km southeast of village of Bait Radam 15° 12' N, 44° 06' E
Elevation: 2643m
Physiographic position: Near low point of gently sloping broad valley
Topography of surrounding country: Very gently undulating plain between mountainous areas
Microtopography: Broad, low terraces
Slope: Between terraces 1-2%; almost flat
Land use: Barley, wheat and beans
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Ustic, 3. Soil temperature regime: Isothermic.

SOIL INFORMATION

Parent material: Fine silty material, mostly alluvial
Drainage class: Class 3, moderately well drained
Moisture conditions: Slightly moist beneath 18cm
Depth to groundwater: Unknown, no effect on profile
Surface stones or outcrops: Class 0, very few stones
Evidence of erosion: None
Salt content: Calcareous
Human influence: Low terracing, cropping

GENERAL DESCRIPTION OF THE PROFILE:

Very obvious change in texture, probably result of sedimentation at 37cm depth.

Horizon 1: Loose, crumbly, rooty layer.
Horizon 2: Same color, etc., but coarse prismatic structure.
Horizon 3: Abruptly heavier horizon, slightly brown; calcareous mycelia.
Horizon 4: "Black" clay horizon, calcareous mycelia.
Horizon 5: Brown affected by coarser materials below the transition
Horizon 6: Sandy loam C materials mottled throughout with few small soft irregular white nodules
Horizon 7: Silty C materials

Profile Description

Ap 0-10cm K109	Dark brown, 7.5YR 4/4 (moist); brown, 7.5YR 5/4 (dry); sandy clay loam; moderate fine crumb structure; slightly sticky, slightly plastic, very friable, soft slightly calcareous; frequent very fine roots; clear, wavy boundary.
C 10-37cm K110	Dark brown, 7.5YR 3/4 (moist); brown, 7.5YR 5/4 (dry); silt loam; moderate coarse prismatic to weak medium subangular blocky structure; nonsticky, slightly plastic, friable, slightly hard, few very fine tubular pores; slightly calcareous; few very fine roots; abrupt, smooth boundary.
A11b 37-50cm K111	Dark brown, 7.5YR 4/2 (moist); strong brown, 7.5YR 4/6 (dry); loam; strong medium prismatic to strong medium angular blocky structure; some slickensides in the top of the horizon; nonsticky, slightly plastic, friable, hard, few very fine tubular pores; moderately calcareous; common calcareous mycelium; few very fine to fine roots on the outside of the peds; clear, smooth boundary.
A12b 50-65cm K112	Black, 10YR 2/1 (moist); very dark greyish-brown, 10YR 3/2 (dry); loam; strong medium prismatic to strong medium angular blocky structure; sticky, plastic, friable, very hard, few very fine tubular pores; moderately calcareous; common calcareous mycelia; few very fine to fine roots; clear, smooth boundary.
B 65-115cm K113	Dark yellowish-brown, 10YR 4/3 (moist); dark yellowish-brown, 10YR 4/3 (dry); loam; strong medium prismatic to strong medium angular blocky structure; slightly sticky, plastic, friable, very hard, few very fine tubular pores; slighhtly calcareous; no roots; gradual, smooth boundary.
C1 115-140cm K114	Dark yellowish-brown, 10YR 4/3 (moist), brown, 10YR 5/3 (dry); sandy loam; massive structure; slighty sticky, slightly plastic, friable, very hard, common very fine tubular pores; strongly calcareous; common mycelia; no roots; clear, wavy boundary.
C2ca 140-150+cm	Dark yellowish-brown, 10YR 4/4 (moist); yellowish-brown, 10YR 5/4 (dry); silt loam; strong coarse

K115 prismatic with some lenses of coarse platy structure; slightly sticky, nonplastic, friable, very hard, many very fine tubular pores; slightly calcareous; no roots.

ANALYTICAL DATA FOR SITE K27

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
k109	0-10	Ap	-	-	78	1	21	scl
k110	10-37	C	-	-	32	53	15	sil
k111	37-50	A11b	-	-	38	49	13	l
k112	50-65	A12b	-	-	31	46	23	l
k113	65-115	B	-	-	37	44	19	l
k114	115-140	C1	-	-	77	14	9	sl
k115	140-150+	C2ca	-	13	37	5)	sil	l-sil

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K109	7.8	0.36	0.43	5.60	7.33
K110	7.8	0.30	0.41	5.90	5.49
K111	7.9	0.24	0.55	5.35	5.49
K112	7.9	0.20	0.52	4.35	7.33
K113	7.8	0.19	0.48	4.45	9.16
K114	7.8	0.18	0.31	4.45	10.99
K115	7.8	0.16	0.22	13.0	12.82

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K28

SITE INFORMATION

Classification: TYPIC USTIFLUVENT, FINE LOAMY, MIXED ISOHYPERTHERMIC FAMILY, IRRIGATED PHASE
Date and time described: November 4, 1981
Authors: J. King and A. E. Abu Ghanem
Location: Northeast corner of field 13 of Surdud farm on the Tihama, 15° 14' N, 43° 11' E
Elevation: 190m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: Flat, 1%
Land use: Intensive cultivation, cotton and sorghum
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Megathermic.

SOIL INFORMATION

Parent material: Fine calcareous alluvium
Drainage class: Class 3, moderately well drained
Moisture conditions: Moist below 24cm
Depth to groundwater: Not known, no effect on profile
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: Calcareous throughout
Human influence: Levelling for irrigation and cropping-intensive irrigation

GENERAL DESCRIPTION OF THE PROFILE: Uniform fine alluvium throughout with horizon differentiated primarily by slight changes in texture and, at 149cm, a change in color.

Profile Description

Ap 0-56cm K116	Dark brown, 10YR 3/3 (moist) and yellowish-brown 10YR 5/4 (dry); silt loam; strong very coarse prismatic to very coarse subangular blocky structure; slightly sticky, plastic (wet); firm (moist); hard (dry); continous thick fine materials along with organic material forming cutans in cracks and channels few very fine to fine tubular and few fine vesicular pores; strongly calcareous; common fine to very fine roots; gradual, smooth boundary.

C1 56-70cm K117	Dark brown, 10YR 4.3 (moist) and yellowish-brown 10YR 5/4 (dry); silt loam; strong coarse, slightly flat subangular blocky structure; slightly sticky, plastic (wet); friable (moist); hard (dry); few fine tubular and few coarse vesicular pores; continous thick fine materials along with organic matter forming cutans in cracks and channels; strongly calcareous; few very fine roots; gradual, smooth boundary.
C2 70-96cm K118	Dark brown, 7.5YR 3/4 (moist) and yellowish-brown 10YR 5/4 (dry); loam; strong coarse, slightly flat subangular blocky structure; slightly sticky, plastic (wet); friable (moist); slightly hard (dry); common very fine tubular pores; continous thick fine materials along with organic matter forming cutans in cracks and channels; strongly calcareous; few very fine roots; gradual, smooth boundary.
C3 96-117cm K119	Dark brown, 7.5YR 3/4 (moist) and yellowish-brown 10YR 5/4 (dry); loam; strong coarse, slightly flat subangular blocky structure; slightly sticky, plastic (wet); friable (moist); slightly hard (dry); common very fine tubular pores; continous thick fine materials along with organic matter forming cutans in cracks and channels; strongly calcareous; few (5-15% by volume) snail shells; few very fine roots; clear, smooth boundary.
C4 117-149cm K120	Brown, 7.5YR 4/4 (moist) and yellowish-brown 10YR 5/4 (dry); loam; strong coarse, slightly flat subangular blocky structure; slightly sticky, plastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores; continous thick fine materials along with organic matter forming cutans in cracks and channels; strongly calcareous; no roots; clear, smooth boundary.
IIC1 149-177cm K121	Dark reddish-brown, 5YR 3/3 (moist) and brown 7.5YR 4/4 (dry); loam; strong coarse, slightly flat subangular blocky structure; slightly sticky, plastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores; continous thick fine materials along with organic matter forming cutans in cracks and channels; strongly calcareous; no roots; clear, smooth boundary.

IIC2 177-200+cm K122	Dark reddish-brown, 5YR 3/3 (moist) and brown 7.5YR 4/4 (dry); loam; strong coarse, slightly flat subangular blocky structure; slightly sticky, plastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores; continous thick fine materials along with organic matter forming cutans in cracks and channels; no roots.

ANALYTICAL DATA FOR SITE K28

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K116	0-56	Ap	-	-	17	60	23	sil
K117	56-70	C1	-	-	55	32	23	sil
K118	70-96	C2	-	-	45	42	13	l
K119	96-117	C3	-	-	29	48	28	l
K120	117-149	C4	-	-	37	50	13	l
K121	149-177	IIC1	-	-	43	48	9	l
K122	177+	IIC2	-	-	47	31	14	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K116	7.8	0.17	1.60	15.0$EN	12.82
K117	8.0	0.19	0.55	10.2$EN	10.99
K118	8.0	0.12	0.51	10.2$EN	10.99
K119	7.9	0.19	0.70	9.85	7.33
K120	8.0	0.21	0.58	7.90	7.33
K121	8.0	0.19	0.58	6.25	5.49
K122	7.9	0.21	0.58	3.70	5.49

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K29

SITE INFORMATION

Classification: TYPIC TORRIORTHENT, FINE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY, IRRIGATED PHASE
Date and time described: November 5, 1981
Authors: J. King and A. E. Abu Ghanem
Location: Block A No. 1 field, Geraba farm, 50m from the north end of the field, 15° 13' N, 43° 8' E
Elevation: 130m
Physiographic position: Plain
Topography of surrounding country: Flat or almost flat
Microtopography: None
Slope: 1° or 2%
Land use: Irrigated pasture
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isohyperthermic.

SOIL INFORMATION

Parent material: Calcareous alluvium
Drainage class: Class 4, well drained
Moisture conditions: Dry down to 38cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: Calcareous throughout
Human influence: Irrigation, cropping, leveling

GENERAL DESCRIPTION OF THE PROFILE: Uniform fine alluvium with most strongly expressed horizon differentiation being texture; other horizons differentiated by color and structure.

Profile Description

IA1 0-10cm K123	Dark brown 10YR 4/3 (moist) and light yellowish-brown, 10YR 6/4 (dry); silt loam; some strong thick platy lenses at surface, but primarily medium subangular blocky structure; slightly sticky, plastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores; strongly calcareous; common very fine roots; clear, smooth boundary.

IIA1 10-38cm K124	Dark brown 7.5YR 3/4 (moist) and brown 10YR 5/3 (dry); loam; moderate coarse prismatic structure; slightly sticky, plastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores; strongly calcareous; common very fine roots; clear, smooth boundary.
IIIC1 38-64cm K125	Dark brown 7.5YR 3/4 (moist) and pale brown, 10YR 6/3 (dry); silt loam; strong very coarse flat subangular blocky structure; slightly sticky, plastic (wet); friable (moist); slightly hard (dry); few fine tubular and few medium vesicular pores; few very fine roots; gradual, wavy boundary.
IIIC2 64-134cm K126	Dark brown 10YR 4/3 (moist) and pale brown, 10YR 6/3 (dry); silt loam; strong very coarse flat subangular blocky structure; slightly sticky, plastic (wet); friable (moist); soft (dry); strongly calcareous; few very fine roots; gradual, smooth boundary.
IVC 134-150cm K127	Very dark greyish-brown, 10YR 3/2 (moist) and light brownish-grey 10YR 6/2 (dry); loamy sand; structureless structure; nonsticky, nonplastic (wet); loose (moist); loose (dry); strongly calcareous; very few very fine roots; abrupt, smooth boundary.
VC 150-165cm K128	Yellowish, 10YR 5/4 (moist) and pale brown 10YR 6/3 (dry); loam; moderate medium subangular blocky structure; slightly sticky, slightly plastic (wet); very friable (moist); soft (dry); strongly calcareous; very few very fine roots; abrupt, smooth boundary.
VIC 165-200cm K129	Very dark greyish-brown 10YR 3/2 (moist) and greyish-brown 10YR 5/2 (dry); sand; structureless; nonsticky, nonplastic (wet); strongly calcareous.

ANALYTICAL DATA FOR SITE K29

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K123	0-10	IA1	-	-	17	59	24	sil
K124	10-38	IIA1	-	-	37	49	14	
K125	38-64	IIIC1	-	-	17	59	24	sil
K126	64-134	IIIC2	-	-	31	53	16	sil
K127	134-150	IVC	-	-	77	19	4	ls
K128	150-165	VC	-	-	47	43	10	l
K129	165-200	VIC	-	-	91	5	4	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K123	7.8	0.55	1.25	11.40	10.99
K124	7.9	0.43	1.25	10.10	9.32
K125	8.0	0.44	0.38	9.50	9.16
K126	8.0	0.39	0.21	9.50	7.33
K127	8.2	0.15	0.19	6.70	5.49
K128	8.2	0.39	0.10	6.55	4.16
K129	8.3	0.12	0.10	6.25	4.16

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K30

SITE INFORMATION

Classification: TYPIC USTIFLUVENT, FINE LOAMY, MIXED ISOHYPERTHERMIC FAMILY, IRRIGATED PHASE
Date and time described: November 5, 1981
Authors: J. King and A. E. Abu Ghanem
Location: 50m from farm road in north central section of field 5 of Surdud farm, 15° 14' N, 43° 11' E
Elevation: 155m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: 1° or 2%
Land use: Intensive irrigated agriculture
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isohyperthermic

SOIL INFORMATION

Parent material: Calcareous alluvium
Drainage class: Class 4, well drained
Moisture conditions: Dry to 109cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: Calcareous throughout
Human influence: Levelling and irrigation, cropping for 15 years

GENERAL DESCRIPTION OF THE PROFILE: Light brown fine alluvium oberlying reddish sandy alluvium; horizon within these strata differentiated by texture.

Profile Description

A1p 0-22cm K130	Dark brown, 10YR 4/3 (moist) and yellowish-brown 10YR 5/4 (dry); silt loam; weak crumb structure; sticky, plastic (wet); friable (moist); slightly hard (dry); strongly calcareous; common very fine to fine roots; clear, wavy boundary.
A1 22-36cm	Dark brown, 10YR 3/3 (moist) and yellowish-brown 10YR 5/4 (dry); silt loam; moderate medium subangular blocky

K131	structure; sticky plastic (wet); friable (moist); slightly hard (dry); strongly calcareous; common very fine to fine roots; clear, wavy boundary.
IIC 36-56cm K132	Dark brown, 10YR 3/3 (moist) and pale brown 10YR 6/3 (dry); silt loam; moderate very coarse prismatic to very coarse subangular structure; sticky, plastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores; strongly calcareous; common very fine to fine roots; clear, wavy boundary.
IIIC 56-112cm K133	Dark brown, 7.5YR 3/4 (moist) and brown 7.5YR 5/4 (dry); silt loam; strong coarse prismatic structure; slightly sticky, plastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores with few calcium mycelia; calcareous; few very fine roots; clear, smooth boundary.
IIIC-IVC 112-145cm K134	Dark reddish-brown 5YR 3/3 (moist) and dark brown, 7.5YR 4/4 (dry); silt loam; strong flat coarse subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores with few calcium mycelia; few very fine roots; abrupt, smooth boundary.
IVC 145-197cm K135	Dark reddish-brown 5YR 3/3 (moist) and dark brown, 7.5YR 4/4 (dry); very gravelly and stony sandy loam; weak coarse subangular blocky structure; slightly sticky, plastic (wet); friable (moist); soft (dry); very frequent rounded fresh gravel to stones of volcanic origin; strongly calcareous.

ANALYTICAL DATA FOR SITE K30

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2mm ***
K130	0-22	A1p	-	-	21	61	18	sil
K131	22-36	A1	-	-	17	70	13	sil
K132	36-56	IIC	-	-	16	56	28	sicl
K133	56-112	IIIC	-	-	36	40	24	l
K134	112-145	IIIC-IVC		-	-	56	24	20 sl
K135	145-197	IVC	-	-	66	16	18	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K130	7.7	0.51	1.05	12.0	8.16
K131	7.7	0.44	1.00	12.4	7.33
K132	7.5	1.20	1.00	12.4	7.33
K133	7.7	0.64	1.60	8.45	7.14
K134	7.5	0.81	0.86	6.80	6.84
K135	7.5	0.84	0.81	4.85	6.20

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K31

SITE INFORMATION

Classification: TYPIC USTORTHENT, COARSE LOAMY, CALCAREOUS, MIXED, ISOMESIC FAMILY
Date and time described: November 24, 1981
Authors: J. King and A. E. Abu Ghanem
Location: Road cut on southwest slope of Jabal Nabal-Shabi 15° 15' N, 43° 58' E
Elevation: 3070m
Physiographic position: Concave slope
Topography of surrounding country: Mountainous
Microtopography: None
Slope: 35° or 70%
Land use: Light grazing
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Ustic, 3. Soil temperature regime: Isomesic.

SOIL INFORMATION

Parent material: Colluvial material derived from volcanic rocks
Drainage class: Class 4, well drained
Moisture conditions: Profile dry throughout
Depth to groundwater: No effect on profile
Surface stones or outcrops: Rubble land with rock, outcrops covering 25% of the surface
Evidence of erosion: Slight rill erosion
Salt content: None
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Five horizons, 177cm to lithic contact

1. Light-colored--may be from water deposition
2. Darker, heavier soil, but not clearly illuviated
3. Transistion to C
4. C--Secondary
5. Calcium on rocks and in form of powder and pseudomycelia

Profile Description

A1 0-11cm K136	Very dark greyish-brown 10YR 3/2 (moist) and brown 10YR 5/3 (dry); sandy loam; weak medium subangular blocky to crumb structure; sticky, nonplastic (wet); friable (moist); soft (dry); fresh, sharp frequent gravel to

boulders of volcanic origin; frequent fine roots; clear, smooth boundary.

B 11-63cm K137	Very dark brown 10YR 2/2 (moist) and dark greyish-brown 10YR 4/2 (dry); sandy loam; moderate coarse prismatic to medium subangular blocky structure; slightly sticky, nonplastic (wet); friable (moist); slightly hard to hard (dry); fresh, sharp frequent gravel to boulders of volcanic origin; noncalcareous; common fine roots; gradual, smooth boundary.
B2 63-80cm K138	Very dark greyish-brown 10YR 3/2 (moist) and dark yellowish-brown 10YR 4/4 (dry); sandy loam; weak subangular blocky structure; nonsticky, slightly plastic (wet); friable (moist); slightly hard (dry); frequent gravel, some stones, fresh sharp of volcanic origin; noncalcareous; common fine roots; clear, smooth boundary.
C1 80-109cm K139	Dark yellowish-brown 10YR 4/4 (moist) and yellowish-brown 10YR 5/6 (dry); sandy loam; strong coarse flat subangular blocky to coarse prismatic structure; sticky, plastic (wet); friable (moist); slightly hard to hard (dry); few very fine tubular pores; frequent sharp weathered gravel of volcanic origin; noncalcareous; very few very fine roots; clear, wavy boundary.
C2 109-177cm Lithic contact K140	Dark brown 10YR 4/3 (moist) and brown 10YR 4/3 (dry); sandy loam; moderate coarse subangular structure; slightly sticky, nonplastic (wet); friable (moist); slightly hard to hard (dry); frequent sharp weathered gravel of volcanic origin; strongly calcareous.

ANALYTICAL DATA FOR SITE K31

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K136	0-11	A1	fr	gb	58	36	6	sl
K137	11-63	B	fr	g	66	24	10	sl
K138	63-80	B2	fr	g,s	56	32	12	sl
K139	80-109	C1	fr	g	66	20	14	sl
K140	109-177	C2	fr	g	60	32	8	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K136	7.4	0.29	1.10	21.5	7.5
K137	7.5	0.18	1.05	20.6	7.3
K138	7.7	0.15	0.98	21.0	6.2
K139	7.7	0.14	0.43	20.7	5.5
K140	7.8	0.20	0.33	22.6	3.7

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K32

SITE INFORMATION

Classification: TYPIC ARGIUDOLL, SANDY SKELETAL, MIXED, ISOMESIC FAMILY
Date and time described: November 24, 1981
Authors: J. King and A. E. Abu Ghanem
Location: Road cut on southwest slope of Jabal Nabal-Shabi 15° 15' N, 43° 58' E
Elevation: 3070m
Physiographic position: Concave slope
Topography of surrounding country: Mountainous
Microtopography: Nil
Slope: 35° or 70%
Land use: Light grazing
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Ustic, 3. Soil temperature regime: Isomesic.

SOIL INFORMATION

Parent material: Colluvial material derived from volcanic rocks
Drainage class: Class 4, well drained
Moisture conditions: Profile dry throughout
Depth to groundwater: No effect on profile
Surface stones or outcrops: Rubble land with rock outcrops covering 25% of the surface
Evidence of erosion: Slight rill erosion
Salt content: None
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: The soil throughout this profile has a low value and chroma with the top two horizons being noticeably lighter colored than the bottom two. Their differences correspond to an increased clay content in the lower two horizons. The top two horizons were differentiated on the basis of color and structure and the bottom two on the basis of color and clay content.

Profile Description

A2 0-23cm K141	Very dark brown 10YR 2/2 (moist) and brown 10YR 5/3 (dry); sandy loam; weak granular structure; slightly sticky and slightly plastic (wet); friable (moist);

slightly hard (dry); fresh slightly rounded frequent stones to boulders of volcanic origin; moderately calcareous; frequent fine roots; clear, wavy boundary.

IIA2 23-81cm K142	Very dark greyish-brown 10YR 3/2 (moist) and dark greyish-brown 10YR 4/2 (dry); sandy loam; weak medium subangular blocky structure; slightly sticky and slightly plastic (wet); friable (moist); slightly hard (dry); slightly weathered frequent gravel and boulders of volcanic origin; noncalcareous; common, fine roots; abrupt, smooth boundary.
IIB2t 81-138cm K143	Black 10YR 2/1 (moist) and very dark grey 10YR 3/1 (dry); sandy clay laom; strong coarse subangular blocky structure; sticky and very plastic (wet); friable (moist); very hard (dry); slightly weathered frequent gravel and boulders of volcanic origin; noncalcareous; very few fine roots; gradual, wavy boundary.
IIC 138-162cm Lithic contact K144	Very dark grey 10YR 3/1 (moist) and very dark greyish-brown 10YR 3/2 (dry); sandy loam; moderate medium subangular blocky structure; slightly sticky and nonplastic (wet); friable (moist); slightly hard (dry); very frequent slightly rounded weathered stones to boulders of volcanic origin; strongly calcareous with common calcareous psuedomycellia.

ANALYTICAL DATA FOR SITE K32

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K141	0-23	A2	fr	s,b	72	22	6	sl
K142	23-81	IIA2	fr	g,b	76	14	10	sl
K143	81-138	IIB2t	fr	g,b	56	20	22	scl
K144	138-162	IIC	vfr	s,b	63	22	15	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K141	7.5	0.22	1.82	21.3	9.2
K142	7.7	0.17	1.32	21.1	7.3
K143	7.5	0.14	1.25	21.3	6.7
K144	7.8	0.21	0.73	22.2	5.4

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from.ce Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K33

SITE INFORMATION

Classification: LITHIC USTORTHENT, SANDY SKELETAL, MIXED ISOMESIC FAMILY
Date and time described: November 24, 1981
Authors: J. King and A. E. Abu Ghanem
Location: Road cut on southwest slope of Jabal Nabal-Shabi 15° 15' N, 43° 59' E
Elevation: 3020m
Physiographic position: Concave slope
Topography of surrounding country: Mountainous
Microtopography: None
Slope: 22° or 40%
Land use: Low, tight sedges and grasses
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Ustic, 3. Soil temperature regime: Isomesic.

SOIL INFORMATION

Parent material: Colluvium dominated by volcanic rocks
Drainage class: Class 4, well drained
Moisture conditions: Dry throughout
Depth to groundwater: No effect on profile
Surface stones or outcrops: Rubble land, gravel to boulders, 25% rock outcrops
Evidence of erosion: Slight sheet erosion
Salt content: None
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Very shallow profile with 48cm to lithic contact.

Profile Description

C1 0-7cm K145	Very dark to greyish-brown, 10YR 3/2 (moist) and greyish-brown, 10YR 5/2 (dry); loamy sand; structureless; slightly sticky and nonplastic (wet); very friable (moist); loose (dry); slightly rounded fresh frequent gravel to stones of volcanic origin; calcareous; few fine roots; abrupt, smooth boundary.

C2 7-48cm Ki46	Very dark brown, 10YR 2/2 (moist) and very dark greyish-brown, 10YR 3/2 (dry); loamy sand; weak crumb to medium subangular blocky structure; slightly sticky and nonplastic (wet); friable (moist); soft (dry); slightly rounded; fresh, frequent gravel to stones of volcanic origin; calcareous; common fine roots; abrupt, smooth boundary.

ANALYTICAL DATA FOR SITE K33

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K145	0-7	C1	fr	g,s	77	17	6	ls
K146	7-48	C2	fr	g,s	79	15	6	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K145	7.5	0.14	1.08	6.3	8.24
K146	7.6	0.11	1.08	6.3	7.33

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K34

SITE INFORMATION

Classification: TYPIC USTORTHENT, FINE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: December 2, 1981
Authors: J. King and A. E. Abu Ghanem
Location: On the Tihama, 200m west of village of Thhar Mhamoud, 2km east of Mganeh, approximately 10km north and slightly east of Wadi Surdud at the base of Mt. Badh Milhan. Province of Mahweet. Farm of Al Habj Mahamat Gassim 15° 21' N, 43° 14' E
Elevation: 150m
Physiographic position: Foot slope
Topography of surrounding country: Undulating, but in close proximity to mountains to the east at 1.5 km and to flat topography to the west about 4km
Microtopography: Situated in a small terraced, bunded field, 60m by 30m, terraces differ by 50cm in elevation with bunds 20cm above level of the terrace
Slope: 2 or 4%
Land use: Bare at the time of profile but used for maize, sorghum and beans primarily, and sometimes for cotton
Climate: No information but similar to Wadi Surdud

SOIL INFORMATION

Parent material: Calcareous alluvium with some influence of calcareous loess and of volcanic alluvium
Drainage class: Class 4, well drained
Moisture conditions: Moist below 35cm
Depth to groundwater: 50m, no effect on profile
Surface stones or outcrops: Class 1, very few stones
Evidence of erosion: None
Salt content: Calcareous, common pseudomycelia and calcium on the rocks at 45-110cm
Human influence: Spate irrigation and terracing

GENERAL DESCRIPTION OF THE PROFILE: The top two horizons are similar differing only in structure with the surface horizon being a loose Ap horizon and the second horizon having moderate coarse subangular blocky structure. The third horizon is heavier in texture with some calcium accumulation. The fourth horizon is characterized by very frequent gravel to stones and differs dramatically from the horizon above it. In this respect the presence of this gravel and stone is probably the result of the method of building these terraces in which gravel and stones are sometimes laid down first and then covered with soil to form the terrace.

Profile Description

A2 0-10cm K147	Dark brown, 10YR 3/3 (moist) and yellowish-brown, 10YR 5/4 (dry); silt loam; structureless; slightly sticky and slightly plastic (wet); very friable (moist); soft (dry); slightly calcareous; few fine roots; clear, smooth boundary.
B21 10-30cm K148	Dark brown, 7.5YR 3/4 (moist) and dark yellowish-brown, 10YR 4/4 (dry); silt loam; moderate coarse subangular blocky structure; slightly sticky and slightly plastic (wet); friable (moist); soft to slightly hard (dry); few fine tubular pores; slightly calcareous; few fine roots; irregular, clear boundary.
B22 30-45cm K149	Dark brown, 7.5YR 3/4 (moist) and dark brown, 7.5YR 4/4 (dry); loam; moderate coarse subangular blocky structure; slightly sticky and plastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores; moderately calcareous; very few fine roots; gradual, smooth boundary.
I-IIC 45-110cm K150	Brown, 7.5YR 4/4 (moist) and strong brown, 7.5YR 4/6 (dry); gravelly to stoney loam; weak medium subangular blocky structure; slightly sticky and slightly plastic (wet); friable (moist); slightly hard (dry); very frequent rounded strongly weathered gravel to stones; strongly calcareous.

ANALYTICAL DATA FOR SITE K34

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K147	0-10	A2	-	-	33	53	14	sil
K148	10-30	B21	-	-	31	51	18	sil
K149	30-45	B22	-	-	27	49	24	l
K150	45-110	I-IIC	vfr	s,b	37	40	23	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K147	7.5	0.40	1.51	4.7	11.91
K148	7.6	0.40	1.13	5.5	10.21
K149	7.6	0.40	1.05	6.3	8.35
K150	7.6	0.78	0.90	10.5	8.24

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K35

SITE INFORMATION

Classification: TYPIC TORRIORTHENT, SANDY SKELETAL, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: December 7, 1981
Authors: J. King and A. E. Abu Ghanem
Location: West bank of small dry Wadi in greater Wadi Mawza on the Abullah Aldimi farm 13° 18' N, 43° 37' E
Elevation: 280m
Physiographic position: Valley bottom
Topography of surrounding country: Flat to almost flat and 500m wide
Microtopography: The areas on both sides of the valley are steeply dissected
Slope: 1° or 2%
Land use: Desert shrubs
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isohyperthermic

SOIL INFORMATION

Parent material: Alluvial material derived from volcanic rocks
Drainage class: Class 5, somewhat excessively drained
Moisture conditions: Dry throughout
Depth to groundwater: 20+m, no effect on profile
Surface stones or outcrops: Rubble land
Evidence of erosion: Wind erosion resulting in exposure of stones on surface of soil; moderate gully erosion
Salt content: None
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Five horizons caused by stratification of alluvial material.

Profile Description

A1 0-5cm K151	Brown, 10YR 4/3 (moist) and light yellowish-brown, 10YR 6/4 (dry); slightly gravelly loam; 1cm cap with no structure then strong fine prismatic structure in the lower 4cm; slightly sticky, slightly plastic (wet); friable (moist); slightly hard (dry); in cap honeycombed with many micro-tubular pores, below that micro-tubular pores are common; very few fresh moderately rounded gravel; strongly calcareous; smooth, gradual boundary.

IIC 5-27cm K152	Brown, 10YR 4/3 (moist) and pale brown, 10YR 6/3 (dry); very gravelly loamy sand; structureless; nonsticky, nonplastic (wet); friable (moist); loose (dry); fresh very frequent moderately rounded gravel to stones of volcanic origin; strongly calcareous; very few coarse roots; smooth, clear boundary.
IIIC 27-87cm K153	Dark yellowish-brown, 10YR 4/4 (moist) and yellowish-brown, 10YR 5/4 (dry); very gravelly to stoney loamy sand; structureless; nonsticky, nonplastic (wet); very friable (moist); loose (dry); fresh very frequent moderately rounded gravel to stones of volcanic origin; strongly calcareous; smooth, clear boundary.
IVC 87-181cm K154	Dark brown, 10YR 3/3 (moist) and brown, 10YR 5/3 (dry); very gravelly to stoney loamy sand; nonsticky, nonplastic (wet); very friable (moist); loose (dry); fresh very frequent moderately rounded gravel to stones of volcanic origin; strongly calcareous; smooth, clear boundary.
VC 181-261cm K155	Brown, 7.5YR 4/4 (moist) and brown, 7.5YR 5/4 (dry); very gravelly to stoney sandy loam; structureless; nonsticky, nonplastic (wet); very friable (moist); loose (dry); fresh very frequent moderately rounded gravel to stones of volcanic origin; noncalcareous;

ANALYTICAL DATA FOR SITE K35

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K151	0-5	A1	vf	g	51	36	13	l
K152	5-27	IIC	vfr	g,s	77	16	7	ls
K153	27-87	IIIC	vfr	g,s	77	16	7	ls
K154	87-181	IVC	vfr	g,s	83	12	5	ls
K155	181-261	VC	vfr	g,s	69	20	11	sl

No.	pH 1:1	EC mmhos	Organic Matter	CaCO3 (%)	Avail. P
K151	8.0	0.24	0.50	10.2	11.91
K152	7.5	4.30	0.48	8.9	9.36
K153	7.7	2.85	0.35	7.0	8.24
K154	7.8	4.70	0.30	7.0	7.12
K155	8.2	0.30	0.15	5.1	5.50

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K36

SITE INFORMATION

Classification: TYPIC CALCIORTHID, SANDY SKELETAL, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: December 7, 1981
Authors: J. King and A. E. Abu Ghanem
Location: Foot slope of volcanic hill on north side of Wadi Mawza in greater Wadi Mose on the Abdullah Aldimi Farm. Taizz province but on the Tihama. 13° 18' N, 43° 37' E
Elevation: 300m
Physiographic position: Concave foot slope of a volcanic hill
Topography of surrounding country: Steeply dissected except for flat adjacent wadi about 500m wide
Microtopography: None
Slope: 12° or 20%, moderately steep
Land use: Light grazing
Climate: 1. Annual rainfall: 300mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isohyperthermic

SOIL INFORMATION

Parent material: Volcanic colluvium
Drainage class: Class 4, well drained
Moisture conditions: Moist below 107cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: Gravelly to stoney rubble land with 40% of surface covered by rock outcrops
Evidence of erosion: Local severe gully erosion
Salt content: Calcareous
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Three strata of colluvial material over a horizon dominated by dark material. The two strata under the dark horizon are similar in color and texture to the three strata above the dark horizon.

Profile Description

A1 0-18cm K156	Brown, 10YR 4/3 (moist) and yellowish-brown, 10YR 5/4 (dry); very gravelly to stoney sandy loam; structureless; slightly sticky, slightly plastic (wet); friable (moist); loose (dry); few fine tubular pores; frequent sharp fresh gravel to stones of volcanic

origin; strongly calcareous; common medium to fine roots; smooth, gradual boundary.

C
18-79cm
K157

Dark yellowish-brown, 10YR 4/4 (moist) and yellowish-brown, 10YR 5/4 (dry); very gravelly to bouldery sandy loam; weak moderate subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); loose (dry); few very fine tubular pores; frequent sharp fresh gravel to boulders of volcanic origin; strongly calcareous; common medium to fine roots; smooth, gradual boundary.

IIC
79-140cm
K158

Brown, 10YR 4/3 (moist) and brown, 10YR 5/3 (dry); very gravelly sandy loam; weak moderate subangular blocky structure; slightly sticky, nonplastic (wet); friable (moist); loose (dry); very few fine tubular pores; very frequent sharp fresh gravel of volcanic origin; strongly calcareous; common fine roots; smooth, gradual boundary.

IIIC
140-165cm
K159

Dark brown, 10YR 3/3 (moist) and greyish-brown, 10YR 5/2 (dry); slightly gravelly sandy loam; weak moderate subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); soft (dry); few very fine tubular pores; few sharp fresh gravel of volcanic origin; strongly calcareous; few fine roots; smooth, gradual boundary.

IVC
165-195cm
K160

Brown, 10YR 4/3 (moist) and brown, 10YR 5/3 (dry); slightly gravelly loam; moderate coarse prismatic to medium subangular blocky structure; slightly sticky, slightly plastic (wet); very friable (moist); slightly hard (dry); few sharp fresh gravel of volcanic origin; strongly calcareous; smooth, clear boundary.

VC
195-250cm
K161

Brown, 10YR 4/3 (moist) and yellowish-brown, 10YR 5/4 (dry); gravelly sandy loam; weak coarse prismatic to medium subangular blocky structure; slightly sticky, nonplastic (wet); friable (moist); soft (dry); frequent sharp fresh gravel of volcanic origin; strongly calcareous.

ANALYTICAL DATA FOR SITE K36

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K156	0-18	A1	fr	g,s	51	24	5	sl
K157	18-79	C	fr	g,s	57	36	7	sl
K158	79-140	IIC	vfr	g	67	28	5	sl
K159	140-165	IIIC	f	g	57	36	7	sl
K160	165-195	IVC	f	g	47	42	11	l
K161	195-120	VC	fr	g	51	44	5	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K156	7.8	0.35	1.29	6.1	9.16
K157	7.9	0.45	0.75	6.2	5.50
K158	7.7	1.90	0.39	7.8	7.88
K159	7.5	5.20	0.54	12.1	7.33
K160	7.7	1.70	0.46	12.3	3.66
K161	7.5	3.10	0.40	13.8	3.54

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
(>250mm
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE 637

SITE INFORMATION

Classification: TYPIC TORRIFLUVENT, COARSE LOAMY, MIXED, ISOMEGATHERMIC FAMILY
Date and time described: December 8, 1981
Authors: J. King and A. E. Abu Ghanem
Location: Approximately 10km west of Hudaydah-Saudi Arabia Road in province of Hudaydah, 500m south of village of Dir Bahri 15° 13' N, 42° 59' E
Elevation: 30 feet
Physiographic position: Plain
Topography of surrounding country: Flat at location of pit but numerous dunes as high as 3m in the immediate area
Microtopography: None
Slope: 1° or 0.5%
Land use: Acacia, used only for browsing by goats
Climate: 1. Annual rainfall: <100cm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isomegathermic

SOIL INFORMATION

Parent material: Silty calcareous alluvium
Drainage class: Class 4, well drained
Moisture conditions: Dry throughout
Depth to groundwater: 15m
Surface stones or outcrops: None
Evidence of erosion: Deposition of sand on surface, many sand dunes in the immediate area
Salt content: Calcareous
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Typical alluvial soil for this region. Light brown throughout but clearly delineated stratification.

Profile Description

IC 0-10cm K162	Dark brown, 10YR 3/3 (moist) and yellowish-brown, 10YR 5/4 (dry); sandy loamy; weak medium subangular blocky structure; slightly sticky, nonplastic (wet); friable (moist); soft (dry); moderately calcareous; clear, smooth boundary.

IIC 10-16cm K163	Brown, 10YR 4/3 (moist) and pale brown, 10YR 6/3 (dry); silt loam; weak fine to medium subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores; moderately calcareous; very few fine to coarse roots; clear, smooth boundary.
IIIC 16-34cm K164	Dark brown, 10YR 3/3 (moist) and brown, 10YR 5/3 (dry); sandy loam; structureless; slightly sticky, nonplastic (wet); very friable (moist); soft (dry); moderately calcareous; very few coarse roots; clear, smooth boundary.
IVC 34-48cm K165	Dark brown, 10YR 3/3 (moist) and brown, 10YR 5/3 (dry); silt loam; weak thin platy and weak medium subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard to hard (dry); few very fine tubular pores; moderately calcareous; clear, smooth boundary.
VC 48-72cm K166	Dark brown, 10YR 4/3 (moist) and brown, 10YR 5/3 (dry); silt loam; weak flat fine to medium subangular blocky structure; few very fine tubular pores; moderately calcareous; very few coarse roots; clear, smooth boundary.
VIC 72-84cm K167	Dark brown, 10YR 3/3 (moist) and yellowish-brown, 10YR 5/4 (dry); silt loam; strong medium subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); soft (dry); moderately calcareous; very few coarse roots; clear, smooth boundary.
VIIC 84-93cm K168	Brown, 10YR 4/3 (moist) and yellowish-brown, 10YR 5/4 (dry); silt loam; strong medium to coarse subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard (dry); many very fine tubular pores; moderately calcareous; very few coarse roots; clear, smooth boundary.
VIIIC 93-98cm K169	Dark brown, 10YR 3/3 (moist) and brown, 10YR 5/3 (dry); loamy sand; weak medium subangular blocky structure; slightly sticky, nonplastic (wet); friable (moist); soft to hard (dry); moderately calcareous; clear, smooth boundary.

IXC 98-127cm K170	Brown, 10YR 4/3 (moist) and pale brown, 10YR 6/3 (dry); silty clay loam; moderate fine to medium subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard (dry); few very fine to coarse tubular pores; moderately calcareous; very few coarse roots; clear, smooth boundary.
XC 127-133cm K171	Dark yellowish-brown, 10YR 3/4 (moist) and light yellowish-brown, 10YR 6/4 (dry); silt loam; weak medium subangular blocky structure; slightly sticky, nonplastic (wet); friable (moist); soft (dry); many very fine and common fine tubular pores; moderately calcareous; clear, smooth boundary.
XIC 133-147cm K172	Brown, 10YR 4/3 (moist) and brown, 10YR 5/3 (dry); silty clay loam; moderate fine to medium subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard (dry); many very fine tubular pores; moderately calcareous; clear, smooth boundary.
XIIC 147-160cm K173	Dark yellowish-brown, 10YR 3/4 (moist) and brown, 10YR 5/3 (dry); sandy loam; weak medium subangular blocky structure; slightly sticky, nonplastic (wet); very friable (moist); soft (dry); moderately calcareous.

ANALYTICAL DATA FOR SITE K37

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K162	0-10	IC	-	-	67	26	7	sl
K163	10-16	IIC	-	-	17	65	18	sil
K164	16-34	IIIC	-	-	51	44	5	sl
K165	34-48	IVC	-	-	17	72	11	sil
K166	48-72	VC	-	-	37	54	9	sil
K167	72-84	VIC	-	-	27	64	9	sil
K168	84-93	VIIC	-	-	17	60	23	sil
K169	93-98	VIIIC	-	-	75	20	5	ls
K170	98-127	IXC	-	-	13	59	28	sicl
K171	127-133	XC	-	-	27	63	10	sil
K172	133-147	XIC	-	-	11	59	30	sicl
K173	147-160	XIIC	-	-	67	25	8	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K162	7.9	0.26	0.51	7.0	8.24
K163	7.9	0.30	0.45	8.2	7.60
K164	8.1	0.31	0.37	8.2	6.40
K165	8.0	0.31	0.47	8.3	9.16
K166	7.9	0.38	0.27	8.6	7.33
K167	7.9	0.49	0.65	10.2	5.50
K168	7.7	0.41	0.92	9.0	10.90
K169	7.9	0.34	0.27	8.7	11.00
K170	7.7	0.39	0.94	8.6	8.24
K171	8.0	0.45	0.12	8.3	8.24
K172	7.8	0.90	1.07	8.0	10.07
K173	8.1	0.28	0.30	6.8	8.24

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K38

SITE INFORMATION

Series name: Not given Classification: TROPAQUENT, COARSE LOAMY, MIXED, ISOMEGATHERMIC FAMILY
Date and time described: December 9, 1981
Authors: J. King and A. E. Abu Ghanem
Location: North of Hudaydah, 5km north of the village of Org, 50m west of Al Saleef-Hudaydah Road, 50m east of the Red Sea 15° 11' N, 42° 49' E
Elevation: 1m
Physiographic position: Shallow depression, 80m wide between beach dunes and low alluvial bluffs.
Topography of surrounding country: Flat where there are no sand dunes
Microtopography: None
Slope: 0.5° or 1%
Land use: Low sedge and grass
Climate: 1. Annual rainfall: >100mm, 2. Soil moisture regime: Aquic, 3. Soil temperature regime: Isomegathermic

SOIL INFORMATION

Parent material: Primarily beach sand with some influence from fine alluvium.
Drainage class: Class 0, very poorly drained
Moisture conditions: Moist throughout
Depth to groundwater: 34cm
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: Assume high salt content because of proximity to sea, but water which seeped into the pit is not salty
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Moist and dark grey throughout. There are two distinct textural horizons: a surface horizon 8cm deep with a significant clay content, and a second horizon consisting primarily of sand from 8cm to the water table at 34cm.

Profile Description

A1 0-8cm K174	Brown, 10YR 4/3,(moist) but in this horizon the surface halfcm has a reddish color with 1cm below this oxidized layer being black and apparently a reduced layer. The brown color is limited to 6 1/2cm below these two very

thin surface colors. and greyish-brown, 10YR 5/2 (dry); sandy clay loam; massive structure; sticky, plastic (wet); firm (moist); slightly hard (dry); few fine tubular pores; strongly calcareous; many fine roots; clear, smooth boundary.

IIC 8-34cm K175	Very dark greyish-brown, 10YR 3/2 (moist) and dark grey, 10YR 4/1 (dry); loamy sand; structureless; nonsticky, nonplastic (wet); very friable (moist); soft (dry); slightly calcareous; common fine roots.

ANALYTICAL DATA FOR SITE K38

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K174	0-8	A1	-	-	57	23	20	scl
K175	8-34	IIC	-	-	87	9	4	ls

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K174	9.7	14.4	1.28	15.6	8.24
K175	9.1	2.3	0.37	7.2	7.88

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K39

SITE INFORMATION

Classification: TYPIC TORRIPSAMMENT, MIXED, CALCAREOUS, ISOMEGATHERMIC FAMILY
Date and time described: December 9. 1982
Authors: J. King and A. E. Abu Ghanem
Location: North of Hudaydah, 11km east of Org which is on the Red Sea coast 15° 13' N 42° 54' E
Elevation: 40m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: Sandy hummocks up to one meter in height
Slope: 1° or 2%
Land use: Sage, light grazing
Climate: 1. Annual rainfall: >100mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isomegathermic

SOIL INFORMATION

Parent material: Wind blown sand and calcareous silt and clay
Drainage class: Class 4, well drained
Moisture conditions: Dry throughout
Depth to groundwater: Not known, but no effect on profile
Surface stones or outcrops: None
Evidence of erosion: Hummocks resulting from combined effects of wind erosion and deposition
Salt content: Calcareous
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: A light textured young soil with four horizons differentiated by slight changes in color and texture

Profile Description

A1 0-10cm K176	Dark brown, 10YR 3/3 (moist) and brown 10YR 5/3 (dry); sand; structureless; nonsticky, nonplastic (wet); very friable (moist); loose (dry); moderately calcareous; clear, smooth boundary.
IIC 10-26cm K177	Very dark greyish-brown 10YR 3/2 (moist) and greyish-brown 10YR 5/2 (dry); loamy sand; weak very thin platey structure; slightly sticky, nonplastic (wet); very

friable (moist); soft (dry); moderately calcareous; few fine to medium roots; abrupt, smooth boundary.

IIIC 26-102cm K178	Dark brown, 10YR 3/3 (moist) and brown 10YR 4/3 (dry); loamy sand; moderate medium to very coarse flat subangular blocky structure; slightly sticky, nonplastic (wet); very friable (moist); soft (dry); many fine tubular pores; moderately calcareous; very few fine roots; abrupt, smooth boundary.
IVC 102-155+cm K179	Dark brown, 10YR 3/3 (moist) and brown 10YR 4/3 (dry); sand; moderate medium to very coarse flat subangular blocky structure; slightly sticky, nonplastic (wet); very friable (moist); soft (dry); many fine tubular pores; moderately calcareous; very few fine roots.

ANALYTICAL DATA FOR SITE K39

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K176	0-10	A1	-	-	89	7	4	s
K177	10-26	IIC	-	-	87	7	6	ls
K178	26-102	IIIC	-	-	87	7	6	ls
K179	102+	IVC	-	-	89	7	4	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K176	8.4	0.96	0.55	5.1	11.91
K177	8.2	0.19	0.38	4.4	11.91
K178	8.2	0.21	0.20	3.9	8.16
K179	8.2	0.41	0.18	3.7	11.91

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

ce on (from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K40

SITE INFORMATION

Classification: TROPIC FLUVAQUENT, COARSE LOAMY, CALCAREOUS, MIXED, ISOMEGATHERMIC FAMILY
Date and time described: December 15, 1981
Authors: J. King and A. E. Abu Ghanem
Location: 50m east of the Red Sea, 7km north of Al Khawkhah 13° 52' N 42° 14' E
Elevation: 2m
Physiographic position: Plain
Topography of surrounding country: Flat or almost flat
Microtopography: 40cm high accumulations of soil around trunks of fallen palm trees
Slope: Shallow depressions where palm trees have been removed. Slight ridging and troughing for irrigation.
Land use: Date palms
Climate: 1. Annual rainfall: <100cm, 2. Soil moisture regime: Aquic (actual), 3. Soil temperature regime: Isomegathermic.

SOIL INFORMATION

Parent material: Fine alluvium mixed with beach sand
Drainage class: Class 1, poorly drained
Moisture conditions: Moist throughout
Depth to groundwater: 108cm
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: Salt accumulations at 5-15cm
Human influence: Cultivation of date palms

GENERAL DESCRIPTION OF THE PROFILE: A poorly drained stratified soil with the surface covered with undecomposed organic matter coming from the palms which are cultivated here.

Profile Description

A1 0-5cm K180	Brown, 10YR 4/3 (moist) and greyish-brown, 10YR 5/2 (dry); loam; strong medium platy structure; slightly sticky, slightly plastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores; strongly calcareous; clear, smooth boundary.

II Asa 5-15cm K181	Brown, 10YR 5/3 (moist) and light grey, 10YR 7/2 (dry); loamy sand; strong coarse subangular blocky structure; slightly sticky, nonplastic (wet); friable (moist); hard (dry); few very fine tubular pores; strongly calcareous; few medium to coarse roots; gradual, wavy boundary.
III A1 15-33cm K182	Pale brown, 10YR 6/3 (moist) and light grey, 10YR 7/2 (dry); sandy loam; strong coarse subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard (dry); strongly calcareous; frequent medium to coarse roots; clear, smooth boundary.
IVC 33-55cm K183	Very pale brown, 10YR 7/3 (moist) and white 10YR 8/2 (dry); silt loam; strong medium subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard (dry); common very fine tubular pores; strongly calcareous; frequent medium to coarse roots; clear, smooth boundary.
VC 55-65cm K184	Yellowish-brown, 10YR 5/8 (moist) and yellowish-brown, 10YR 5/6 (dry); sand; weak coarse subangular blocky structure; nonsticky, nonplastic (wet); loose (moist); soft (dry); strongly calcareous; common medium to coarse roots; clear, smooth boundary.
VIC 65-81cm K185	Pale olive, 5YR 6/4 (moist) and pale yellow, 5YR 7/4 (dry); sand; weak corase prismatic structure; nonsticky, nonplastic (wet); loose (moist); loose (dry); strongly calcareous; common medium to coarse roots; gradual, smooth boundary.
VIIC 81-108cm K186	Grey, 5YR 5/1 (moist) and light olive grey, 5YR 6/2 (dry); sand; weak coarse subangular blocky structure; nonsticky, nonplastic (wet); loose (moist); loose (dry); strongly calcareous; common medium to coarse roots.

ANALYTICAL DATA FOR SITE K40

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K180	0-5	A1	-	-	49	38	13	l
K181	5-15	IIAsa	-	-	79	16	5	ls
K182	15-33	IIIA1	-	-	57	38	5	sl
K183	33-55	IVA1	-	-	43	52	5	sil
K184	55-65	VC	-	-	93	2	5	s
K185	65-81	VIC	-	-	93	2	5	s
K186	81-108	VIIC	-	-	95	2	3	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K180	7.6	65	1.18	16.6	8.24
K181	7.5	17.5	0.96	18.6	8.24
K182	7.5	9.9	2.20	24.3	8.24
K183	7.6	7.7	1.65	24.3	7.33
K184	7.6	5.4	0.41	24.3	13.74
K185	7.9	2.4	0.35	24.6	12.82
K186	7.7	2.1	0.15	24.7	10.99

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K41

SITE INFORMATION

Classification: TYPIC TORRIFLUVENT, SANDY, MIXED, CALCAREOUS, ISOMEGATHERMIC FAMILY
Date and time described: December 15, 1981
Authors: J. King
Location: 600m east of the Red Sea, 4.7km north of Al Khawkhah 13° 5' N 43° 14' E
Elevation: 60m
Physiographic position: Plain, 300m across between low gravel hills, 10m high
Topography of surrounding country: Flat in immediate area, rolling gravel hills within 200m
Microtopography: Many sandy hummocks up to one meter in height in immediate area
Slope: 1° or 2%
Land use:
Climate: 1. Annual rainfall: <100mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isomegathermic.

SOIL INFORMATION

Parent material: Fine alluvial sand and silt
Drainage class: Class 4, well drained
Moisture conditions: Dry throughout
Depth to groundwater: Unknown, but no effect on profile
Surface stones or outcrops: None, but gravel covers 30% of the surface
Evidence of erosion: Wind erosion of fine particles from surfaces, wind deposition of sand in hummocks
Salt content: No visible salt or alkaline
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: This profile is light brown throughout with the horizons being differentiated by texture. The surface is covered with a thin white crust, about one millimeter thick, consisting of coarse materials which have numerous pores, giving it a honeycombed appearance.

Profile Description

A1 0-9cm K187	Brown, 10YR 4/3 (moist) and brown, 10YR 5/3 (dry); loamy sand; moderate, fine, platey structure; nonsticky, nonplastic (wet); friable (moist); loose to

soft (dry); strongly calcareous; abrupt, smooth boundary.

IIC
9-32cm
K188

Brown, 10YR 4/3 (moist) and pale brown, 10YR 6/3 (dry); sandy loam; moderate medium subangular structure; slightly sticky, slightly plastic (wet); friable (moist); soft to slightly hard (dry); common very fine tubular pores; strongly calcareous; few very fine to medium roots; clear, smooth boundary.

IIIC
32-94cm
K189

Dark greyish-brown, 10YR 4/2 (moist) and dark greyish-brown, 10YR 5/2 (dry); sand; weak, medium, subangular blocky structure; nonsticky, nonplastic (wet); loose (moist); loose (dry); strongly calcareous; few very fine to medium roots; clear, smooth boundary.

IVC
94-125cm
K190

Dark yellowish-brown, 10YR 4/4 (moist) and yellowish-brown, 10YR 5/4 (dry); loamy sand; weak, flat, medium, subangular blocky structure; nonsticky, nonplastic (wet); very friable (moist); loose to soft (dry); strongly calcareous; very few fine to medium roots; clear, smooth boundary.

VC
125-134cm
K191

Dark greyish-brown, 10YR 4/2 (moist) greyish-brown, 10YR 5/2 (dry); sand; nonsticky, nonplastic (wet); loose (moist); loose (dry); strongly calcareous; abrupt, smooth boundary.

VIC
134-157cm
K192

Dark yellowish-brown, 10YR 4/4 (moist) and pale brown, 10YR 6/3 (dry); sandy loam; strong, medium subangular blocky structure; sticky, slightly plastic (wet); friable (moist); slightly hard to hard (dry); strongly calcareous.

ANALYTICAL DATA FOR SITE K41

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K187	0-9	A1	-	-	87	6	7	ls
K188	9-32	IIC	-	-	53	38	9	sl
K189	32-94	IIIC	-	-	93	4	3	s
K190	94-125	IVC	-	-	77	17	6	ls
K191	125-134	VC	-	-	91	5	4	s
K192	134-157	VIC	-	-	71	21	8	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K187	8.3	0.53	1.20	14.6	7.33
K188	7.9	2.3	1.20	14.1	6.76
K189	7.9	2.4	1.09	12.2	6.41
K190	7.9	4.3	1.02	12.7	7.05
K191	8.0	.7	0.94	12.9	8.24
K192	7.8	5.8	-	16.6	8.24

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K42

SITE INFORMATION

Classification: TYPIC TORRIFLUVENT, SANDY, MIXED, CALCAREOUS, ISOHYPERTHERMIC FAMILY
Date and time described: December 16, 1981
Authors: J. King
Location: In the southern Tihama 500m from the Red Sea, 4.7km north of Al Khawkhah, immediately north of village of Buzahr
Elevation: 43m
Physiographic position: Convex slope of low gravel hill about 15m high
Topography of surrounding country: Undulating
Microtopography: None
Slope: 3^0 or 5%
Land use: Vegetation, infrequent, scattered sage
Climate: 1. Annual rainfall: <100mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Isohyperthermic.

SOIL INFORMATION

Parent material: Gravelly to fine stratified fine calcareous alluvium, sand, and gravel of volcanic origin.
Drainage class: Class 4, well drained
Moisture conditions: Dry throughout
Depth to groundwater: Not known, but no effects on profiles
Surface stones or outcrops: Small gravel covers 80% of the surface
Evidence of erosion: Wind erosion which has left surface covered with gravel
Salt content: Calcareous
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: This profile is made up of dominantly coarse alluvial materials. The profile is greyish-brown to brown throughout. Horizons are differentiated by stratification of materials of different texture. Calcium mycelia appear at 56cm and at 121-178cm large random calcium nodules are present in the profile.

Profile Description

A1 0-9cm K193	Dark brown, 10YR 3/3 (moist) and brown, 10YR 5/3 (dry); slightly gravelly loamy sand; weak, coarse, platey structure; nonsticky, nonplastic (wet); very friable (moist); loose (dry); few rounded fresh gravels; strongly calcareous; abrupt, smooth boundary.

C 9-56cm K194	Dark greyish-brown, 10YR 4/2 (moist) and brown, 10YR 5/3 (dry); gravelly loamy sand; weak, medium, subangular blocky structure; slightly sticky, nonplastic (wet); very friable (moist); loose (dry); frequent rounded fresh gravel; strongly calcareous; common very fine roots; clear, wavy boundary.
IIC 56-91cm K195	Dark brown, 10YR 3/3 (moist) and brown, 10YR 5/3 (dry); sandy loam; moderate, medium, subangular blocky structure; nonsticky, nonplastic (wet); friable (moist); loose to slightly hard (dry); strongly calcareous; common very fine roots; abrupt, wavy boundary.
IIIC 91-104cm K196	Very dark greyish-brown, 10YR 3/2 (moist) and greyish-brown, 10YR 5/2 (dry); gravelly loamy sandy; nonsticky, nonplastic (wet); friable (moist); loose (dry); frequent rounded fresh gravel; strongly calcareous; few very fine roots; abrupt, wavy boundary.
IVC 104-121cm K197	Dark brown, 10YR 3/3 (moist) and grey, 10YR 5/3 (dry); sandy loam; moderate coarse prismatic structure; slightly sticky, nonplastic (wet); friable (moist); soft to slightly hard (dry); very frequent rounded fresh gravel; strongly calcareous; few very fine roots; abrupt, wavy boundary.
VC 122+cm K198	Dark greyish-brown, 10YR 4/2 (moist) and greyish-brown, 10YR 5/2 (dry); very gravelly sand; nonsticky, nonplastic (wet); friable (moist); loose to soft (dry); strongly calcareous.

ANALYTICAL DATA FOR SITE K42

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K193	0-9	A1	f	g	85	9	6	ls
K194	9-56	C	fr	g	85	7	8	ls
K195	56-91	IIC	-	-	69	25	6	sl
K196	91-104	IIIC	fr	g	85	11	4	ls
K197	104-121	IVC	vfr	g	69	27	4	sl
K198	122+	VC	fr	g	69	7	4	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K193	7.8	1.18	1.28	15.1	13.10
K194	7.8	1.28	0.61	15.1	7.51
K195	7.4	4.20	0.55	14.7	8.84
K196	7.6	4.30	0.51	14.5	7.05
K197	7.5	5.30	0.45	13.6	5.77
K198	7.6	3.90	0.45	11.6	5.31

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K43

SITE INFORMATION

Profile number: 43 (SCS-USDA) (S-82-YE-965-2)
Classification: ENTIC HAPLUDOLL, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: January 10, 1982
Authors: A. Van Wambeke, J. King, A. E. Abu Ghanem
Location: Road cut 0.35km from radio relay station on summit of Jabal Sabir on road to Taizz
Elevation: 2840m
Physiographic position: Slightly convex slope
Topography of surrounding country: Mountainous
Microtopography: None
Slope: 40% steep
Land use: Grazing
Climate: No information available

SOIL INFORMATION

Parent material: Acidic igneous rock
Drainage class: Class 4, well drained
Moisture conditions: Dry throughout
Depth to groundwater: Not known, no effect on profile
Surface stones or outcrops: Rubble land, rock outcrops and boulders cover 90% of the land
Evidence of erosion: Bare rocks, small hummocks would indicate some water erosion.
Salt content: None
Human influence: none

GENERAL DESCRIPTION OF THE PROFILE: The profile is dark brown throughout with two clear differences in structure. The two top horizons appear granular and the lowest horizon appears more massive.

Profile Description

A1 0-20cm K198	Black, 10YR 2/1 (moist) on aggregate, very dark brown, 10YR 2/2 (dry); sandy loam; moderate, medium, subangular blocky to crumb structure; slightly sticky, slightly plastic; friable; soft to slightly hard; many very fine tubular pores; very few fresh slightly angular stones; noncalcareous frequent fine to coarse roots; gradual, wavy boundary.

IIA1 20-35cm K200	Very dark brown, 10YR 2/2 (moist) and very dark greyish-brown, 10YR 3/2 (dry); sandy loam; moderate, coarse, subangular blocky to weak crumb structure; slightly sticky, slightly plastic; friable; soft to slightly hard; common very fine tubular and few coarse tubular pores; very fine horizontal cracks, few fresh slightly angular gravel mineral fragments; noncalcareous; common fine to coarse roots; clear, wavy boundary.
C 35-87cm K201	Dark brown, 10YR 2/2 (moist) and very dark greyish-brown, 10YR 3/2 (dry); sandy loam; moderate, coarse, subangular blocky to crumb structure; slightly sticky, slightly plastic; friable; soft to slightly hard; few very fine tubular pores; few fresh slightly angular stones; noncalcareous; common fine to coarse roots.

ANALYTICAL DATA FOR SITE K43

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K199	0-20	A1	vf	s	54	38	8	sl
K200	20-35	IIA1	f	g	70	22	8	sl
K201	35-87	C	f	s	64	24	12	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K199	6.75	0.24	9.4	5.5	7.33
K200	6.75	0.11	5.8	4.5	5.77
K201	6.75	0.11	2.9	4.5	6.41

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K44

SITE INFORMATION

Classification: TYPIC HAPLUDOLL, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: January 10, 1982
Authors: A. Van Wambeke, J. King, A. E. Abu Ghanem
Location: Road cut on left side of road 6.2km from summit of Jabal Sabir on road to Taizz
Elevation: 2460m
Physiographic position: Concave between vertical ridges of the straight slope
Topography of surrounding country: Mountainous
Microtopography: Flat surface because of contour terracing
Slope: 16^0 or 29% between terraces, 1% on terraces
Land use: Rain-fed farming, potatoes, barley, beans, lentils
Climate: Not given

SOIL INFORMATION

Parent material: Caluvient derived from acidic volcanic rock
Drainage class: Class 4, well drained
Moisture conditions: Moist below 15cm
Depth to groundwater: Not known, no effect on profile
Surface stones or outcrops: Class 4, 80% coverage, but with approximately half gravel and half stones
Evidence of erosion: Some deterioration of terraces because of road building activity in the immediate area
Salt content: None
Human influence: Terracing

GENERAL DESCRIPTION OF THE PROFILE: The profile is apparently a man-made soil resulting from cutting and filling which put an A1 horizon at the bottom of the profile. Some evidence of genetic development in the upper horizons with the fourth horizon showing significantly more chroma than the fifth horizon.

Profile Description

A11 0-7cm K202	Dark brown, 10YR 3/3 (moist) and brown, 10YR 4/3 (dry); very gravelly to stony sandy loam; weak crumb to structureless structure; nonsticky, nonplastic (wet); friable (moist); loose (dry); frequent fresh subangular gravel to stones of igneous origin; noncalcareous; common fine roots; clear, smooth boundary.

A12 7-27cm K203	Dark brown, 10YR 3/3 (moist) and brown, 10YR 4/3 (dry); gravelly sandy loam; moderate, subangular blocky to moderate crumb structure; slightly sticky, slightly plastic (wet); friable (moist); soft (dry); very fine to fine tubular pores; frequent fresh subangular gravel to stones of igneous origin; noncalcareous; common fine roots; gradual, smooth boundary.
B1 20-38cm K204	Dark brown, 10YR 3/3 (moist) and brown, 10YR 4/3 (dry); gravelly loam; moderate, medium to fine subangular blocky structure; sticky, slightly plastic (wet); friable (moist); slightly hard (dry); many very fine to fine tubular pores; frequent fresh subangular gravel to stone of igneous origin; noncalcareous; few fine to medium roots; gradual, smooth boundary.
C 38-73cm K205	Dark brown, 10YR 3/3 (moist) and brown, 10YR 4/3 (dry); gravelly to stony sandy loam; moderate, medium to fine subangular blocky structure; nonsticky, nonplastic (wet); friable (moist); soft (dry); many very fine to fine tubular pores; frequent subangular gravel to stones of igneous origin; noncalcareous; very few medium to fine roots; gradual, smooth boundary.
IIC 73-127cm K206	sandy loam.
IIIC 127-225cm K207	Very dark brown, 10YR 2/2 (moist) and very dark greyish-brown, 10YR 3/2 (dry); gravelly to slightly stony sandy loam; moderately medium to fine subangular blocky structure; nonsticky, nonplastic (wet); friable (moist); slightly hard (dry); many very fine to fine tubular pores; frequent fresh subangular gravel to stone of igneous origin; noncalcareous.

ANALYTICAL DATA FOR SITE K44

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K202	0-7	A11	fr	g,s	56	36	8	sl
K203	7-27	K204	fr	g,s	52	38	10	sl
K204	20-38	B1	fr	g,s	46	38	16	l
K205	38-73	C	fr	g,s	52	36	12	sl
K206	73-127	IIC-	-		56	32	12	sl
K207	127-225	IIICfr		gs	52	35	13	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)
K202	7.50	0.19	2.2	5.9	8.24
K203	7.55	0.15	2.2	4.0	10.76
K204	7.45	0.21	1.2	3.7	8.70
K205	7.65	0.10	0.8	4.4	7.14
K206	7.50	0.20	1.2	4.5	7.33
K207	7.65	0.10	1.2	5.4	11.90

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K45

SITE INFORMATION

Profile number: 45 (S-82-YE-965-3)(SCS-USDA)
Classification: VERTIC HAPLUSTOLL, FINE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: January 17, 1982
Authors: J. King, A. Van Wambeke and A. E. Abu Ghanem
Location: Intermountain plains, 75m from north corner of milking parlor at the Rabat dairy farm
Elevation: 2450m
Physiographic position: Area of slight depression on broad intermountain plain
Topography of surrounding country: Almost flat
Microtopography: None
Slope: 1^0 or 2%
Land use: Tight cover of short grass
Climate: Calculated as udic

SOIL INFORMATION

Parent material: Fine alluvium
Drainage class: Class 3, moderately well drained
Moisture conditions: moist below 29cm
Depth to groundwater: 3m
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: None
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: not given

Profile Description

Ap 0-9cm K208	Very dark greyish-brown, 10YR 3/2 (moist) and very dark greyish-brown 10YR 3/2 and dark greyish-brown 10YR 4/2 (dry); clay; fine subangular blocky to crumb structure with only crumb structure at the surface; slightly sticky, plastic; friable; hard; no pores; no mineral fragments or nodules; strongly calcareous; frequent medium to fine roots; clear, smooth boundary.

A1 9-29cm K209	Very dark grey 10YR 3/1 (moist) and dark greyish-brown 10YR 4/2 (dry); silty clay loam; strong medium to fine subangular structure; sticky, very plastic; friable; slightly hard; no pores; no mineral fragments or nodules; moderately calcareous; many medium to fine roots; clear, smooth boundary.
A3 29-42cm K210	Very dark grey 10YR 3/1 (moist) and grey 10YR 5/1 and greyish-brown 10YR 5/2 (dry); clay; strong coarse to fine subangular blocky structure with oblique 1cm cracks; sticky, very plastic; friable; slightly hard; few fine interstitial pores; very few gravel and stones and few small hard irregular white nodules; moderately calcareous; common fine roots roots; gradual smooth boundary.
Cca 42-68cm K211	Very dark greyish-brown 10YR 3/2 (moist) and greyish-brown 10YR 5/2 (dry); clay; strong coarse to fine subangular blocky structure; oblique vertical 1cm cracks to 55cm; sticky, plastic; friable; hard; no pores; few small hard irregular white nodules; moderately calcareous; few fine roots; gradual smooth boundary.
IIC 68-115cm K212	Very dark greyish-brown 10YR 5/2 (moist) and greyish 10YR 5/3 and greyish-brown 10YR 5/2 (dry); clay; strong coarse to fine subangular blocky structure; sticky, plastic; friable; very hard; few fine interstitial pores; few small hard irregular white nodules; non calcareous; few fine roots; clear smooth boundary.
IIIC 115+cm K213	Very dark greyish-brown 10YR (moist) and light brownish-grey 10YR 6/2 and brown 10YR 5/3 (dry); clay; strong, medium prismatic to strong medium to fine subangular blocky structure; sticky, very plastic; friable; very hard; few fine interstitial pores; few small hard irregular white nodules; non calcareous; few fine roots;

ANALYTICAL DATA FOR SITE K45

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K208	0-9	Ap	-	-	25	41	34	cl
K209	9-29	A1	-	-	21	33	46	c
K210	29-42	A3	-	-	15	35	50	c
K211	42-68	Cca	-	-	15	39	46	c
K212	68-115	IIC	-	-	25	33	42	c
K213	115+	IIIC	-	-	27	44	29	cl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K208	7.2	0.33	7.9	15	40	40
K209	7.3	0.18	5.5	16.5	30	41
K210	7.5	0.18	1.34	8.8	20	33
K211	7.7	0.20	0.89	9.4	10	31
K212	7.5	0.14	0.30	8.0	8	27
K213	7.4	0.75	0.41	6.5	7	20

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K46

SITE INFORMATION

Series name: Yakhtul series
Classification: TYPIC SALORTHID, SANDY, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: March 9, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 500m east of the Red Sea, 3km south of Yakhtul on the Tihama north of Al Mukha
Elevation: 1m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: Surface of the soil has buckled into small ridges
Slope: 1^0 or 2%
Land use: None
Climate: No infomation

SOIL INFORMATION

Parent material: Mixture of beach sand, loess and fine materials from the Tihama and the coarser materials from the beach
Drainage class: Poorly drained due to a high water table
Moisture conditions: Profile moist throughout
Depth to groundwater: 64cm
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: Some salt accumulations on the surface suspected strong influence throughout the profile
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: From 0-11cm this profile has an area of coarse sand with some salt accumulations. From 11-28cm it is slightly darker than from 28-64cm.

Profile Description

A1 0-11cm K214	Dark brown 10YR 3/3 (moist) and grey 10YR 6/1 and 10YR 7/1 light grey (dry); sandy loam; no structure; nonsticky, nonplastic (wet); very friable (moist); soft (dry); no pores; no mineral fragments; very slightly calcareous; no roots; clear, smooth boundary.

B11 11-28cm K215	Very dark greyish-brown 10YR 3/2 (moist) and greyish-brown 10YR 5/2 and brown 10YR 5/3 (dry); sand; no structure; nonsticky, nonplastic (wet); very friable (moist); soft (dry); no pores; no mineral fragments; noncalcareous; no roots; clear, smooth boundary.
B12 28-64cm K216	Very dark greyish-brown 10YR 3/2 (moist) and greyish-brown 10YR 5/2 and brown 10YR 5/3 (dry); sand; no structure; nonsticky, nonplastic (wet); loose (moist);--(dry); no pores; noncalcareous; no roots.

ANALYTICAL DATA FOR SITE K46

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K214	0-11	A1	-	-	72	18	10	sl
K215	11-28	B11-	-	96	2	6	s	
K216	28-64	B12	-	-	98	2	4	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K214	7.3	85.	0.91	10.2	16.6	5.6
K215	7.7	20.	0.49	8.4	1.	5.6
K216	7.8	29.	0.11	7.6	2.	5.4

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K47

SITE INFORMATION

Classification: TYPIC CALCIORTHID, COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: March 10, 1982
Authors: J. King and A. E. Abu Ghanem
Location: Near Al Mukha
Elevation: 122m
Physiographic position: Plain formed by wadis, plain with shallow wadi cuts
Topography of surrounding country: Flat with volcanic mountains within a half kilometer
Microtopography: None
Slope: 2^0 or 5%
Land use: Sage, Accacia, light grazing
Climate: No infomation

SOIL INFORMATION

Parent material: Coarse alluvium of mixed origin
Drainage class: well drained
Moisture conditions: Dry throughout
Depth to groundwater: No effect on profile
Surface stones or outcrops: Gravelly to stony desert pavement covers the surface of the soil, stones just cover it enough to make it a Class 1 (fairly stony) surface
Evidence of erosion: Some wind-blown sand
Salt content: Profile is calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: This is a coarse alluvial soil which is calcareous throughout. It has a horizon of maximum calcium accumulation from 39-74cm.

Profile Description

A1 0-2.5cm K217	Brown 10YR 4/3 (moist) and pale brown, 10YR 6/3 and pale brown 10YR 6/3 (dry); very gravelly to stony sandy loam; no structure; slightly sticky, slightly plastic (wet); very friable (moist); soft (dry); numerous very fine pores giving a honeycombed appearance; very frequent, angular to rounded weathered gravel to stones; strongly calcareous; no roots; clear smooth boundary.

B11
2.5-39cm
K218

Brown 10YR 4/3 (moist) and yellowish-brown 10YR 5/4 (dry); very gravelly to bouldery sandy loam; no structure; slightly plastic (wet); very friable (moist); loose (dry); few very fine tubular pores; very frequent, angular to rounded weathered gravel, stones and boulders; strongly calcareous; common fine roots; gradual smooth boundary.

B12
39-74cm
K219

Yellowish brown 10YR 5/4 (moist) and pale brown 10YR 6/3 (dry); very gravelly to bouldery sandy loam; no structure; nonsticky, nonplastic (wet); very friable (moist); loose (dry); few very fine tubular pores; very frequent, angular to rounded weathered gravel to stones; strongly calcareous; few fine roots; abrupt smooth boundary.

C
74-86cm
K220

Brown 10YR 4/3 (moist) and pale brown 10YR 6/3 (dry); very gravelly to stony loamy sand; no structure; nonsticky, nonplastic (wet); very friable (moist); loose (dry); very few very fine tubular pores; very frequent, angular to rounded weathered gravel to stones; strongly calcareous; very few fine roots; clear wavy boundary.

IIC
86-100cm
K221

Brown 10YR 4/3 (moist) and pale rub 10YR 6/3 (dry); very gravelly to bouldery sandy loam; fine weak subangular blocky structure; nonsticky, nonplastic (wet); very friable (moist); soft (dry); common very fine tubular pores; very frequent, angular to rounded weathered gravel, stones to boulders; strongly calcareous; very few fine roots; gradual wavy boundary.

IIIC
100-150+cm
K222

Brown 10YR 4/3 (moist) and light grey, 10YR 7/2 (dry); very gravelly to bouldery sandy loam; no structure; nonsticky, nonplastic (wet); very friable (moist); loose (dry); no pores; very frequent, angular to rounded weathered gravel, stones and boulders; strongly calcareous; no roots.

ANALYTICAL DATA FOR SITE K47

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K217	0-2.5	A1	-	-	68	28	4	sl
K218	2.5-39	B11	-	-	68	28	4	sl
K219	39-74	B12	-	-	70	20	10	sl
K220	74-86	C	-	-	88	8	4	ls
K221	86-100	IIC	-	-	72	20	8	sl
K222	100-150	IIIC	-	-	80	12	8	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	$CaCO^3$ (%)	Avail P (ppm)	C E C me/100g
K217	7.2	31.	1.63	12.4	9.	12.4
K218	6.9	17.5	1.52	15.2	3.	14.3
K219	7.2	5.9	1.48	20.	8.	12.8
K220	7.4	3.7	1.10	9.5	1.	10.4
K221	7.0	5.1	1.25	16.7	3.	12.4
K222	7.3	4.95	1.41	12.2	3.	9.8

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K48

SITE INFORMATION

Classification: TYPIC TORRIFLUVENT, COARSE LOAMY, MIXED, CALCAREOUS, ISOHYPERTHERMIC FAMILY
Date and time described: March 10, 1982
Authors: J. King and A. E. Abu Ghanem
Loacation: Near Al Mukha
Elevation: 126m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: 1^0 or 2%
Land use: Bunch grass, Acacia, light grazing
Climate: No information

SOIL INFORMATION

Parent material: Primarily silty alluvium with some gravel strata
Drainage class: Class 4, well drained
Moisture conditions: Dry throughout
Depth to groundwater: Unknown, but no effect on profile
Surface stones or outcrops: No stones, but the surface is covered with gravel
Evidence of erosion: Desert pavement and some accumulations of fine material where there is low vegetation
Salt content: The profile is calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: The profile is primarily made up of pale brown to brown fine silty alluvium. Final development is limited to the movement of calcium which has accumulated from 53-137cm. However, the profile is strongly calcareous throughout.

Profile Description

Ap 0-15cm K223	Brown; 10YR 4/3 (moist) and very pale brown 10YR 7/3, pale brown 10YR 6/3 (dry); slightly gravelly silt loam; moderate to weak medium subangular blocky to platey structure; slightly sticky, slightly plastic (wet); very friable (moist); soft (dry); in the top 2cm, many fine tubular pores, from 2 to 15cm, few medium tubular pores; very few slightly rounded weathered gravel; strongly calcareous; no roots; wavy, clear boundary.

C 15-29cm K224	Brown, 10YR 4/3 (moist) and yellowish-brown 10YR 5/4 (dry); slightly gravelly silt; structureless; slightly sticky, slightly plastic (wet); very friable (moist); loose to soft (dry); no pores; very few slightly rounded weathered gravel; strongly calcareous; no roots; clear, smooth boundary.
IIC 29-53cm K225	Brown, 10YR 4/3 (moist) and pale brown 10YR 6/3 (dry); very gravelly loam; strutureless; slightly sticky, slightly plastic (wet); friable (moist); loose to soft (dry); few fine tubular pores; frequent slightly rounded gravel; strongly calcareous; no roots; gradual, smooth boundary.
IIIC 53-102cm K226	Yellowish-brown 10YR 5/4 (moist) and 10YR 6/3 pale brown (dry); very gravelly slightly loam; structureless; slightly sticky, slightly plastic (wet); friable (moist); slightly hard to loose (dry); few fine tubular pores; frequent slightly rounded gravel; strongly calcareous; no roots; gradual, smooth boundary.
IVC 102-116cm K227	Brown 10YR 4/3 (moist) and 10YR 6/3 very pale brown (dry); slightly gravelly loam; moderate medium subangular blocky structure; sticky, plastic (wet); friable (moist); hard to slightly hard (dry); few fine tubular pores; frequent slighly rounded gravel; strongly calcareous; no roots; clear, wavy boundary.
VC 116-137cm K228	Brown 10YR 4/3 (moist) and very pale brown 10YR 7/4 (dry); gravelly to stony silty loam; structureless; nonsticky, nonplastic (wet); very friable (moist); soft to slightly hard (dry); few fine tubular pores; frequent slightly rounded fresh gravel and stone; strongly calcareous; no roots; clear, smooth boundary.
VIC 137-150cm K229	Brown 10YR 4/3 (moist) and yellowish-brown 10YR 5/4 (dry); slightly gravelly loam; moderate medium subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); soft (dry); few fine tubular pores; few slightly rounded fresh gravel and stone; strongly calcareous; no roots.

ANALYTICAL DATA FOR SITE K48

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K223	0-15	Ap	-	-	28	66	6	sil
K224	15-29	C	-	-	20	74	6	sil
K225	29-53	IIC	-	-	42	48	10	l
K226	53-102	IIIC	-	-	34	46	20	l
K227	102-116	IVC	-	-	30	50	20	l
K228	116-137	V	-	-	44	54	2	sil
K229	137-150	VIC	-	-	60	38	2	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K223	7.8	0.73	1.63	10.7	8.0	13.5
K224	7.7	2.1	1.22	10.5	14.0	15.0
K225	7.1	8.6	1.29	10.1	12.6	14.8
K226	6.8	10.2	1.14	10.0	14.0	14.4
K227	6.9	10.3	1.22	10.8	8.0	13.0
K228	7.0	7.4	11.6	11.6	0.99	11.0
K229	7.0	7.7	1.06	12.6	10.0	15.2

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K48

SITE INFORMATION

Classification: TYPIC SALORTHID,COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY, HUMMOCKY PHASE
Date and time described: March 11, 1982
Authors: J. King and A. E. Abdu Ghanem
Location: At Ruys about 2km north of Yakhtul
Elevation: 7m
Physiographic position: Plain
Topography of surrounding country: Flat or almost flat
Microtopography: Scattered, covering about 30% of the land, the hummocks are up to about a meter and a half high
Slope: 1^0 or 2%
Land use: Bermuda type vegetation covering the hummocks; the vegetation is used for light grazing, there is no vegetation betweeen the hummocks
Climate: No information

SOIL INFORMATION

Parent material: Mixture of light alluvium and loess
Drainage class: Class 2, wet for long periods of time
Moisture conditions: Moist below 10cm
Depth to groundwater: Unknown, but shallow due to the closeness to the Red Sea
Surface stones or outcrops: None, but fine gravel and sand covers the surface
Evidence of erosion: Wind erosion is shown by the hummocks where vegetation has caught the soil
Salt content: Some white frosting on the soil and some evidence of salt in the profile itself, but it is not certain whether this is calcareous salt or actual saline conditions
Human influence: No information given

GENERAL DESCRIPTION OF THE PROFILE: The surface 26cm of this profile is made up of wind-blown sand. The rest of the profile consists of brown stratified alluvium ranging in texture from clay loam to loamy sand.

Profile Description

Ap 0-10cm K238	Brown, 10YR 4/3 (moist) and brown 10YR 5/3 and 10YR 6/3 (dry); sandy loam; structureless; nonsticky, nonplastic (wet); loose (moist); soft (dry); no pores; no mineral fragments; calcareous; common medium roots; clear, smooth boundary.
B1 10-26cm K239	Brown, 10YR 4/3 (moist) and light yellowish-brown 10YR 6/4 and very pale brown, 10YR 7/4 (dry); slightly gravelly loamy sand; weak medium subangular blocky structure; nonsticky, nonplastic (wet); very friable (moist); soft to loose (dry); no pores; few fresh slightly rounded gravel; calcareous; common medium roots; clear, smooth boundary.
IIC 26-36cm K240	Brown, 10YR 4/3 (moist) and brown 10YR 5/3 and pale brown 10YR 6/3 (dry); slightly gravelly sandy loam; weak medium subangular blocky structure; nonsticky, nonplastic (wet);--(moist); soft to loose (dry); few fine tubular pores; few fresh slightly rounded gravel; strongly calcareous; common medium roots; clear, smooth boundary.
IIIC 36-63cm K241	Brown, 10YR 4/3 (moist) and brown 10YR 5/3 and pale brown 10YR 6/3 (dry); sandy loam; moderate medium subangular blocky structure; sticky, plastic (wet); very friable (moist); soft (dry); few very fine tubular pores; no mineral fragments; strongly calcareous; common medium roots; gradual, smooth boundary.
IVC 36-63cm K242	Brown, 10YR 4/3 (moist) and brown 10YR 5/3 and pale brown 10YR 6/3 (dry); loam; weak medium subangular blocky structure; sticky, plastic (wet); friable (moist); soft (dry); few very fine tubular pores; no mineral fragments; strongly calcareous; common medium roots; gradual, smooth boundary.
VC 95-116cm K243	Dark greyish-brown 10YR 4/2 (moist) and brown 10YR 5/3 and pale brown 10YR 6/3 (dry); sandy loam; moderate medium subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); soft (dry); few very fine tubular pores; no mineral fragments; strongly calcareous; common medium roots; gradual, smooth boundary.

VIC 116-168+cm K244	Dark greyish-brown 10YR 4/2 (moist) and pale brown 10YR 6/3 and very pale brown 10YR 7/3 (dry); loam; moderate medium subangular blocky structure; sticky, plastic (wet); friable (moist); soft (dry); few very fine tubular pores; no mineral fragments; strongly calcareous.

ANALYTICAL DATA FOR SITE K49

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K238	0-10	C	Ap	-	72	14	14	sl
K239	10-26	C	B1	-	80	12	6	ls
K240	26-36	C	IIC	-	76	16	8	sl
K241	36-63	C	IIIC	-	54	34	12	sl
K242	36-63	C	IVC	-	44	46	10	l
K243	95-116	C	VC	-	70	20	10	sl
K244	116-168	C	VIC	-	48	42	10	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K238	7.7	85.0	2.05	7.0	9.	8.0
K239	8.1	23.0.	0.95	9.5	9.	10.0
K240	8.0	16.0	1.25	11.2	6.	22.0
K241	7.9	14.4	1.06	13.5	9.	28.0
K242	7.3	13.6	1.22	13.4	9.	35.0
K243	7.4	10.0	1.14	12.3	9.	16.0
K244	7.4	8.8	1.10	11.5	10.	9.0

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K50

SITE INFORMATION

Classification: TYPIC TORRIORTHENT, COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY, SALINE PHASE
Date and time described: March 11, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 4km west of the Red Sea and 5km north of Yakhtul
Elevation: 8m
Physiographic position: Slightly concave slope of low hill from dilation in alluvial plain
Topography of surrounding country: Slightly undulating plain
Microtopography: Sand hummocks up to a meter and a half in height
Slope: 2^0 or 1%
Land use: Light grazing, vegetation on hummocks to be identified later
Climate: No information

SOIL INFORMATION

Parent material: Alluvium and loess
Drainage class: Class 5, well drained
Moisture conditions: Moist below 90cm
Depth to groundwater: Unknown, but probably comparatively shallow
Surface stones or outcrops: Few stones on the surface but coarse sand, fine gravel and stones cover the entire surface
Evidence of erosion: Wind erosion is shown by the coarse material covering the surface, sand dunes in the immediate area and hummocks
Salt content: Some salt accumulations, probably calcareous
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: This profile consists of stratified brown alluvium under a surface layer. Texture of the stratified material ranges from very gravelly sand to silt. Evidence of calcium accumulation is limited to very few mycelia in horizons 2 and 3 and calcareous nodules in horizon 7. It is not clear if the calcareous nodules were developed in situ or transported to this location.

Profile Description

C 0-3cm K230	Dark greyish-brown 10YR 4/2 (moist) and brown 10YR 5/3 (dry); loam; no structure; nonsticky, nonplastic (wet); loose (moist);--(dry); no pores; frequent sharp to slightly weathered gravel; strongly calcareous; no roots; abrupt, smooth boundary.

IIC 3-10cm K231	Dark brown 10YR 3/3 (moist) and brown 10YR 5/3 and yellowish-brown 10YR 5/3 (dry); loamy sand; weak medium subangular blocky structure; nonsticky, nonplastic (wet); loose to soft (moist);--(dry); few very fine tubular pores; few sharp to slightly rounded weathered gravel; very few calcium mycelia; strongly calcareous; no roots; clear, smooth boundary.
IIIC 10-24cm K232	Dark greyish-brown 10YR 4/2 (moist) and brown, 10YR 5/3 and brown 10YR 5/3 (dry); slightly gravelly loamy sand; weak medium subangular blocky structure; nonsticky, nonplastic (wet); loose (moist);--(dry); no pores; few sharp to slightly rounded weathered gravel; very few calcium mycelia; strongly calcareous; no roots; clear, wavy boundary.
IVC 24-69cm K233	Very dark greyish-brown 10YR 3/2 (moist) and greyish-brown 10YR 5/2 (dry); very gravelly sand; no structure; nonsticky, nonplastic (wet); loose (moist);--(dry); no pores; very frequent weathered rounded gravel to stone; strongly calcareous; no roots; clear, wavy boundary.
VC 69-95cm K234	Very dark greyish-brown 10YR 3/1 (moist) and grey, 10YR 5/1 (dry); very gravelly sand; no structure; nonsticky, nonplastic (wet); loose (moist);--(dry); no pores; very frequent rounded gravel to stone; calcareous; no roots; clear, wavy boundary.
VIC 95-112cm K235	Brown 10YR 4/3 (moist) and pale brown 10YR 6/3 and light yellowish-brown 10YR (dry); gravelly sandy loam; moderate medium subangular blocky structure; slightly sticky, nonplastic (wet); friable (moist); soft (dry); no pores; few rounded fine fresh gravel; strongly calcareous; no roots; clear, wavy boundary.
VIIC 112-124cm K236	Brown 10YR 4/3 (moist) and brown 10YR 5/3 (dry); loam; moderate medium subangular blocky structure; sticky, plastic (wet); friable (moist); soft (dry); no pores; common small hard white calcareous nodules; strongly calcareous; no roots; clear, wavy boundary.
VIIIC 124-150cm K237	Very dark greyish-brown 10YR 3/2 (moist) and dark greyish-brown 10YR 5/2 and brown 10YR 5/3 (dry); loamy sand; no structure; nonsticky, nonplastic (wet); loose to soft (moist);--(dry); no pores; no mineral fragments; strongly calcareous; no roots;

ANALYTICAL DATA FOR SITE K50

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K230	0-3	C	-	-	54	44	2	l
K231	3-10	IIC	-	-	78	16	6	ls
K232	10-24	IIIC	-	-	80	12	8	ls
K233	24-69	IVC	-	-	94	4	2	s
K234	69-95	VC	-	-	96	2	2	s
K235	95-112	VIC	-	-	72	20	8	sl
K236	112-124	VIIC	-	-	46	38	16	l
K237	124-150	VIIIC	-	-	84	12	4	ls

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K230	7.5	4.1	1.10	7.0	15.0	6.25
K231	7.5	5.8	1.06	8.5	8.0	10.00
K232	7.5	7.8	1.22	9.3	8.0	9.75
K233	7.7	8.2	0.72	7.8	6.0	8.75
K234	7.7	7.6	1.06	6.2	11.6	8.50
K235	7.7	14.4	1.33	5.8	5.0	11.25
K236	7.5	21.0	1.29	5.2	14.0	30.00
K237	8.0	4.0	1.18	8.9	9.0	20.00

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K51

SITE INFORMATION

Classification: TYPIC TORRIORTHENT, COARSE LOAMY, MIXED, CALCAREOUS, HYPERTHERMIC FAMILY
Date and time described: April 22, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 2km west of Al Safia, in Al Jawf Province: 16° 9' N, 44° 23' E
Elevation: 1240m
Physiographic position: Concave, foot slope
Topography of surrounding country: Steeply dissected
Microtopography: None
Slope: 20° or 37%
Land use: Vegetation is sparse, used for light grazing
Climate: 1. Annual Rainfall: 100mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Hyperthermic.

SOIL INFORMATION

Parent material: Calcareous loess and colluvium
Drainage class: Well drained
Moisture conditions: Moist below 30cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: Rubble land
Evidence of erosion: Moderate gully erosion
Salt content: Profile strongly calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: None

Profile Description

C 0-28cm K245	Yellowish-brown 10YR 5/4 (moist), and light yellowish-brown 10YR 6/4 (dry aggregate) and light yellowish-brown 10YR 6/4 (dry rubbed); sandy loam; weak medium to fine subangular blocky structure; nonsticky and nonplastic (wet); friable (moist); soft (dry); no pores; sequence of fresh sharp gravel to stone of sedimentary and volcanic origin; strongly calcareous; few fine roots; clear, smooth boundary.

IIC 28-46cm K246	Yellowish-brown 10YR 5/4 (moist), very pale brown 10YR 7/3 (dry aggregate) and very pale brown 10YR 7/3 (dry rubbed); sandy loam; weak medium to fine subangular blocky structure; nonsticky and nonplastic (wet); friable (moist); soft (dry); no pores; few fresh sharp gravel to stone of sedimentary and volcanic origin; strongly calcareous; few fine roots; clear, smooth boundary.
IIIC 46-66cm K247	Dark brown 10YR 4/3 (moist), pale brown 10YR 6/3 (dry aggregate) and pale brown 10YR 6/3 (dry rubbed); sandy loam; weak fine subangular blocky structure; nonsticky and nonplastic (wet); very friable (moist); loose (dry); no pores; few slightly rounded gravel of sedimentary and volcanic origin; strongly calcareous; very few fine roots; clear, smooth boundary.
IVC 66-86cm K248	Dark grayish-brown 10YR 4/2 (moist), light grayish-brown 10YR 6/2 (dry aggregate) and light grayish-brown 10YR 6/2 (dry rubbed); sandy loam; strong medium to subangular blocky structure; nonsticky and nonplastic (wet); firm (moist); slightly hard (dry); few fine tubular pores; strongly calcareous; no roots; gradual, smooth boundary.
VC 86-115cm K249	Dark grayish-brown 10YR 4/2 (moist), light gray 10YR 6/1 (dry aggregate) and 10YR 6/1 (dry rubbed); silt loam; moderate medium to fine subangular blocky structure; nonsticky and nonplastic (wet); friable (moist); slightly hard (dry); no pores; strongly calcareous; no roots.

ANALYTICAL DATA FOR SITE K51

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K245	0-28	C	-	-	60	34	6	sl
K246	28-46	IIC	-	-	64	32	4	sl
K247	46-66	IIIC	-	-	72	26	2	sl
K248	66-86	IVC	-	-	64	34	2	sl
K249	86-115	VC	-	-	46	52	2	si

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K245	7.70	0.23	1.63	21.8	7.	8.4
K246	7.15	3.70	1.7[illegible]	22.0	12.	20.0
K247	7.35	9.90	1.86	24.09	7.	24.
K248	7.40	13.00	2.20	24.9	3.	23.0
K249	7.20	14.00	2.20	24.9	6.	21.0

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K52

SITE INFORMATION

Classification: TYPIC USTIFLUVENT, COARSE LOAMY, MIXED, CALCAREOUS, HYPERTHERMIC FAMILY
Date and time described: April 22, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 1/2km east of the village of Al Safia, in the Al Jawf Province 16° 9' N 44° 23' E
Elevation: 1240m
Physiographic position: Valley bottom
Topography of surrounding country: Flat
Microtopography: Bunds 40cm high around fields.
Slope: None
Land use: Used for watermelon and wheat production, now out of production,
Climate: 1. Annual rainfall: 100mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Hyperthermic

SOIL INFORMATION

Parent material: Fine calcareous alluvium in the surface horizon, coarse textured, volcanic sediments in the lower horizons
Drainage class: Well drained
Moisture conditions: Moist below 3cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: Very few stones
Evidence of erosion: None
Salt content: Noncalcareous throughout
Human influence: Irrigation, farming and bunding

GENERAL DESCRIPTION OF THE PROFILE: An alluvial soil with three strata differentiated by colors, with the surface layer differentiated by the presence of a Ap. The top two horizons have color and texture which are typical of soil strongly influenced by reworked loess. The bottom two horizons show the strong influence of volcanic material. The presence of gravel in this profile establishes it as belonging to a phase found in wadis within or close to mountains or hills.

Profile Description

C 0-7cm K250	Yellowish-brown 10YR 5/4 (moist), pale brown 10YR 6/3 (dry aggregate) and very pale brown 10YR 7/3 (dry rubbed); loam; moderate medium to fine subangular

blocky structure; slightly sticky and slightly plastic (wet); friable (moist); slightly hard (dry); common very fine tubular pores; very few slightly rounded fresh gravel of volcanic and sedimentary origin; strongly calcareous; common very fine roots; clear, smooth boundary.

IIC
7-52cm
K251

Yellowish-brown 10YR 5/4 (moist), 10YR 6/3 (dry aggregate) and 10YR 7/3 (dry rubbed); sandy loam; moderate medium to fine subangular blocky structure; slightly sticky and slightly plastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores; few slightly rounded fresh gravel of volcanic and sedimentary origin; strongly calcareous; common very fine roots; gradual, smooth boundary.

IIIC
52-93cm
K252

Very dark grayish-brown 10YR 3/2 (moist), brown 10YR 5/3 (dry aggregate) and brown 10YR 5/3 (dry rubbed); loam; moderate medium to fine subangular blocky structure; nonsticky and nonplastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores; very few slightly rounded fresh gravel of volcanic and sedimentary origin; strongly calcareous; few very fine roots; clear, smooth boundary.

IVC
93-148cm
K253

Dark grayish-brown 10YR 4/2 (moist), light gray 10YR 7/2 (dry aggregate) and light gray 10YR 7/2 (dry rubbed); sandy loam; moderate medium subangular blocky structure; nonsticky and nonplastic (wet); friable (moist); slightly hard (dry); no pores; strongly calcareous; very few very fine roots.

ANALYTICAL DATA FOR SITE K52

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K250	0-7	C	-	-	52	38	10	l
K251	7-52	IIC	-	-	54	34	12	sl
K252	52-93	IIIC	-	-	46	34	20	l
K253	93-148	IVC	-	-	70	18	12	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K250	7.9	0.42	1.86	24.6	3.	3.0
K251	7.9	0.24	1.94	24.7	5.	18.0
K252	7.8	0.33	2.62	24.9	6.	9.8
K253	7.9	0.27	2.17	24.9	8.	22.0

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K53

SITE INFORMATION

Classification: TYPIC TORRIFLUVENT, COARSE LOAMY, MIXED, CALCAREOUS, HYPERTHERMIC FAMILY, HUMMOCKY PHASE
Date and time described: April 23, 1982
Authors: J. King and A. E. Abu Ghanem
Location: At A.H.T. tent camp for measuring flow of Wadi Gurdud, approximately 5km southwest from Al Shanan town, in Al Jawf Province 16° 12' N 44° 23' E
Elevation: 1150m
Physiographic position: Plain
Topogrephy of surrounding country: Flat
Microtopography: Hummocks 3m high, covering about 50% of the surface
Slope: 1° or 2%
Land use: Used for light grazing
Climate: 1. Annual rainfall: 100mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Hyperthermic

SOIL INFORMATION

Parent material: Calcareous silty alluvium
Drainage class: Well drained
Moisture conditions: Profile dry throughout
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: Severe gully erosion which has transformed the surface into a hummocky configuration, some wind erosion
Salt content: None, profile calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Stratified, dominantly silty alluvium of uniform light brown color throughout. This is the hummocky phase of the series found close to the mountains, rather than in the plains. The hummocky phase is assumed to be caused by water erosion.

Profile Description

C 0-29cm K254	10YR 5/4 yellowish-brown (moist) and 10YR 6/4 light yellowish-brown and 10YR 6/4 light yellowish-brown (dry); silt loam; moderate medium subangular blocky and weak medium platey structure; sticky and plastic (wet); friable (moist); soft (dry); no pores; strongly

calcareous; very few very fine roots; abrupt, wavy boundary.

IIC
25-46cm
K255

10YR 4/4 dark yellowish-brown (moist) and 10YR 7/4 very pale brown and 10YR 7/4 very pale brown (dry); silt loam; moderate coarse to medium subangular blocky structure; slightly sticky and plastic (wet); friable (moist); hard (dry); common fine tubular pores; very few common very fine calcareous pseudomycelia, strongly calcareous; no roots; abrupt, smooth boundary.

IIIC
46-55cm
K256

10YR 5/4 yellowish-brown (moist) and 10YR 6/4 light yellowish-brown and 10YR 6/4 light yellowish-brown (dry); sandy loam; weak medium to fine subangular blocky structure; slightly sticky and slightly plastic (wet); friable (moist); slightly hard (dry); few fine tubular pores; strongly calcareous; no roots; abrupt, wavy boundary.

IVC
55-72cm
K257

10YR 5/4 yellowish-brown (moist) and 10YR 6/4 light yellowish-brown and 10YR 7/4 very pale brown (dry); silt loam; strong coarse angular blocky structure; nonsticky and slightly plastic (wet); friable (moist); hard (dry); common fine, few medium tubular or vesicular pores; common very fine pseudomycelia, strongly calcareous; no roots; abrupt, smooth boundary.

VC
72-129cm
K258

10YR 5/4 yellowish-brown (moist) and 10YR 6/4 light yellowish-brown and 10YR 6/4 light yellowish-brown (dry); loam; moderate medium to fine angular blocky structure; nonsticky and plastic (wet); friable (moist); soft (dry); no pores; strongly calcareous; no roots; abrupt, smooth boundary.

VIC
129-142cm
K259

10YR 5/4 yellowish-brown (moist) and 10YR 6/4 light yellowish-brown and 10YR 6/4 light yellowish-brown (dry); sandy loam; moderate coarse to medium angular blocky structure; nonsticky and plastic (wet); friable (moist); slightly hard (dry); no pores; strongly calcareous; no roots; abrupt, smooth boundary.

VIIC
142-152cm
K260

10YR 5/4 yellowish-brown (moist) and 10YR 6/4 light yellowish-brown and 10YR 6/4 light yellowish-brown (dry); silt loam; moderate coarse to medium subangular blocky structure; nonsticky and nonplastic (wet); friable (moist); soft (dry); few medium tubular pores; strongly calcareous; no roots; abrupt, smooth boundary.

VIIIC 152-164cm K261	10YR 5/4 yellowish-brown (moist) and 10YR 6/4 light yellowish-brown and 10YR 6/4 light yellowish-brown (dry); sandy loam; moderate medium to fine subangular blocky; nonsticky and slightly plastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores; strongly calcareous; no roots; abrupt, smooth boundary.
IXC 164-180cm K262	10YR 5/4 yellowish-brown (moist) and 10YR 6/4 light yellowish-brown and 10YR 6/4 light yellowish-brown (dry); sandy loam; weak medium subangular blocky structure; nonsticky and slightly plastic (wet); friable (moist); soft (dry); no pores; strongly calcareous; no roots.

ANALYTICAL DATA FOR SITE K53

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K254	0-29	C	-	-	30	68	2	sil
K255	29-46	IIC	-	-	34	60	6	sil
K256	46-55	IIIC	-	-	44	48	8	sl
K257	55-72	IVC	-	-	30	60	10	sil
K258	72-129	VC	-	-	48	42	10	l
K259	129-142	VIC	-	-	56	36	8	sl
K260	142-152	VIIC	-	-	31	52	17	sil
K261	152-164	VIIIC	-	-	63	28	9	sl
K262	164-180	IXC	-	-	53	38	9	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K254	6.9	27.0	1.67	24.6	18.0	8.0
K255	7.5	8.5	1.60	23.0	16.6	24.0
K256	7.0	14.8	1.44	22.0	15.0	9.0
K257	7.1	15.1	1.90	21.0	18.0	16.0
K258	7.4	8.6	1.48	20.0	11.6	9.8
K259	7.9	6.5	1.33	20.0	15.0	9.0
K260	7.9	9.7	1.52	19.8	16.6	20.0
K261	8.1	6.7	.29	19.7	11.6	8.0
K262	8.0	7.8	1.22	18.0	12.6	8.5

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K54

SITE INFORMATION

Classification: LITHIC TORRIORTHENT, COARSE LOAMY, MIXED, CALCAREOUS, HYPERTHERMIC FAMILY
Date and time described: April 23, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 1km southwest of A.H.T. construction camp, 3km southwest of Al Shanan village, on the south slope of Mount Braima, in Al Jawf Province 16° 12' N 44° 26' E
Elevation: 1150m
Physiographic position: Concave, foot slope
Topography of surrounding country: Steeply dissected
Microtopography: None
Slope: 22° or 40%
Land use: None
Climate: 1. Annual rainfall: 100mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Hyperthermic.

SOIL INFORMATION

Parent material: Volcanic colluvium and calcareous silt
Drainage class: Well drained
Moisture conditions: Dry throughout
Depth to groundwater: No effect on profile
Surface stones or outcrops: Rubble land
Evidence of erosion: Moderate gully erosion
Salt content: Strongly calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Profile has two horizons differentiated by parent material and calcium carbonate accumulation The surface consists of colluvium and of calcareous silt. The second horizon is a mixture of the surface material and the underlying gray bedrock. The undersurface of the rocks in this horizon are coated with calcite.

Profile Description

C 0-23cm K263	10YR 5/6 yellowish-brown (moist) and 10YR 6/4 light yellowish-brown (dry); sandy loam; structureless; nonsticky and slightly plastic (wet); loose noncoherent (moist); few fine tubular pores; very frequent sharp fresh gravel to boulders; strongly calcareous; no roots; gradual, wavy boundary.

IIC 23-60cm K264	10YR 6/6 brownish-yellow (moist) and 10YR 6/4 light yellowish-brown (dry); sandy loam; weak medium subangular blocky structure; nonsticky and slightly plastic (wet); friable (moist); soft (dry); no pores; very frequent sharp fresh gravel to boulders, probably of volcanic origin; strongly calcareous with crystalline calcite accumulation on the undersurface of rocks; no roots; lithic contact.

ANALYTICAL DATA FOR SITE K54

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K263	0-23	C	vfr	g.s.b.	67	26	7	sl
K264	23-60	IIC	vfr	g.s.b.	73	22	5	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K263	7.4	1.8	1.29	21.0	8.	12.5
K264	7.3	4.0	1.33	21.4	3.	5.0

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K55

SITE INFORMATION

Classification: TYPIC TORRIFLUVENT, COARSE LOAMY, MIXED, CALCAREOUS, HYPERTHERMIC FAMILY
Date and time described: April 23, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 1km southeast of Al Shanan town 16° 14' N 44° 27' E
Elevation: 1160m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: 1° or 2%
Land use: Light grazing
Climate: 1. Annual rainfall: 100mm, 2. Soil moisture regime: Aridic, 3. Soil temperature regime: Hyperthermic

SOIL INFORMATION

Parent material: Primarily fine calcareous alluvium
Drainage class: Well drained
Moisture conditions: Moist from 17-71cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: Very few stones
Evidence of erosion: Slight rill erosion
Salt content: None, calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Wind blown light brown silty cap over reddish-brown silty alluvium in horizons two and three differentiated by the presence of gravel in the third horizon. Calcium has accumulated in nodules in the second and third horizons but there is no evidence of vertical calcium movement in the profile.

Profile Description

C 0-11cm K265	10YR 5/6 yellowish-brown (moist) and 10YR 6/4 light yellowish-brown and 10YR 7/4 very pale brown (dry); loamy sand; weak subangular blocky to crumb structure; nonsticky and nonplastic (wet); friable (moist); slightly hard (dry); no pores; strongly calcareous; few very fine roots; abrupt, smooth boundary.

IIC
11-106cm
K266

7.5YR strong brown (moist) and 7.5YR 6/6 reddish-yellow and 7.5YR 7/6 reddish-yellow (dry); sandy loam; moderate medium to fine subangular blocky structure; slightly sticky and plastic (wet); friable (moist); slightly hard to hard (dry); no pores; frequent small to large hard irregular white calcium nodules; strongly calcareous; very few fine and few very fine roots; abrupt, smooth boundary.

IIIC
106-135cm
K267

7.5YR 4/6 strong brown (moist) and 7.5YR 7/6 reddish-yellow and 7.5YR 6/6 reddish-yellow (dry); gravelly sandy loam; strong medium to fine subangular blocky structure; slightly sticky and slightly plastic (wet); friable (moist); slightly hard (dry); no pores; frequent slightly rounded fresh gravel; strongly calcareous; very few very fine roots.

ANALYTICAL DATA FOR SITE K55

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K265	0-11	C	-	-	85	10	5	ls
K266	11-106	IIC	-	-	57	34	9	sl
K267	106-135	IIIC	fr	g	71	16	13	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K265	7.4	2.5	1.52	24.8	12.6	16.0
K266	7.5	2.7	1.33	24.9	2.0	18.0
K267	7.5	3.2	1.52	24.9	3.0	14.2

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K56

SITE INFORMATION

Classification: TYPIC UDIFLUVENT, COARSE LOAMY, CALCAREOUS, MIXED, HYPERTHERMIC FAMILY, SALINE PHASE
Date and time described: April 23, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 1 1/2km south of Al Shanan town, in Al Jawf Province 16° 12' N44° 26' E
Elevation: 1170m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: 1° or 2%
Land use: None, but there is a typical vegetation of these type of soils
Climate: Unknown

SOIL INFORMATION

Parent material: Alluvial silt
Drainage class: Perfectly drained
Moisture conditions: Moist below 10cm
Depth to groundwater: Unknown, it may be a factor here
Surface stones or outcrops: None
Evidence of erosion: Wind erosion, which has resulted in 50cm high hummocks around scattered shrubs of this area.
Salt content: Possibly saline soil
Human influence: Possibly this is an old irrigated soil that has become saline.

GENERAL DESCRIPTION OF THE PROFILE: There are only two horizons in this profile with the top 8cm differing from the rest of the profile in texture and structure. Samples were taken of every 50cm to test for salt movement and to differentiate between a possible ORTHENT or FLUVENT classification. The lack of stratification and the possibility of salt in this can probably both be attributed to this land having been farmed and irrigated in the past. Soil is now considered salty, and unfit for agricultural use. It is uniformly silty and light brown throughout.

Profile Description

C 0-8cm K268	10YR yellowish-brown (moist) and 10YR 7/4 very pale brown and 10YR 6/4 light yellowish-brown (dry); sandy loam; strong very thick platey to moderate medium to fine subangular blocky structure; sticky and plastic (wet); friable (moist); slightly hard (dry); no pores; strongly calcareous; few very fine roots; abrupt, smooth boundary.
IIC 8-108cm K269 K270 K271	10YR 5/6 yellowish-brown (moist) and 10YR 7/4 very pale brown and 10YR 6/4 light yellowish-brown (dry); silt loam; coarse to medium subangular blocky structure; sticky and plastic (wet); wet and friable (moist);--(dry); few very fine tubular pores; strongly calcareous; down to 108cm there were common very fine roots; no boundary.

ANALYTICAL DATA FOR SITE K56

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K268	0-8	-	-	-	53	36	11	sl
K269	8-108	-	-	-	27	68	5	sil
K270	8-108	-	-	-	19	78	3	sil

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K268	7.2	14.6	1.52	19.9	8.	7.3
K269	7.3	21.5	1.67	21.3	6.	9.8
K270	7.4	20.5	1.63	24.3	7.	11.0

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K57

SITE INFORMATION

Classification: TYPIC USTIFLUVENT, COARSE LOAMY, MIXED, CALCAREOUS, HYPERTHERMIC FAMILY
Date and time described: April 26, 1982
Authors: J. King and A. E. Abu Ghanem
Location: Alfhdi Naji farm, in Wadi Khabb, in the town of Alabrag, in Al Jawf Province 16° 43' N 44° 52' E
Elevation: 1390m
Physiographic position: Plain in narrow valley
Topography of surrounding country: Flat to steeply dissected
Microtopography: None
Slope: 1° or 2%
Land use: Irrigated farming with continuous alfalfa, date palms, apricots, pomegranates, apples, lemons, qat, and watermelons.
Climate: Unknown

SOIL INFORMATION

Parent material: Alluvial silt
Drainage class: Moist throughout
Moisture conditions: Depending on season from 10-40cm
Depth to groundwater: None
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: None, profile calcareous throughout
Human influence: Irrigated farming; the farmers here use no commercial fertilizers, but they do put animal manure on these soils.

GENERAL DESCRIPTION OF THE PROFILE: Profile uniform light brown silt loam throughout with horizons differentiated by a plow layer and the presence of pores resulting from the roots of the alfalfa crops growing on this land.

Profile Description

C 0-20cm K272	10YR 4/4 dark yellowish-brown (moist) and 10YR 7/3 very pale brown and 10YR 6/3 pale brown (dry); loam; moderate medium to fine subangular blocky structure; slightly sticky and slightly plastic (wet); friable (moist); slightly hard (dry); common medium fine continuous tubular pores; very few fresh sharp gravel and stones; common medium to fine roots; clear, wavy boundary.

IIC 20-84cm K273	10YR 4/4 dark yellowish-brown (moist) and 10YR 6/3 pale brown and 10YR 6/3 pale brown (dry); loam; strong medium prismatic to coarse to fine subangular blocky; slightly sticky and slightly plastic (wet); friable (moist); hard (dry); common medium to fine continuous tubular pores; few medium to fine roots; clear, wavy boundary.
IIIC 84-155cm K274	10YR 4/4 dark yellowish-brown (moist) and 10YR 6/3 light yellowish-brown and 10YR 6/4 light yellowish-brown (dry); silt loam; strong medium prismatic to strong coarse to fine subangular blocky structure; slightly sticky and slightly plastic (wet); firm (moist); hard (dry); few medium to fine pores; strongly calcareous; very few medium to fine roots.

ANALYTICAL DATA FOR SITE K57

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K272	0-20	C	-	-	41	48	11	l
K273	20-84	IIC	-	-	35	48	17	l
K274	84-155	IIIC	-	-	31	52	17	sil

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K272	7.1	1.1	2.62	15.8	6.	17.
K273	7.4	0.58	1.67	15.9	9.	40.
K274	7.5	0.64	1.71	17.6	1.	37.

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K58

SITE INFORMATION

Classification: TYPIC TORRIORTHENT,, LOMAY SKELETAL, MIXED, CALCAREOUS, HYPERTHERMIC FAMILY, EXTREMLY GRAVELY TO BOULDERY PHASE
Date and time described: April 27, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 4km north of Al Hazm, in Al Jawf Province
Elevation: 1080m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: 1^0 or 2%
Land use: Acacia with light grazing, pictures of other vegetation taken for identification
Climate: Unknown

SOIL INFORMATION

Parent material: Alluvium with frequent gravel and stones of mixed origin in silt matrix
Drainage class: Well drained
Moisture conditions: Moist below 11cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: Very stony, but gravel or stones cover the entire surface
Evidence of erosion: Slightly moderate gully erosion
Salt content: None, profile calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: A very gravelly and stony alluvial soil with the surface horizon which is lighter in color than the two lower horizons. The two lower horizons differ in quantity of calcium carbonate nodules.

Profile Description

C 0-7cm K275	10YR 5/6 yellowish-brown (moist) and 10YR 7/4 very pale brown and 10YR 7/4 very pale brown (dry); very gravelly to stony sandy loam; moderate medium subangular blocky structure; sticky and plastic (wet); friable (moist); slightly hard (dry); no pores; frequent gravel and few stones somewhat rounded and fresh; strongly calcareous; no roots; gradual, wavy boundary.

IIC 7-61cm K276	7.5YR 5/6 strong brown (moist) and 7.5YR 6/6 reddish-yellow and 7.5YR 6/6 very reddish-yellow (dry); very gravelly to bouldery sandy loam; moderate medium to fine subangular blocky structure; slightly sticky and slightly plastic (wet); friable (moist); soft (dry); no pores; very frequent stones and gravel, somewhat rounded and weathered of mixed origin; small frequent irregular white soft calcium carbonate nodules; strongly calcareous; very few very fine roots; wavy boundary.
IIIC 61-220cm K276	7.5YR 5/6 strong brown (moist) and 7.5YR 4/6 strong brown and 7.5YR 4/6 strong brown (dry); very gravelly to bouldery sandy loam; moderate medium to fine subangular blocky structure; slightly sticky and plastic (wet); friable (moist); soft (dry); no pores; few boulders; many stones and gravel somewhat rounded, fresh of mixed origin; large very frequent irregular white soft calcium nodules; strongly calcareous; no roots.

ANALYTICAL DATA FOR SITE K58

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K275	0-7	C	vfr	g,s	43	54	3	sl
K276	7-220	IIC & IIIC	vfr	s, b	57	40	3	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K275	6.6	25.	1.79	24.6	3.	37.
K276	6.5	39.	2.05	24.9	1.	33.

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K58

SITE INFORMATION

Classification: TYPIC SALORTHID, COARSE LOAMY, MIXED, HYPERTHERMIC FAMILY, HUMMOCKY PHASE
Date and time described: April 27, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 4km northwest of Al Hazm, in the Zahran area, in Wadi Jawf Province
Elevation: 1060m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: 1.5m hummocks
Slope: 1^0 or 2%
Land use: The juniper type shrub that is very common in very saline soil
Climate: No information

SOIL INFORMATION

Parent material: Silty to sandy alluvium
Drainage class: Class 2, moderately well drained
Moisture conditions: Moist below 12cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: Wind erosion resulting in hummocks
Salt content: Probable saline soil, apparent accumulation in 33-42cm
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: None

Profile Description

C 0-12cm K276	Dark yellowish-brown 10YR 4/4 (moist) and light yellowishbrown 10YR 6/4 and light yellowish-brown 10YR 6/4 (dry); sandy loam; nonsticky, nonplastic (wet); very friable (moist); loose (dry); no pores; no mineral fragments; strongly calcareous; no roots; clear, smooth boundary.
IIC 12-33cm K277	Dark yellowish-brown 10YR 4/4 (moist) and light yellowishbrown 10YR 6/4 and light yellowish-brown 10YR 6/4 (dry); sandy loam; weak medium to fine subangular

blocky structure; nonsticky, nonplastic (wet); very friable (moist); loose (dry); no pores; no mineral fragments; strongly calcareous; no roots; gradual, smooth boundary.

IIIC
33-42cm
K278

Dark yellowish-brown 10YR 4/4 (moist) and light yellowish-brown 10YR 6/4 and light yellowish-brown 10YR 6/4 (dry); loamy sand; weak medium to fine subangular blocky structure; slightly sticky, plastic (wet); friable (moist); soft (dry); crystallizing salt accumulations; no pores; strongly calcareous; no roots; gradual, wavy boundary.

IVC
42-59cm
K279

Brown 10YR 5/3 (moist) and brownish-yellow 10YR 6/6 (dry); loamy sand; moderate medium platy structure; sticky, plastic (wet); friable (moist); soft (dry); no pores; no mineral fragments; common pseudomycelia; strongly calcareous; no roots; gradual, smooth boundary.

VC
59-76cm
K280

Yellowish-brown 10YR 5/4 (moist) and very pale brown 10YR 7/4 (dry); sandy loam; moderate medium platy and moderate medium subangular blocky structure; sticky, plastic (wet); friable (moist); soft (dry); few tubular pores; no mineral fragments; few pseudomycelia; strongly calcareous; few fine roots; clear, smooth boundary.

VIC
76-78cm
K281

Yellowish-brown 10YR 5/4 (moist) and very pale brown 10YR 7/4 (dry); silt loam; moderate medium platy and moderate medium subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard (dry); common tubular pores; very few calcareous mycelia; strongly calcareous; no roots; clear, smooth boundary.

VIIC
78-81cm
K282

Yellowish-brown 10YR 5/6 (moist) and light yellowish-brown 10YR 6/4 (dry); silt loam; slightly sticky, plastic (wet); friable (moist); slightly hard (dry); common tubular pores; very few calcareous mycelia; strongly calcareous; no roots; clear, smooth boundary.

VIIIC
81-94cm
K283

Dark yellowish-brown 10YR 4/6 (moist) and light yellowishbrown 10YR 6/4 (dry); silt loam; moderate medium platy and moderate medium subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard (dry); common tubular pores; very few calcareous pseudomycelia; strongly calcareous; no roots; clear, smooth boundary.

IXC 94-99cm K284	Yellowish-brown 10YR 5/6 (moist) and light yellowish-brown 10YR 6/4 (dry); silt loam; moderate medium to fine platy structure; slightly sticky, slightly plastic (wet);--(moist); soft (dry); no pores; no mineral fragments; strongly calcareous; no roots; clear, smooth boundary.
XC 99-106cm K285	Dark yellowish-brown 10YR 4/6 (moist) and light yellowishbrown 10YR 6/4 (dry); silt loam; sticky, plastic (wet); friable (moist); slightly hard (dry); no pores; no mineral fragments; strongly calcareous; no roots; clear, smooth boundary.
XIC 106-137+cm K286	Yellowish-brown 10YR 5/6 (moist) and 10YR 6/4 light yellowish-brown (dry); silt loam; moderate medium subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); soft (dry); no pores; no mineral fragments; strongly calcareous; no roots.

ANALYTICAL DATA FOR SITE K59

No.	Depth (cm)	Horizon	Coarse frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K276	0-12	C	-	-	57	40	3	sl
K277	12-33	IIC	-	-	57	36	7	sl
K278	33-42	IIIC	-	-	85	8	7	ls
K279	42-59	IVC	-	-	89	2	9	ls
K280	59-76	VC	-	-	59	26	15	sl
K281	76-78	VIC	-	-	21	68	11	sil
K282	78-81	VIIC	-	-	15	76	9	sil
K283	81-94	VIIIC	-	-	13	80	7	sil
K284	94-99	IXC	-	-	17	76	7	sil
K285	99-106	XC	-	-	23	74	3	sil
K286	106-137	XIC	-	-	37	60	3	sil

No.	pH 1:1	EC mmhos	Organic Matter (%)	$CaCO^3$ (%)	Avail P (ppm)	C E C meq/100g
K276	6.5	38.	2.05	24.9	1.	33.0
K277	6.7	38.	2.17	28.5	7.	28.6
K278	6.5	16.5	1.44	16.	18.	5.8
K279	7.3	34.	1.49	18.5	6.	5.4
K280	7.1	120.	2.39	24.3	2.	8.2
K281	7.1	80.	2.36	26.	1.	33.0
K282	7.3	47.	1.94	26.2	18.	27.8
K283	7.3	67.	1.94	26.8	6.	35.6
K284	7.4	52.	1.67	27.7	6.	27.8
K285	7.3	62.	1.24	25.3	6.	34.0
K286	7.6	36.	1.14	24.5	7.	12.0

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K60

SITE INFORMATION

Classification: TYPIC CALCIORTHID, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: May 9, 1982
Authors: J. King and P. Martins
Location: 15km north of Sadah on the Saudi road, 0.5km north of the village of Al Asafi, in Sadah Province
Elevation: 1840m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: 1^0 or 2%
Land use: Light grazing, vegetation is Acacia
Climate: No information

SOIL INFORMATION

Parent material: Fluvial deposits of calcareous silt mixed with coarse material derived from granitic rock
Drainage class: Class 4, well drained
Moisture conditions: Moist to 18cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: Back-cutting gully erosion
Salt content: Profile calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Stratified light brown alluvial material with calcium nodules in all subsurface strata dominated by finer materials.

Profile Description

C 0-18cm K289	Dark yellowish-brown, 10YR 4/4 (moist) and no color (dry); loamy sand; moderate coarse to medium subangular blocky to crumb structure; nonsticky, slightly plastic (wet); friable (moist);--(dry); few fine tubular pores; few carbonate mycelia; weakly calcareous; very few very fine to fine roots; gradual, smooth boundary.

Cca 18-54cm K290	Yellowish-brown 10YR 5/4 (moist) and very pale brown 10YR 7/4 and very pale brown 10YR 7/4 (dry); sandy loam; moderate fine prismatic to medium subangular blocky structure; slightly sticky, plastic (wet); friable (moist); slightly hard (dry); few fine tubular pores; few medium soft irregular white calcareous nodules; strongly calcareous; very few very fine roots; clear, smooth boundary.
IICca 54-69cm K291	Yellowish-brown 10YR 5/4 (moist) and very pale brown 10YR 7/3 and very pale brown 10YR 7/3 (dry); slightly gravelly sandy loam; moderate medium to fine subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); slightly hard (dry); few fine tubular pores; few slightly rounded fresh coarse fine gravel of granitic origin, particularly orthoclase and quartz; few medium soft irregular white calcareous nodules; strongly calcareous; very few very fine to fine roots; clear, smooth boundary.
IIICca 69-101cm K292	Yellowish-brown 10YR 5/4 (moist) and very pale brown 10YR 7/4 and very pale brown 10YR 7/4 (dry); slightly gravelly sandy loam; moderate fine prismatic medium to fine subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); slightly hard (dry); common fine tubular pores; few slightly rounded fresh coarse fine gravel of granitic origin, particularly orthoclase and quartz; few medium soft irregular white calcareous nodules; strongly calcareous; very few very fine to fine roots; clear, smooth boundary.
IVC 101-138cm K293	Strong brown, 7.5YR 4/6 (moist) and strong brown, 7.5YR 4/6 and reddish-yellow 7.5YR 6/6 (dry); slightly gravelly loamy sand; weak medium subangular blocky structure; nonsticky, nonplastic (wet); loose (moist); loose (dry); no pores; few slightly rounded fresh coarse fine gravel of granitic origin, particularly orthoclase and quartz; strongly calcareous; very few very fine to fine roots; clear, wavy boundary.
VC 139-160+cm K294	Yellowish-brown 10YR 5/6 (moist) and very pale brown 10YR 7/4 and very pale brown 10YR 7/4 (dry); sandy loam; moderate medium prismatic to coarse to medium subangular blocky structure; sticky, plastic (wet); friable (moist); hard (dry); few fine tubular pores; few large soft irregular white calcareous nodules; strongly calcareous; very few very fine to fine roots.

ANALYTICAL DATA FOR SITE K60

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K289	0-18	C	-	-	81	14	5	ls
K290	18-54	CCa	-	-	71	16	13	sl
K291	54-69	IICca	f	g	77	14	9	sl
K292	69-101	IIICca	f	g	75	14	11	sl
K293	101-138	IVC	f	g	71	16	13	sl
K294	139-160	VC	-	-	73	14	3	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	$CaCO_3$ (%)	Avail. P (ppm)	C E C meq/100g
K289	7.2	0.35	2.05	5.5	5	24.0
K290	7.4	0.32	1.86	17.1	trace	20.0
K291	7.6	0.21	1.56	10.8	1	7.4
K292	7.5	0.33	1.48	18.3	2	16.0
K293	7.6	0.53	1.33	6.8	3	4.5
K294	7.6	0.54	0.84	16.5	1	15.0

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K61

SITE INFORMATION

Classification: TYPIC CALCIORTHID,COARSE LOAMY, MIXED, ISOTHERMIC FAMILY, VERY DARK HORIZON PHASE
Date and time described: May 10, 1982
Authors: J. King, A. E. Abu Ghanem and P. Martins
Location: 120m east of the main Sana road, 2km southwest of Sadah
Elevation: 1790m
Physiographic position: Slope of low hill
Topography of surrounding country: Undulating
Microtopography: None
Slope: 2^0 or 4%
Land use: Slight grazing picture series of vegetation
Climate: No information

SOIL INFORMATION

Parent material: Calcareous silt and material from granitic rocks
Drainage class: Class 4, well drained
Moisture conditions: Very moist, varying from 10 to 24cm, slightly moist and somewhat moist down to 114cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: Very few stones but entire surface is covered with coarse sand, fine gravel or small stones
Evidence of erosion: Slight gully erosion
Salt content: Entire profile calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: A buried A1 horizon under 53cm of sand loam and over a calcic horizon.

Profile Description

C1 0-1.5cm K295	Dark yellowish-brown 10YR 4/6 (moist) and no color given (dry); slightly gravelly loamy sand; weak fine platy structure; nonsticky, nonplastic (wet); friable (moist);--(dry); many microtubular pores; few slightly rounded fresh gravel of granitic origin; strongly calcareous; no roots; clear, smooth boundary.
C2 1.5-53cm	Dark yellowish-brown 10YR 4/6 (moist) and yellowish-brown 10YR 5/6 (dry); slightly gravelly sandy loam;

K296	weak medium to fine subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); slightly hard (dry); few fine tubular pores; few slightly rounded fresh gravel of granitic origin; strongly calcareous; common very fine roots; gradual, smooth boundary.
A1b 53-84cm K297	Dark yellowish-brown 10YR 3/4 (moist) and dark brown 10YR 4/3 and brown 10YR 5/3 (dry); slightly gravelly sandy loam; weak medium prismatic to crumb structure; sticky, plastic (wet); friable (moist); slightly hard (dry); common fine and few medium tubular pores; few rounded weathered gravel from metamorphic rock; few calcareous mycelium; strongly calcareous; common very fine roots; gradual, smooth boundary.
IICca 84-140cm K298	Yellowish-brown 10YR 5/6 (moist) and very pale brown 10YR 7/4 and very pale brown 10YR 7/4 (dry); silt loam; weak medium prismatic to fine subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); slightly hard (dry); many very fine tubular pores; frequent large irregular white calcium nodules, strongly calcareous; few very fine roots; smooth boundary.
IIIC 140-200cm K299	Dark yellowish-brown 10YR 4/4 (moist) and brownish-yellow 10YR 6/6 and yellow 10YR 7/6 (dry); silt loam; weak medium prismatic to medium subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); slightly hard (dry); few very fine tubular pores; few large irregular white calcium nodules; strongly calcareous; very few very fine roots.

ANALYTICAL DATA FOR SITE K61

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K295	0-1.5	C1	f	g	81	14	5	ls
K296	1.5-53	C2	f	g	69	24	7	sl
K297	53-84	A1b	f	g	63	26	11	sl
K298	84-140	IICca	-	-	29	68	3	sil
K299	140-200	IIIC	-	-	45	52	3	sil

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K295	7.8	0.39	1.52	8.6	trace	6.8
K296	7.6	1.90	1.44	7.4	2	9.6
K297	8.3	0.38	1.67	9.1	trace	16.0
K298	7.2	15.00	1.56	24.8	5	21.0
K299	7.5	6.3	1.06	14.0	1	23.0

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K62

SITE INFORMATION

Classification: TYPIC CALCIUSTOLL, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY, SAND CAP PHASE
Date and time described: May 10, 1982
Authors: P. Martins, A. E. Abu Ghanem and J. King
Location: 6km north of Sadah, 2km west of Al Hamarat, in Sadah Province
Elevation: 1760m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: Small hummocks
Slope: 1^0 or 2%
Land use: Typical for this area, light grazing
Climate: No information

SOIL INFORMATION

Parent material: Derived from sandstone and calcareous silt
Drainage class: Class 4, well drained
Moisture conditions: Moist to 33cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: Some wind erosion shown by small hummocks 10cm high where vegetation is present and sheet and slight gully erosion
Salt content: Profile calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: A Mollisol with a 10cm sand cap and strongly expressed calcic horizon.

Profile Description

C 0-10cm K300	Yellowish brown 10YR 5/6 (moist); sand; granular structure; nonsticky, nonplastic (wet); loose (moist); few fine tubular pores; no mineral fragments; strongly calcareous; few fine roots; abrupt, smooth boundary.
A11b 10-41cm K301	Dark brown 10YR 3/3 (moist) and brown 10YR 4/4 and brown 10YR 4/3 (dry); sandy loam; weak medium subangular blocky to crumb structure; slightly sticky, slightly plastic (wet); friable (moist); soft (dry);

few fine tubular pores; no mineral fragments; strongly calcareous; common fine, many very fine roots; gradual, smooth boundary.

A12b
41-59cm
K302

Dark yellowish 10YR 4/4 (moist) and yellowish-brown 10YR 5/7 and yellowish-brown 19YR 5/5 (dry); sandy loam; weak medium subangular blocky structure; nonsticky, slightly plastic (wet); friable (moist); slightly hard (dry); few fine, many very fine tubular pores; few calcareous mycelia; strongly calcareous; few fine, common very fine roots; clear, wavy boundary.

Cca
59-85cm
K303

Brownish-yellow 10YR 6/6 (moist) and very pale brown 10YR 7/4 and very pale brown 10YR 7/4 (dry); sandy loam; weak medium to fine subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); slightly hard (dry); common very fine tubular pores; very frequent large irregular hard white calcareous nodules; strongly calcareous; common very fine roots; gradual, wavy boundary.

IICca
85-118cm
K304

Yellowish-brown 10YR 5/6 (moist) and brownish-yellow 10YR 6/6 and brownish-yellow 10YR 6/6 (dry); loamy sand; weak medium subangular blocky to crumb structure; slightly sticky, nonplastic (wet); very friable (moist); slightly hard (dry); few very fine pores; frequent large hard irregular calcareous nodules; strongly calcareous; few very fine roots; gradual, smooth boundary.

IIIC1
118-142cm
K305

Strong brown 7.5YR 4/6 (moist) and strong brown 7.5YR 5/6 and strong brown 10YR 5/6 (dry); loamy sand; weak medium subangular blocky to granular structure; nonsticky and nonplastic (wet); very friable (moist); soft (dry); few very fine tubular pores; frequent large hard irregular white calcareous nodules; strongly calcareous; few very fine roots; gradual, smooth boundary.

IVC
142-155cm
K306

Strong brown 7.5YR 4/6 (moist) and yellowish-brown 7.5YR 5/7 and yellowish-brown 5/7 (dry); sand; weak medium subangular blocky to granular structure; nonsticky, nonplastic (wet); very friable (moist); soft to loose (dry); very few very fine pores; few subrounded stones of sandstone origin; strongly calcareous; no roots.

ANALYTICAL DATA FOR SITE K62

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K300	0-10	C	-	-	91	6	3	s
K301	301	A11b	-	-	77	14	9	sl
K302	41-59	A12b	-	-	77	12	11	sl
K303	59-85	Cca	-	-	65	26	9	sl
K304	85-118	IICca	-	-	77	20	3	ls
K305	118-142	IIIC	-	-	81	16	3	ls
K306	142-155	IVC	-	-	89	8	3	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K300	8.1	0.13	1.22	1.0	2	5.4
K301	7.8	0.33	1.94	4.8	1	14.0
K302	8.0	0.16	1.41	4.8	1	15.0
K303	8.1	0.37	1.71	24.2	6	6.8
K304	7.7	2.2	1.25	10.0	5	4.4
K305	7.4	2.15	1.22	3.4	6	9.6
K306	7.4	2.00	1.29	2.6	6	4.5

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K63

SITE INFORMATION

Classification: USTIC TORRIPSAMMENT, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: May 10, 1982
Authors: P. Martins, A. E. Abu Ghanem, and J. King
Location: 7km north of Sadah, 1km west of Al Tweelah, in Sadah Province
Elevation: 1762m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: Small hummocks 10cm high
Slope: 1^0 or 2%
Land use: Light grazing
Climate: No information

SOIL INFORMATION

Parent material: Derived from sandstone
Drainage class: Class 5, somewhat excessively drained
Moisture conditions: Moist below 40cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: Wind erosion is evidenced by hummocks, some sheet and slight gully erosion
Salt content: Profile calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: A deep sand cap bearing a mollic epipedon which is over a calcic horizon and a petrocalcic horizon.

Profile Description

C 0-112cm K307	Dark yellowish-brown 10YR 4/5 (moist) and yellowish-brown 10YR 5/6 (dry); sand; weak medium subangular blocky structure; nonsticky, nonplastic (wet); very friable (moist); soft (dry); common very fine tubular pores; few calcium mycelia; strongly calcareous; common fine and medium roots to 60cm, few very fine roots below 60cm; gradual, smooth boundary.

A1b 112-139cm K308	Very dark greyish-brown 10YR 3/2 (moist) and very dark greyish-brown 10YR 3/2 (dry); sandy loam; moderate coarse to medium subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard (dry); many very fine tubular pores; common pseudomycelia; strongly calcareous; few very fine roots; gradual, smooth boundary.
IIC 139-181cm K309	Very pale brown 10YR 7/4 (moist) and very pale brown 10YR 7/3 (dry); sandy loam; massive structure; sticky, slightly plastic (wet); friable (moist); slightly hard (dry); no pores; hard large irregular white calcareous nodules; strongly calcareous; no roots.

ANALYTICAL DATA FOR SITE K63

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K307	0-112	C	-	-	89	4	7	s
K308	112-139	A1b	-	-	69	28	3	sl
K309	139-181	IIC	-	-	37	60	3	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	$CaCO_3$ (%)	Avail. P (ppm)	C E C me/100g
K307	7.4	0.13	1.22	3.1	10	4.6
K308	7.2	1.29	1.82	4.0	10	22.0
K309	7.4	1.10	1.79	24.7	16	23.0

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K64

SITE INFORMATION

Classification: TYPIC CALCIORTHID, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: May 11, 1982
Authors: J. King, P. Martins and A. E. Abu Ghanem
Location: Al Ubap 7.5km north of north-northwest in Sadah Province
Elevation: 1780m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: 2%
Land use: Similar to severely browsed Acacia and clump grass, spider grass, and salt alfalfa
Climate: No information

SOIL INFORMATION

Parent material: Alluvium of granitic and calcareous origin
Drainage class: Class 4, well drained
Moisture conditions: Moist to 40cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: Slight gully erosion
Salt content: Calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: This profile consists of stratified material ranging in textures from coarse sand to loam and has weakly expressed varied A1 horizon just above the calcic horizon.

Profile Description

C 0-3cm K310	Brownish-yellow 10YR 6/6 (moist) and very pale brown 10YR 7/4 and very pale brown 10YR 7/4 (dry); loamy sand; granular structure; nonsticky, nonplastic (wet); loose (moist); loose (dry); no pores; frequent fresh gravel of granitic origin consisting primarily of orthoclase; strongly calcareous; no roots; abrupt, smooth boundary.

A11b
3-20cm
K311

Yellowish-brown 10YR 5/6 (moist) and--(dry); slightly gravelly loamy sand; weak fine to medium subangular blocky structure; nonsticky, nonplastic (wet); friable (moist);--(dry); common very fine tubular pores; frequent fresh gravel of granitic origin, primarily orthoclase; strongly calcareous; common very fine roots; clear, smooth boundary.

A12b
20-37cm
K312

Dark brown 10YR 3/3 (moist) and dark yellowish-brown 10YR 4/4 and brown 10YR 5/3 (dry); sandy loam; moderate medium subangular blocky structure; sticky, plastic (wet); friable (moist); slightly hard (dry); many very fine tubular pores; very few fresh gravel of granitic origin, primarily orthoclase; strongly calcareous; many very fine roots; clear, wavy boundary.

Cca
37-62cm
K313

Brownish-yellow 10YR 6/6 (moist) and very pale brown 10YR 7/4 and very pale brown 10YR 7/3 (dry); slightly gravelly silt loam; moderate medium subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); slightly hard (dry); common very fine tubular pores; very few fresh gravel of volcanic origin, primarily orthoclase; strongly calcareous; common very fine roots; broken boundary.

The next horizon has two descriptions because of the broken boundary.

IIC
62-119cm
K314

Light yellowish-brown 10YR 6/4 (moist) and light grey 10YR 7/2 and light grey 10YR 7/2 (dry); gravelly sand; granular structure; nonsticky, nonplastic (wet); loose (moist); loose (dry); frequent fresh gravel, primarily orthoclase derived from granite; strongly calcareous; few very fine roots; clear, wavy boundary.

IIC
62-119cm
K315

Light yellowish-brown 10YR 6/4 (moist) and light grey 10YR 7/2 and light grey 10YR 7/2 (dry); gravelly loamy sand; granular structure; nonsticky, nonplastic (wet); loose (moist); loose (dry); no pores; frequent gravel derived from granite primarily orthoclase; few very fine roots; abrupt, wavy boundary.

IIIC
119-135cm
K316

Brownish-yellow 10YR 6/6 (moist) and yellow 10YR 7/6 and yellow 10YR 7/6 (dry); sand; weak fine to medium subangular blocky structure; nonsticky, nonplastic (wet); loose (moist); soft (dry); few very fine tubular pores; frequent gravel derived from granite, primarily orthoclase; strongly calcareous; no roots.

ANALYTICAL DATA FOR SITE K64

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K310	0-3	C	-	-	83	12	5	ls
K311	3-17	11b	f	g	85	8	7	ls
K312	20-37	A12b	f	g	53	44	3	sl
K313	37-62	Cca	f	g	65	32	3	sil
K314	62-119	IIC	fr	g	97	0	3	s
K315	62-119	IIC	fr	g	84	13	3	ls
K316	119-135	IIIC	-	-	85	12	3	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K310	7.6	1.28	1.44	3.7	20	5.4
K311	7.7	0.78	1.29	2.5	16	9.2
K312	7.4	0.92	1.98	7.2	18	30.0
K313	7.1	0.51	1.03	17.7	10	16.0
K314	7.3	0.54	0.87	7.0	8	5.2
K315	7.2	1.40	1.03	24.5	4	30.0
K316	7.2	0.12	0.61	4.2	8	1.0

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K65

SITE INFORMATION

Classification: TYPIC HAPLUSTOLL, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY, SOMEWHAT POORLY DRAINED PHASE
Date and time described: May 11, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 6km north northwest of Sadah, 200m north northwest from the end of the Sadah airfield
Elevation: 1780m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: 1^0 or 2%
Land use: None
Climate: No information

SOIL INFORMATION

Parent material: Calcareous silt over coarse alluvium derived from granite
Drainage class: Class 3, somewhat poorly drained
Moisture conditions: Slightly moist to 55cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: Slight sheet erosion
Salt content: Profile calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: A mollisol with dark grey silty materials in the top three horizons and a slightly coarse yellow material in the lower three horizons.

Profile Description

A11ca 0-15cm K317	Very dark brown 10YR 2/2 (moist) and greyish-brown 10YR 5/2 and greyish-brown 10YR 5/2 (dry); sandy loam; weak medium to fine subangular blocky structure; nonsticky, plastic (wet); very friable (moist); soft (dry); no pores; common calcareous mycelia; strongly calcareous; few very fine roots; smooth, gradual boundary.

A12ca 15-33cm K318	Very dark greyish-brown 10YR 3/2 (moist) and grey 10YR 5/1 (dry); silt loam; moderate coarse prismatic to coarse subangular blocky structure; nonsticky, plastic (wet); friable (moist); slightly hard (dry); common very fine to fine tubular pores; common calcareous mycelia; strongly calcareous; few very fine roots; smooth, clear boundary.
A13 33-40cm K319	Very dark greyish-brown 10YR 3/1 (moist) and very dark greyish-brown 10YR 4/2 and greyish-brown 10YR 5/2 (dry); sandy loam; moderate medium to fine subangular blocky structure; nonsticky, nonplastic (wet); friable (moist); hard (dry); many fine to very fine tubular pores; common calcareous mycelia; strongly calcareous; few very fine roots; clear, irregular boundary.
IIAb 40-59cm K320	Greyish-brown 10YR 5/8 (moist) and brownish-yellow 10YR 6/8 and light yellowish-brown 10YR 6/4 (dry); sandy loam; moderate coarse prismatic to strong coarse fine subangular blocky structure; nonsticky, plastic (wet); firm (moist); very hard (dry); no pores; few slightly rounded weathered orthoclase gravel; strongly calcareous; common very fine roots on ped surfaces; gradual, wavy boundary.
IIB 59-85cm K321	Yellowish-brown 10YR 5/6 (moist) and pale yellow 2.5YR 7/4 (dry); sandy loam; strong very coarse prismatic structure; nonsticky, plastic (wet); friable (moist); very hard (dry); common very fine to fine tubular pores; few slightly rounded fresh orthoclase gravel; strongly calcareous; few very fine roots on ped surfaces; gradual, wavy boundary.
IIC 85-98cm K322	Yellowish-brown 10YR 5/6 (moist) and light yellowish-brown 2.5YR 6/4 and pale yellow 2.5YR 7/4 (dry); loamy sand; moderate medium to fine subangular blocky structure; nonsticky, nonplastic (wet); very friable (moist); slightly hard (dry); many very fine tubular pores; common slightly rounded fresh orthoclase gravel; moderately calcareous; very few very fine roots; gradual, wavy boundary.
IIIC 98-128+cm K323	Dark yellowish-brown 10YR 4/6 (moist) and light yellowish-brown 10YR 6/4 and brownish-yellow 10YR 6/6 (dry); sand; weak medium subangular blocky to granular structure; nonsticky, nonplastic (wet); loose (moist); soft (dry); no pores; common slightly rounded fresh orthoclase gravel; moderately calcareous; no roots.

ANALYTICAL DATA FOR SITE K65

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K317	0-15	A11ca	-	-	51	46	3	sl
K318	15-33	A12ca	-	-	45	52	3	sil
K319	33-40	A13	-	-	3	44	3	sl
K320	40-59	IIAb	-	-	57	40	3	sl
K321	59-85	IIB	-	-	59	36	5	sl
K322	85-98	IIC	-	-	77	20	3	ls
K323	98-128+	IIIC	-	-	93	4	3	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K317	7.5	0.31	3.80	10.00	28.00	2.0
K318	7.0	0.61	4.67	23.90	16.00	30.0
K319	6.9	0.61	17.50	2.47	2.00	50.0
K320	7.10	0.43	7.1	0.43	1.52	52.0
K321	6.9	2.90	1.37	5.60	6.00	31.0
K322	7	0.52	1.41	5.10	6.00	13.0
K323	7.0	1.10	0.38	47.00	6.00	4.5

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K66

SITE INFORMATION

Classification: TYPIC CALCIUSTOLL, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: May 11, 1982
Authors: J. King, P. Martins and A. E. Abu Ghanem
Location: 5.7km north of Sadah, 1km east of the Sadah air strip in Sadah Province
Elevation: 1780m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: 1^0 or 2%
Land use: Usual bunch grass which grows on this hummocky type sandy land
Climate: No information

SOIL INFORMATION

Parent material: Calcareous silt and sandstone
Drainage class: Class 4, well drained
Moisture conditions: Moist to 35cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: Wind erosion is shown by the presence of hummocks 10cm high where there is vegetation, slight sheet and gully
Salt content: Profile calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Except for the sand caps the profile has uniform sand loam texture throughout. It has a strongly expressed A1 and calcareous horizon

Profile Description

C1 0-6cm K324	Light yellowish-brown 10YR 6/4 (moist) and very pale brown 10YR 7/4 (dry); sand; granular structure; nonsticky, nonplastic (wet); loose (moist); loose (dry); no pores; no mineral fragments; strongly calcareous; no roots; abrupt, smooth boundary.

C2
6-20cm
K325

Dark yellowish-brown 10YR 3/4 (moist) and--(dry); loamy sand; weak medium to fine subangular blocky structure; nonsticky, nonplastic (wet); friable (moist);--(dry); few fine and common very fine tubular pores; no mineral fragments; strongly calcareous; few fine and common very fine roots; clear, smooth boundary.

A1b
20-50cm
K326

Dark brown 10YR 3/3 (moist) and dark yellowish-brown 10YR 4/4 and dark yellowish-brown 10YR 5/4 (dry); sandy loam; moderate coarse to medium subangular blocky structure; slightly sticky (wet); friable (moist); slightly hard (dry); few fine, many very fine pores; common calcium mycelia; strongly calcareous; common fine roots; gradual, smooth boundary.

IIAb
50-72cm
K327

Dark yellowish-brown 19YR 4/6 (moist) and yellowish-brown 10YR 5/6 (dry); loamy sand; strong coarse angular to subangular blocky structure; slightly sticky, plastic (wet); very friable (moist); slightly hard to hard (dry); many very fine tubular pores; common calcareous mycelia; strongly calcareous; few fine roots; clear, wavy boundary.

IIB
72-95cm
K328

Yellowish-brown 10YR 5/6 (moist) and light yellowish-brown 10YR 6/6 and very pale brown 10YR 7/4 (dry); sandy loam; stong coarse to medium angular to subangular blocky structure; slightly sticky, plastic (wet); very friable (moist); slightly hard (dry); many very fine tubular pores; frequent medium and large soft and hardy irregular white calcareous nodules; strongly calcareous; few fine roots; gradual, smooth boundary.

IIC
95-125cm
K329

Strong brown 7.5YR 4/6 (moist) and strong brown 7.5YR 5/6 and brown 7.5 5/4 (dry); sandy loam; moderate coarse to medium subangular blocky structure; slightly sticky, plastic (wet); very friable (moist); slightly hard (dry); common fine tubular pores; frequent medium and large soft and hard irregular white calcareous nodules; strongly calcareous; very few fine roots.

ANALYTICAL DATA FOR SITE K66

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K324	0-6	C1	-	-	89	6	5	s
K325	6-20	C2	-	-	83	10	7	ls
K326	20-50	A1b	-	-	71	26	3	sl
K327	50-72	IIAb	-	-	77	20	3	ls
K328	72-95	IIB	-	-	73	24	3	sl
K329	95-125	IIC	-	-	65	32	3	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K324	7.0	0.52	0.53	4.4	4	4.3
K325	6.8	0.57	0.84	4.7	6	8.8
K326	7.1	0.69	1.25	6.8	6	20.0
K327	7.1	0.61	1.25	9.2	2	22.0
K328	7.2	0.67	0.80	15.1	8	12.0
K329	7.5	0.33	1.48	13.7	3	25.0

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K67

SITE INFORMATION

Classification: TYPIC USTIFLUVENT, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY, SPATE IRRIGATED PHASE
Date and time described: May 11, 1982
Authors: J. King, A. E. Abu Ghanem and P. Martins
Location: 3.5km north of Sadah, between Al Rada and Al Rukya in Sadah Province
Elevation: 1705 m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: 40cm bunds for spate irrigation
Slope: Flat
Land use: Alfalfa and usual vegetaation
Climate: No information

SOIL INFORMATION

Parent material: Calcareous silt alluvium
Drainage class: Class 4, well drained
Moisture conditions: Moist to 40cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: Profile calcareous throughout
Human influence: Soil has been irrigated and farmed and bunds have been built around it

GENERAL DESCRIPTION OF THE PROFILE: Light brown silty alluvium which shows only gradual stratification because of being worked as it accumulated through spate irrigation. The deepest two horizons of this profile are in order a buried mollic epipedon and a cemented calcic horizon.

Profile Description

C 0-22cm K330	Dark yellowish-brown 10YR 3/6 (moist) and yellowish-brown 10YR 5/6 and yellowish-brown 10YR 5/6 (dry); sandy loam; strong coarse prismatic structure; no pores; a few carbonate mycelia; strongly calcareous; few very fine roots; gradual, smooth boundary.

IIC 22-57cm K331	Dark yellowish-brown 10YR 3/6 (moist) and yellowish-brown 10YR 5/4 and yellowish-brown 10YR 5/6 (dry); sandy loam; strong coarse prismatic structure; slightly sticky, plastic (wet); friable (moist); soft (dry); many fine tubular pores; few calcareous mycelia; strongly calcareous; few very fine roots; gradual, smooth boundary.
IIIC 57-83cm K332	Dark yellowish-brown 10YR 2/6 (moist) and yellowish-brown 10YR 5/6 (dry); sandy loam; moderate medium subangular blocky structure; slightly sticky, plastic (wet); friable (moist); soft (dry); common fine tubular pores; few calcareous mycelia; strongly calcareous; few very fine roots; gradual, smooth boundary.
IVC 83-133cm K333	Dark yellowish-brown 10YR 3/6 (moist) and yellowish-brown 10YR 5/6 (dry); sandy loam; strong medium subangular blocky structure; nonsticky, plastic (wet); friable (moist); soft (dry); common fine tubular pores; common calcareous mycelia and very few small irregular soft white calcareous nodules; strongly calcareous; very few very fine roots; diffuse, smooth boundary.
VC 134-157cm K334	Dark yellowish-brown 10YR 6/4 (moist) and yellowish-brown 10YR 5/4 and light yellowish-brown 10YR 6/4 (dry); silt loam; strong medium prismatic to medium subangular blocky structure; slightly sticky, plastic (wet); friable (moist); loose (dry); many fine tubular pores; common calcareous mycelia; strongly calcareous; very few very fine roots; gradual, smooth boundary.
IIAlb 157-202cm K335	Very dark greyish-brown 10YR 3/2 (moist) and dark yellowish-brown 10YR 4/2 and greyish-brown 10YR 5/2 (dry); loamy sand; coarse strong prismatic structure; slightly sticky, plastic (wet); friable (moist); slightly hard (dry); many fine few medium tubular pores; common calcareous mycelia; strongly calcareous; no roots; gradual, smooth boundary.
VICca 202-230cm K336	This is a cemented calcareous horizon; fine earth is sandy loam.

ANALYTICAL DATA FOR SITE K67

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K330	0-22	C	-	-	73	22	5	sl
K331	22-57	IIC	-	-	73	22	5	sl
K332	57-83	IIIC	-	-	59	36	5	sl
K333	83-133	IVC	-	-	49	46	5	sl
K334	134-157	VC	-	-	41	54	5	sil
K335	157-202	VIA1b	-	-	77	20	3	ls
K336	202-230	VICca	-	-	47	48	5	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K330	7.5	0.31	1.25	7.8	7.0	15
K331	6.9	6.50	1.48	8.8	10.0	38
K332	7.1	0.40	1.67	7.6	11.6	19
K333	7.1	0.44	2.32	10.9	8.0	30
K334	6.9	1.50	1.44	10.3	11.6	30
K335	7.4	0.51	0.76	6.8	3.0	12
K336	7.4	0.51	0.99	24.5	9.0	22

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K68

SITE INFORMATION

Classification: TYPIC CALCIORTHID, COARSE LOAMY, MIXED, CALCAREOUS, HYPERTHERMIC FAMILY
Date and time described:
Authors:
Location: 10km north of Sadah, 0.5km north of Al Bawarrah
Elevation: 1810m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: 1^0 or 2%
Land use: Similar to other sand-capped soils
Climate: No information

SOIL INFORMATION

Parent material: Silty alluvium over very coarse alluvium of granitic origin
Drainage class: Class 4, well drained
Moisture conditions: Moist to 32cm
Depth to groundwater: Unknown
Surface stones or outcrops: Few stones, but the surface is covered with coarse sand, gravel and stones
Evidence of erosion: Slight sheet erosion
Salt content: Profile is calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: The profile has two distinct texture differences with the surface three horizons being loam to 44cm. These three horizons consist of a very shallow surface over wash and Ai and a C. Coarse materials are divided into a top layer of accumulation and an underlying horizon which has less calcium than the horizon above.

Profile Description

C 0-1.5cm K337	Brown 7.5YR 4/4 (moist) and brown 7.5YR 4/4 (dry); gravelly loam; moderate medium subangular blocky structure; slightly sticky, plastic (wet); friable (moist); soft (dry); many fine tubular pores; frequent slightly rounded gravel of granitic origin, primarily orthoclase; strongly calcareous; no roots; clear, smooth boundary.

A1b 1.5-18cm K338	Dark brown 7.5YR 3/2 (moist) and dark brown 10YR 4/3 (dry); slightly gravelly sandy loam; weak medium subangular blocky to crumb structure; nonsticky, slightly plastic (wet); friable (moist); soft (dry); few fine tubular pores; frequent slightly rounded gravel of granitic origin, primarily orthoclase; few calcareous mycelia; strongly calcareous; common very fine roots; clear, wavy boundary.
IIC 18-44cm K339	Strong brown 7.5YR 5/6 (moist) and reddish-yellow 7.5YR 6/6 (dry); slightly gravelly sandy loam; weak medium subangular blocky to crumb structure; nonsticky, slightly plastic (wet); friable (moist);--(dry); no pores; frequent slightly rounded gravel of granitic origin, primarily orthoclase; few calcareous mycelia, strongly calcareous; common very fine roots; clear, wavy boundary.
IIICca 44-94cm K340	Strong brown 7.5YR 4/6 (moist) and light yellowish-brown 10YR 6/4 (dry); gravelly to stony sand; structureless structure; nonsticky, nonplastic (wet); loose (moist); loose (dry); no pores; frequent slightly rounded gravel of granitic origin, primarily orthoclase; calcium evident on the surface of gravel and stones with some accumulation in the matrix as well; strongly calcareous; common very fine roots; clear, wavy boundary.
IVC 94-130cm K341	Brown 7.5YR 5/4 (moist) and light brown 7.5YR 6/4 (dry); gravelly to stony sand; structureless structure; nonplastic, nonsticky (wet); loose (moist); loose (dry); no pores; frequent slightly rounded gravel of granitic origin, primarily orthoclase; moderately calcareous; common very fine roots.

ANALYTICAL DATA FOR SITE K68

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K337	0-1.5	C	fr	g	49	38	13	l
K338	1.5-18	A1b	f	g	73	22	5	sl
K339	18-44	IIC	f	g	71	24	5	sl
K340	44-94	IIICca	-	-	89	6	5	s
K341	94-130	IVC	-	-	97	0	3	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K337	7	0.15	1.82	10.9	15.0	25.0
K338	7	0.30	1.90	6.7	16.3	14.0
K339	7.0	1.20	1.82	7.3	8.0	19.0
K340	7.1	0.37	1.27	12.0	2	14.0
K341	7.3	0.56	1.52	5.8	9.0	2.8

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K64

SITE INFORMATION

Classification: TYPIC CALCIORTHID, COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: May 12, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 20km north of Sadah, 2km east of Sadah-Saudi road, 300m east of the village of Al Qubat
Elevation: 810km
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: 1^0 or 2%
Land use: Extremely sparse vegetation, but of the usual types found here
Climate: No information

SOIL INFORMATION

Parent material: Alluvium derived from calcareous silt and granite
Drainage class: Class 4, well drained
Moisture conditions: Moist to 70cm
Depth to groundwater: No effect on the profile
Surface stones or outcrops: Fairly stony
Evidence of erosion: Wind erosion is shown by exposed stones on the surface, also slight sheet and gully erosion
Salt content: Profile calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: A truncated calcic horizon over alluvial material differing in texture and color.

Profile Description

Cca 0-5cm K342	Yellowish-brown 10YR 5/4 (moist) and very pale brown 10YR 8/3 (dry); gravelly to stony sandy loam; weak medium platy to weak medium subangular blocky structure; nonsticky, slightly plastic (wet); friable (moist); soft (dry); many fine pores; few slightly rounded gravel to stone of granitic origin; frequent calcareous mycelia; strongly calcareous; very few very fine roots; clear, wavy boundary.

IIC 5-78cm K343	Yellowish-brown 10YR 5/6 (moist) and yellow 10YR 7/6 and brownish-yellow 10YR 6/6 (dry); loamy sand; weak medium subangular blocky structure; nonsticky, nonplastic (wet); friable (moist); soft (dry); many fine to medium pores; frequent slightly rounded gravel to stones of granitic origin; frequent calcareous mycelia; strongly calcareous; very few very fine roots; clear, smooth boundary.
IIIC 78-148cm K344	Dark yellowish-brown 10YR 3/6 (moist) and yellowish-brown 10YR 5/8 (dry); loamy sand; moderate coarse to medium subangular blocky structure; nonsticky, slightly plastic (wet); friable (moist); soft (dry); few fine tubular pores; frequent slightly rounded gravel to stones of granitic origin; frequent calcareous mycelia; strongly calcareous; no roots; clear, wavy boundary.
K345	It is a petrocalcic horizon of which samples were taken, but no further description was made.

ANALYTICAL DATA FOR SITE K68

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K342	0-5	Cca	vfr	g,s	73	20	7	sl
K343	5-78	IIC	-	-	85	12	3	ls
K344	78-148	IIIC	-	-	75	22	3	ls

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K342	7.3	0.37	1.93	22.7	12.6	12
K343	7.1	0.39	1.12	6.5	9.0	13
K344	7.1	0.30	1.01	8.9	6.0	38

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K70

SITE INFORMATION

Classification: TYPIC CALCIORTHID, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: May 12, 1982
Authors: J. King, P. Martins and A. E. Abu Ghanem
Location: 5km south of Sadah-Saudi road, 20km north of Sadah at the village of Al Barkah in the Sadah Province
Elevation: 1870m
Physiographic position: Terrace
Topography of surrounding country: Undulating
Microtopography: None
Slope: 1^0 or 2%
Land use: None
Climate: No information

SOIL INFORMATION

Parent material: Coarse alluvium of granitic, metamorphic and sandstone origins
Drainage class: Class 4, well drained
Moisture conditions: Moist to 38cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: Class 1, fairly stony, entire surface covered with coarse sand, gravel or stone
Evidence of erosion: Wind erosion is evidenced by coarse material exposed on the surface, slight gully erosion
Salt content: Profile calcareous throughout
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: The entire profile consists of coarse materials and includes an old eroded and broken petrocalcic horizon at 52-115cm.

Profile Description

A1 0-23cm K346	Dark yellowish-brown 10YR 4/4 (moist) and dark yellowish-brown 10YR 4/4 and yellowish-brown 10YR 5/4 (dry); slightly gravelly loamy sand; very weak fine subangular blocky to crumb structure; nonsticky, nonplastic (wet); very friable (moist); soft (dry); many very fine tubular pores; few slightly weathered subrounded gravel of granitic, metamorphic and

sandstone origin; few calcareous mycelia; strongly calcareous; common very fine roots; abrupt, smooth boundary.

C
23-52cm
K347

Strong brown 7.5YR 4/6 (moist) and strong brown 7.5YR 5/6 (dry); gravelly slightly stony to loamy sand; granular structure; nonsticky, nonplastic (wet); loose (moist); loose (dry); no pores; frequent weathered stones and fresh slightly rounded gravel of granitic origin, primarily orthoclase; few calcareous mycelia; strongly calcareous; common very fine roots; clear, wavy boundary.

Note: The third horizon is divided into two parts because there is a broken petrocalcic horizon.

IIC
52-115cm
K348

Strong brown 7.5YR 4/6 (moist) and strong brown 7.5YR 5/8 (dry); gravelly sand; granular structure; nonsticky, nonplastic (wet); loose (moist); soft (dry); no pores; frequent weathered stones and fresh slightly rounded gravel of granitic origin, primarily orthoclase; strongly calcareous; few very fine roots; abrupt, smooth boundary.

IICca
52-115cm
K348

Pink 7.5YR 8/4 (moist) and white (dry); sand; cemented; nonsticky, nonplastic (wet); friable (moist); hard (dry); frequent weathered granitic stones and fresh slightly rounded gravel of orthoclase; strong reaction; no roots; abrupt, smooth boundary.

IIIC
115-155+cm
K349

Light brown 7.5YR 6/4 (moist) and pink 7.5YR 7/4 (dry); very gravelly sand; granular structure; nonsticky, nonplastic (wet); loose (moist); loose (dry); no pores; very frequent fresh and slightly weathered gravel and stones of granitic origin; strongly calcareous; no roots.

ANALYTICAL DATA FOR SITE K70

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K346	0-23	A1	f	g	83	14	3	ls
K347	23-52	IIC	f	g,s	87	8	5	ls
K348	52-115	IIC & IICA	fr	g	97	0	3	s
K349	115-155	IIIC	vfr	g	89	6	5	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C me/100g
K346	7.4	0.21	2.21	6.7	10	10
K347	7.2	1.20	0.81	4.6	3	13
K348	7.4	0.45	0.81	5.5	2	14
K349	7.5	0.68	1.63	18.1	3	20

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K71

SITE INFORMATION

Classification: TYPIC TORRIPSAMMENT, MIXED, HYPERTHERMIC FAMILY
Date and time described: May 13, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 15km south of Sadah, 300m west of the Sadah-Sana road
Elevation: 1840m
Physiographic position: Valley
Topography of surrounding country: Flat to steeply dissected
Microtopography: None
Slope: Yellow sticker and Acacia, land used for some light grazing
Land use: No information
Climate: No information

SOIL INFORMATION

Parent material: Coarse alluvium of granitic origin
Drainage class: Class 5, somewhat excessively drained
Moisture conditions: Profile moist throughout
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: None
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Sandy alluvium with well-defined fine stratifications within the horizons.

Profile Description

C 0-15cm K351	Dark yellowish-brown 10YR 4/4 (moist) and pale brown 10YR 6/3 and very pale brown 10YR 7/4 (dry); sandy; weak medium subangular blocky structure; nonsticky, nonplastic (wet); friable (moist); soft (dry); common very fine pores; few fresh subrounded gravel of granitic origin; moderately calcareous; common very fine roots; gradual, wavy boundary.
IIC 15-54cm K352	Dark yellowish-brown 10YR 4/4 (moist) and pale brown 10YR 6/3 and very pale brown 10YR 7/4 (dry); loamy sand; weak medium subangular blocky structure; nonsticky, nonplastic (wet); very friable (moist); soft

(dry); common very fine pores; few fresh subrounded gravel of granitic origin; moderately calcareous; common very fine roots; clear, smooth boundary.

IIIC 54-78cm K353	Dark brown 7.5YR 4/4 (moist) and brown 7.5YR 5/4 and light 7.5YR 6/4 (dry); slightly gravelly to stony sand; weak medium subangular blocky structure; nonsticky, nonplastic (wet); loose (moist); soft (dry); common fine pores; few fresh subrounded gravel of granitic origin; slightly calcareous; few very fine roots; clear, wavy boundary.
IVC 78-94cm K354	Strong brown 7.5YR 4/6 (moist) and light brown 7.5YR 6/4 and light brown 7.5YR 6/4 (dry); sand; granular structure; nonsticky, nonplastic (wet); loose (moist); soft (dry); common fine pores; few fresh subrounded gravel of granitic origin; slightly calcareous; few very fine roots; clear, smooth boundary.
VC 94-110cm K355	Strong brown 7.5YR 4/6 (moist) and light brown 7.5YR 6/4 and light brown 7.5YR 6/4 (dry); sandy; moderate coarse platy structure; nonsticky, nonplastic (wet); friable (moist); soft (dry); common fine pores; no mineral fragments; slightly calcareous; clear, wavy roots; clear, wavy boundary.
VIC 110-129cm K356	Brown 7.5YR 4/4 (moist) and pinkish-gray 7.5YR 6/2 and 7.5YR 5/4 (dry); slightly gravelly sand; granular structure; nonsticky, nonplastic (wet); loose (moist); no (dry); no pores; few slightly rounded fresh gravel of granitic origin; slightly calcareous; no roots; clear, smooth boundary.
VIIC 129-146cm K357	Dark brown 7.5YR 4/4 (moist) and light brown 7.5YR 6/4 and brown 7.5YR 5/4 (dry); slightly gravelly sand; granular structure; nonsticky, nonplastic (wet); friable (moist); loose (dry); common fine pores; few slightly rounded fresh gravel and stones of granitic origin; slightly calcareous; no roots; clear, smooth boundary.
VIIIC 146-175+cm K358	Dark brown 7.5YR 3/4 (moist) and brown 7.5YR 5/4 and brown 7.5YR 5/4 (dry); slightly gravelly and stony sand; moderate coarse platey structure; nonsticky, nonplastic (wet); friable (moist); soft (dry); common fine pores; few slightly rounded fresh gravel and stones of granitic origin; slightly calcareous; no roots.

ANALYTICAL DATA FOR SITE K71

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K351	0-15	C	-	-	91	4	5	s
K352	15-54	IIC	-	-	95	2	3	s
K353	54-78	IIIC	f	g	97	0	3	s
K354	78-94	IVC	-	-	97	0	3	s
K355	94-110	VC	-	-	97	0	3	s
K356	110-129	VIC	f	g	97	0	3	s
K357	129-146	VIIC	f	g	97	0	3	s
K358	146-175	VIIIC	f	g,s	97	0	3	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K351	7.4	0.20	2.02	5.2	3	16
K352	7.5	0.22	1.52	4.4	2	28
K353	7.5	0.34	0.76	3.2	1	9
K354	7.1	0.18	0.46	4.2	4	10
K355	7.2	0.18	0.61	4.1	2	10
K356	7.2	0.14	0.30	3.3	2	21
K357	7.0	0.15	0.19	3.6	2	31
K358	7.0	0.35	0.61	4.2	6	44

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K72

SITE INFORMATION

Classification: TYPIC USTIFLUVENT, COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: May 26, 1982
Authors: J. King
Location: Tihama, Wadi Mawr region, 75m east of Hudaydah-Saudi road, 10km north of Wadi Mawr
Elevation: 110m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: Bunds 57cm high around fields up to 5 hectares in size
Slope: 1^0 or 2%
Land use: Used for millet and sorghum production
Climate: No information

SOIL INFORMATION

Parent material: Alluvium and silt loam
Drainage class: Class 4, well drained
Moisture conditions: Moist to 30cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: Mild sheet erosion
Salt content: None
Human influence: Bunding and spate irrigation

GENERAL DESCRIPTION OF THE PROFILE: This profile is in the fine brown noncalcareous parent material of the northern Tihama. It has a buried A horizon at 61cm which would now classify as an Umbric epipedon. These soils are significant but not extensive in the northeastern Tihama, and less evident as you move westward because the cap over them becomes deeper and no longer classifies them as buried soils

Profile Description

Ap 0-9cm K359	Brown 7.5YR 4/4 dark brown (moist) and dark yellowish-brown 10YR 5/6 and dark yellowish-brown 10YR 4/6 (dry); sandy loam; weak medium subangular blocky structure; nonsticky, slightly plastic (wet); friable (moist); soft (dry); no pores; no mineral fragments; noncalcareous; common very fine roots; clear, smooth boundary.

C1
9-32cm
K360

Dark brown 7.5YR 3.4 (moist) and dark yellowish-brown 10YR 4/4 and dark brown 7.5YR 4/4 (dry); sandy loam; moderate medium subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); hard (dry); few coarse, common, fine tubular pores; no mineral fragments; noncalcareous; few very fine roots; smooth, diffuse boundary.

C2
32-61cm
K361

Dark brown 10YR 4/3 (moist) and dark brown 7.5YR 4/4 and brown 7.5YR 5/4 (dry); sandy loam; strong coarse prismatic structure; slightly sticky, plastic (wet); firm (moist); hard (dry); few coarse fine tubular pores; no mineral fragments; slightly calcareous; very few very fine roots; smooth, gradual boundary.

A1b
61-110cm
K362

Dark yellowish-brown 10YR 3/4 (moist) and dark brown 10YR 3/3 and dark brown 10YR 4/3 (dry); silt loam; moderate coarse prismatic to strong very coarse subangular blocky structure; slightly sticky, plastic (wet); firm (moist); hard (dry); few very coarse vesicular pores; there are some slickensides in this horizon; common, white noncalcareous pseudomycelia, slightly calcareous; very few very fine roots; smooth, gradual boundary.

IIB
110+cm
K363

Dark yellowish-brown 10YR 4/6 (moist) and yellowish-brown 10YR 5/6 and yellowish-brown 10YR 5/6 (dry); silt loam; strong coarse prismatic structure; slightly sticky, plastic (wet); friable (moist); hard (dry); no pores; few very fine gravel; slightly calcareous; no roots.

ANALYTICAL DATA FOR SITE K72

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K359	0-9	Ap	-	-	71	24	5	sl
K360	9-32	C1	-	-	55	42	3	sl
K361	32-61	C2	-	-	55	42	3	sl
K362	61-110	A1b	-	-	43	54	3	sil
K363	110+	IIB	-	-	43	54	3	sil

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K359	7.4	0.24	1.41	2.8	1	21
K360	6.9	0.11	1.10	4.1	1	32
K361	7.1	0.86	1.14	4.3	6	38
K362	6.9	0.45	1.33	4.6	5	30
K363	7.2	0.21	1.25	4.1	6	24

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K73

SITE INFORMATION

Classification: TYPIC USTIPSAMMENT, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: May 26, 1982
Authors: A. E. Abu Ghanem and J. King
Location: 15km west of Hudaydah-Saudi road, 40km north of Wadi Mawr crossing, 500m east of the village of Dir Daresh
Elevation: 105m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: 1^0 or 2%
Land use: Photo series on natural vegetation, no crops, but they grow millet on this land every year with rainwater
Climate: No information

SOIL INFORMATION

Parent material: Noncalcareous silt and sand
Drainage class: well drained
Moisture conditions: Moist to 69cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: Slight evidence of sand erosion shown by some sand being caught and trapped by vegetation
Salt content: None
Human influence: Land is tilled

GENERAL DESCRIPTION OF THE PROFILE: Yellowish-brown throughout and consists of three horizons, the top two primarily silt and the lowest horizon (69-150cm) primarily sand.

Profile Description

C 0-53cm K364	Dark yellowish-brown 10YR 3/4 (moist) and yellowish-brown 10YR 5/6 and yellowish-brown 10YR 5/6 (dry); loamy sand; weak medium to fine subangular blocky structure; slightly sticky, slightly plastic (wet); friable (moist); soft (dry); few medium and very few, very fine tubular pores; no mineral fragments; noncalcareous; few very fine roots; clear, smooth boundary.

IIC 53-69cm K365	Dark brown 10YR 3/3 (moist) and yellowish-brown 10YR 5/6 and yellowish-brown 10YR 5/6 (dry); loamy sand; weak, medium to fine subangular blocky structure; nonsticky, nonplastic (wet); friable (moist); soft (dry); very few, very fine tubular pores; very few, fresh slightly rounded stones; noncalcareous; very few, very fine roots; clear, smooth boundary.
IIIC 69-150cm K366	Dark greyish-brown 10YR 4/2 (moist) and yellowish-brown 10YR 5/4 and yellowish-brown 10YR 5/6 (dry); gravelly sand; weak, medium to fine subangular blocky structure; nonsticky, nonplastic (wet); friable (moist); soft (dry); very few, very fine tubular pores; very few, fresh slightly rounded stones; noncalcareous; very few, very fine roots.

ANALYTICAL DATA FOR SITE K73

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K364	0-53	C	-	-	79	18	3	ls
K365	53-39	IIC	-	-	79	18	3	ls
K366	69-150	IIIC	-	-	91	6	3	s

No.	pH 1:1	EC mmhos	Organic Matter	CaCO3 (%)	Avail. P	C E C meq/100g
K364	7.4	0.16	6.00	2.2	0.87	15.0
K365	7.5	0.24	1.48	3.4	3.00	14.0
K366	7.9	0.25	1.29	2.5	1.00	6.2

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K74

SITE INFORMATION

Classification: TYPIC TORRIFLUVENT, COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: May 26, 1982
Authors: A. E. Abu Ghanem and J. King
Location: 17km west of Hudaydah-Saudi Road, 40km north of Wadi Mawr crossing, 2km west of village of Dir Baresh
Elevation: 105m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: None
Slope: 1^0 or 2%
Land use: No cropping, picture series taken
Climate: No information

SOIL INFORMATION

Parent material: Coarse alluvium
Drainage class: Class 4, well drained
Moisture conditions: Moist to 20cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: Class 2, stony; entire surface is covered with gravel and stones, stones making up about 5% of the cover
Evidence of erosion: Moderate gully erosion
Salt content: None
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Profile consists of two yellowish-brown alluvial horizons, each of which consists primarily of sand.

Profile Description

C 0-21cm K367	Dark yellowish-brown 10YR 4/4 (moist) and yellowish-brown 10YR 5/6 and yellowish-brown 10YR 5/6 (dry); slightly stony, slightly gravelly sandy; weak medium to fine subangular blocky structure; nonsticky, nonplastic (wet); friable (moist); soft (dry); few fresh, slightly rounded gravel and stones; slightly calcareous; very few very fine roots; clear, smooth boundary.

IIC 21-110+cm K368	Dark greyish-brown 10YR 4/2 (moist) and greyish-brown 10YR 5/2 (dry); slightly stony and gravelly sand; weak medium to fine subangular blocky structure; nonsticky, nonplastic (wet); friable (moist); soft (dry); no pores; fresh slightly rounded, common gravel and few stones; slightly calcareous; very few very fine roots.

ANALYTICAL DATA FOR SITE K74

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K367	0-21	C	f	g,s	89	6	5	s
K368	21-110+	IIC	f	g,s	95	2	3	s

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K367	7.0	0.66	3.70	0.61	5	7
K368	7.1	0.46	0.76	3.50	7	43

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K75

SITE INFORMATION

Classification: TYPIC GYPSIORTHID, COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: May 27, 1982
Authors: A. E. Abu Ghanem and J. King
Location: Eastern Wadi Mawr, Mahal Bani Cephan
Elevation: 200m
Physiographic position: Concave slope, almost straight
Topography of surrounding country: Steeply dissected
Microtopography: None
Slope: 28^0 or 53%
Land use: Photo series taken
Climate (calculated): No information, but it is more moist in the north than it is in the south

SOIL INFORMATION

Parent material: Igneous colluvium and silt loess
Drainage class: Class 4, well drained
Moisture conditions: Moist throughout
Depth to groundwater: No effect on profile
Surface stones or outcrops: Completely covered with stones
Evidence of erosion: Slight gully erosion
Salt content: None
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Alluvial soil with three horizons, a mollic epipedon over light-colored horizon with a great deal of decomposed granite in it, which in turn overlies a horizon composed primarily of silt with no rock in it at all

Profile Description

A1 0-30cm K369	Brown 10YR 3/3 (moist); gravelly loamy sand; moderate medium subangular blocky structure; nonsticky, nonplastic (wet); very friable (moist); common fine few medium tubular pores; frequent fresh slightly rounded gravel and stones of igneous origin; slightly calcareous; common fine to medium roots; diffuse, wavy boundary.

IIC 30-57cm K370	Yellowish-brown 10YR 5/4 (moist); gravelly loam; weak, medium subangular blocky structure; nonsticky, slightly plastic (wet); very friable (moist); common fine pores; frequent weathered gravel of granitic origin; moderately calcareous; few fine to medium roots; diffuse, wavy boundary.
IIIC 57-83+cm K371	Dark yellowish-brown 10YR 4/6 (moist); sandy loam; moderate coarse to medium subangular blocky structure; slightly sticky, plastic (wet); friable (moist); few fine tubular pores; no mineral fragments; moderately calcareous; very few fine to medium roots.

ANALYTICAL DATA FOR SITE K75

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K369	0-30	A1	f	g	84	11	5	ls
K370	30-57	IIC	f	g	63	28	9	sl
K371	57-83+	IIIC	-	-	47	46	7	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K369	7.6	0.24	1.63	3.9	12.6	24
K370	7.3	2.8	1.60	5.6	12.6	27
K371	7.1	0.7	0.99	7.8	2	52

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K76

SITE INFORMATION

Classification: TYPIC GYPSIORTHID, COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: May 27, 1982
Authors: A. E. Abu Ghanem and J. King
Location: Eastern Wadi Mawr in the Mahal Bani Cephan region
Elevation: 200 m
Physiographic position: Concave slope
Topography of surrounding country: Steeply dissected
Microtopography: None
Slope: 28° or 53%
Land use: Picture series taken
Climate: No information

SOIL INFORMATION

Parent material: Igneous colluvium and silt loess
Drainage class: Class 4, well-drained
Moisture conditions: Moist throughout
Depth to groundwater: No effect on profile
Surface stones or outcrops: Rubble land
Evidence of erosion: Slight gully erosion
Salt content: None
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: This profile consists of a mollic epipedon over a light-colored C horizon composed primarily of decomposed granite.

Profile Description

A1 0-22cm K372	Dark brown 10YR 3/3 (moist) and stony, gravelly sandy loam (dry); weak medium subangular blocky; slightly sticky, nonplastic structure, very friable (wet); very friable (moist); few fine tubular pores; frequent, fresh sharp gravel and stones of igneous origin; moderately calcareous; common fine few coarse roots; clear, wavy boundary.
IICca 22-80+cm	Very pale brown 10YR 8/3 (moist); gravelly loam; weak coarse to medium subangular blocky structure;

K373 nonsticky, nonplastic (wet); friable (moist); no pores; frequent weathered gravel of granitic origin; calcareous; no roots.

ANALYTICAL DATA FOR SITE K76

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K372	0-22	A1	fr	g	63	34	3	sl
K373	22-80+	IICca	fr	g	79	14	7	ls

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K372	7.4	0.21	1.56	5.8	12.6	30
K373	7.6	0.80	1.03	4.7	5.0	15

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

PROFILE SITE K77

SITE INFORMATION

Classification: TYPIC TORRIFLUVENT, COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: May 27, 1987
Authors: A. E. Abu Ghanem and J. King
Location: Eastern Wadi Mawr on the north side of Wadi Mawr, 8km east of the Hudaydah-Saudi road
Elevation: 225m
Physiographic position: Plain
Topography of surrounding country: Flat to steeply dissected
Microtopography: None
Slope: 1° or 2%
Land use: Photo series taken
Climate: No information

SOIL INFORMATION

Parent material: Stony alluvium
Drainage class: Class 4, well drained
Moisture conditions: Profile became moist throughout during the description because it rained
Depth to groundwater: No effect on profile
Surface stones or outcrops: Rubble land
Evidence of erosion: Moderate gully erosion
Salt content: None
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Stratified stony, alluvial material with silty alluvium and calcium accumulation from 43-59cm.

Profile Description

C 0-43cm K374	Brown 10YR 3/3 (moist); gravelly, stony, loamy sand; weak subangular blocky to crumb structure; nonsticky, nonplastic (wet); very friable (moist); few fine tubular pores; frequent fresh slightly rounded gravel and stones of mixed origin; slightly calcareous; few fine common very fine roots; clear, wavy boundary.
IIC 43-59cm	Dark yellowish-brown 10YR 3/4 (moist); loamy sand; nonsticky, nonplastic (wet); loose (moist); no pores;

K375	frequent fresh and slightly rounded gravel and stones of mixed origin; strongly calcareous; common very fine roots; clear, wavy boundary.
IIIC 59-120cm K376	Very dark grayish-brown 10YR 3/2 (moist); gravelly sand; weak subangular blocky to crumb structure; nonsticky, nonplastic (wet); loose (moist); no pores; few weathered stones frequent fresh slightly rounded gravel of mixed origin; noncalcareous; very few very fine roots; clear, wavy boundary.
IVC 120-140cm K377	Dark yellowish-brown 10YR 4/6 (moist); sandy loam; weak subangular blocky structure; slightly sticky (wet); firm (moist); no pores; no mineral fragments; slightly calcareous; no roots.

ANALYTICAL DATA FOR SITE K77

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K374	0-43	C	fr	g,s	81	14	5	ls
K375	43-59	C	-	-	77	20	3	ls
K376	59-120	IIC	f	g	93	4	3	s
K377	120-140	IIIC	-	-	55	42	3	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K374	7.6	0.64	0.87	4.9	7.0	18
K375	7.4	0.32	1.10	6.0	7.0	20
K376	7.4	1.20	0.53	4.4	12.6	12
K377	7.3	0.28	0.76	5.3	9.0	32

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977).

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K78

SITE INFORMATION

Classification: TYPIC TORRIORTHENT, COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: May 28, 1982
Authors: A. E. Abu Ghanem and J. King
Location: Wadi Al Ackaytah by Jabal al Ngyahdah, 30 km east of bridge where the Hudaydah-Saudi road crosses Wadi Baual
Elevation: 410 m
Physiographic position: Concave slope
Topography of surrounding country: Steeply dissected
Microtopography: None
Slope: 28° or 53%
Land use: Picture series taken
Climate: No information

SOIL INFORMATION

Parent material: Sandstone colluvium and silt loess
Drainage class: Class 4 ,well-drained
Moisture conditions: Moist throughout
Depth to groundwater: No influence on profile
Surface stones or outcrops: Rubble land
Evidence of erosion: Slight gully erosion
Salt content: None
Human influence: None

GENERAL DESCRIPTION OF THE PROFILE: Colluvial soil covered with rubble derived from sandstone lying over highly weathered sandstone. Some accumulation of organic matter in the surface 5cm. Percentage silt increases with depth.

Profile Description

A1 0-5cm K378	Dark brown 10YR 3/3 (moist); gravelly loam; weak medium subangular blocky structure; non-sticky, slightly plastic (wet); very friable (moist); - (dry); many very fine tubular pores; frequent fresh slightly rounded gravel and stones derived from sandstone and some quartz; non-calcareous; common very fine roots; gradual, wavy boundary.

C. 5-30cm K379	Dark yellowish-brown 10YR 3/4 (moist); gravelly sandy loam; weak medium subangular blocky to crumb structure; nonsticky, slightly plastic (wet); friable (moist); common fine tubular pores; frequent fresh slightly rounded gravel and stones derived from sandstone and some quartz; noncalcareous; few very fine roots; clear, wavy boundary.
	K380 and K381 are both at the same depth. K380 consists of tongues of silt or loess that go down into highly weathered sandstone (K381)
IIC 30-115cm K380	Dark yellowish-brown 10YR 3/6 (moist); loamy sand; weak coarse subangular blocky to crumb structure; nonsticky, nonplastic (wet); friable (moist); no pores; noncalcareous; few very fine roots.
IIIC 30-115cm K381	Yellowish-brown 10YR 5/4 (moist); decomposed sandstone; sandy loam; granular structure; nonsticky, nonplastic (wet); friable (moist); no pores; noncalcareous; few very fine roots.

ANALYTICAL DATA FOR SITE K78

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K378	0-5	A1	fr	g	79	14	7	sl
K379	5-30	-	fr	g	79	12	9	sl
K379	30-115	C	-	-	81	10	9	ls
K380	30-115	C	-	-	63	28	9	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K378	6.9	0.29	1.98	4.5	9	11
K379	6.8	0.19	1.48	5.1	3	20
K380	6.9	0.28	1.52	4.8	2	18
K381	7.0	0.20	0.84	3.1	7	5

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K79

SITE INFORMATION

Classification: TYPIC USTIFLUVENT, COARSE LOAMY, MIXED, ISOHYPERTHERMIC FAMILY
Date and time described: May 28, 1982
Authors: A. E. Abu Ghanem and J. King
Location: 25km east of where Hudaydah-Saudi road crosses Wadi Baual
Elevation: 340m
Physiographic position: Valley
Topography of surrounding country: Flat to steeply dissected
Microtopography: None
Slope: 1^0 or 2%
Land use: Corn and sorghum production. Picture series on native vegetation in the area.
Climate: No information (northern Tihama seems to be quite a bit more moist than the southern Tihama)

SOIL INFORMATION

Parent material: Alluvial fine sand and silt
Drainage class: Class 4, well-drained
Moisture conditions: Moist down to 10cm
Depth to groundwater: No effect on profile
Surface stones or outcrops: None
Evidence of erosion: Undercutting bank by stream
Salt content: None
Human influence: Soil is tilled and spate irrigated

GENERAL DESCRIPTION OF THE PROFILE: Uniformly light yellowish-brown alluvium with comparatively deep ill-defined strata, differing slightly in texture.

Profile Description

C 0-42cm K382	Dark brown 10YR 3/3 (moist) and light yellowish-brown 10YR 6/4 and brown 10YR 5/3 (dry); sandy loam; weak medium subangular blocky structure; nonsticky, slightly plastic (wet); loose (moist); few very fine pores; no mineral fragments; slightly calcareous; common very fine roots; gradual, wavy boundary.

IIC 42-80cm K383	Dark brown 10YR 4/3 (moist) and light yellowish-brown 10YR 6/4 and brown 10YR 5/4 (dry); sandy loam; weak medium subangular blocky structure; nonsticky, slightly plastic (wet); friable (moist); few very fine tubular pores; no mineral fragments; moderately calcareous; common very fine roots; gradual, smooth boundary.
IIIC 80-105cm K384	Dark brown 10YR 4/3 (moist) and light yellowish-brown 10YR 6/4 and light yellowish-brown 10YR 6/4 (dry); sandy loam; moderate medium to fine subangular blocky structure; nonsticky, slightly plastic (wet); friable (moist); soft (dry); few very fine tubular pores; no mineral fragments; moderately calcareous; common very fine roots; gradual, smooth boundary.
IVC 105-152cm K385	Dark brown 10YR 3/3 (moist) and light yellowish-brown 10YR 5/4 and light yellowish-brown 10YR 6/4 (dry); sandy loam; weak medium to fine subangular blocky structure; slightly sticky, plastic (wet); friable (moist); soft (dry); very few medium pores; no mineral fragments; moderately calcareous; few very fine roots.

ANALYTICAL DATA FOR SITE K79

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K382	0-42	C	-	-	63	28	9	sl
K383	42-80	IIC	-	-	63	28	9	sl
K384	80-105	IIIC	-	-	61	28	11	sl
K385	105-152	IVC	-	-	67	24	9	sl

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K382	7.1	0.60	1.67	7.1	14.0	16
K383	7.2	0.40	1.52	7.0	11.6	15
K384	7.1	0.13	1.67	6.4	9.0	17
K385	7.8	2.90	1.25	6.1	10.0	15

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K80

SITE INFORMATION

Classification: PETROCALCIC CALCIUSTOLL, FINE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: August 23, 1982
Authors: J. King
Location: 6 km south of Ibb, immediately east of the Ibb-Taizz highway
Elevation: 1850 m
Physiographic position: Convex slope
Topography of surrounding country: Mountainous
Microtopography: Nil
Slope: 30° or 58%
Land use: Grazing
Climate: No information

SOIL INFORMATION

Parent material: Volcanic rocks, calcareous loess
Drainage class: Class 4, well drained
Moisture conditions: Profile moist throughout
Depth to groundwater: Not known, but no effect on profile
Surface stones or outcrops: Very few stones
Evidence of erosion: Slight rill erosion
Salt content: Profile calcareous throughout
Human influence: Nil

GENERAL DESCRIPTION OF THE PROFILE: Profile was calcareous throughout with a mollic epipedon overlying a petrocalcic horizon.

Profile Description

A11 0-11cm K386	Dark brown, 7.5 YR 3/2 (moist); silt loam; crumb structure; plastic (wet); nonsticky (moist); friable (dry); common fine tubular pores; no mineral fragments; moderately calcareous; very frequent to fine to medium roots; smooth, gradual boundary.
A12 11-64cm K387	Dark brown, 7.5YR 3/2 (moist); slightly stony and gravelly loam; crumb structure; plastic (wet); slightly sticky (moist); friable (dry); common fine tubular pores; few fresh sharp gravel and stones of volcanic origin; strongly calcareous; frequent fine to medium roots; smooth boundary.

A&C
64-80cm
K388

Dark brown, 7.5YR 3/4 (moist); slightly stony and gravelly loam; crumb structure; plastic (wet); slightly sticky (moist); friable (dry); common fine tubular pores; few fresh sharp gravel and stones of volcanic origin; strongly calcareous; common fine to medium roots; smooth, abrupt boundary.

ANALYTICAL DATA FOR SITE K80

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K386	0-11	A1	-	-	37	52	11	sil
K387	11-64	A	f	g,s	41	42	17	l
K388	64-80	AC	f	g,s	39	40	21	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K386	7.5	0.38	10.8	12.8	14.0	52
K387	7.9	0.18	5.3	17.7	11.6	45
K388	7.6	0.81	4.4	24.3	10.0	42

*vf- very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr- very frequent (40-80% by volume)

** g-gravel (2-75 mm)
s-stones (75-250 mm)
b-boulders (>250 mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K81

SITE INFORMATION

Classification: TYPIC CALCIORTHID, FINE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: August 23, 1982
Authors: J. King
Location: 3.5km east of the Taizz-Ibb road in the Asyani area of the Ibb Province, 1km south of the village of Junaid
Elevation: 1820m
Physiographic position: Convex slope
Topography of surrounding country: Mountainous
Microtopography: Nil
Slope: 14^0 or 25%
Land use: Grazing
Climate: No information

SOIL INFORMATION

Parent material: Calcareous loess and granitic rock
Drainage class: Class 4, well drained
Moisture conditions: Profile moist throughout
Depth to groundwater: Not known, but no influence on profile
Surface stones or outcrops:
Evidence of erosion: Slight ril erosion
Salt content: Calcareous
Human influence: Nil

GENERAL DESCRIPTION OF THE PROFILE: Not given

Profile Description

A11 0-12cm K389	Dark brown, 10YR 4/3 dark brown (moist); loam; crumb structure; plastic (wet); slightly sticky (moist); friable (dry); common fine tubular pores; no mineral fragments; strongly calcareous; frequent fine roots; smooth, gradual boundary.
A12 12-42cm K390	Dark brown, 10YR 4/3 (moist); slightly gravelly to stony loam; crumb structure; nonsticky (wet); slightly sticky (moist); friable (dry); few fine tubular pores; some lime visible on under surface of stones and gravel, few sharp gravel to stones of volcanic origin;

strongly calcareous; common fine roots; smooth, clear boundary.

A&C
42-54cm
K391

Yellowish-brown, 10YR 5/4 (moist); slightly gravelly to stony loam; weak fine subangular blocky structure; nonsticky (wet); slightly plastic (moist); friable (dry); few fine tubular pores; some lime on undersurface of stones and on surfaces of peds, few sharp gravel to stone of volcanic origin; strongly calcareous; common fine roots; clear, smooth boundary.

ANALYTICAL DATA FOR SITE K81

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K389	0-12	A11	-	-	40	49	11	l
K390	12-42	A12	f	g,s	42	43	15	l
K391	42-54	A6C	f	g,s	36	41	23	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K389	7.8	0.22	5.1	17.4	10.0	32
K390	7.9	0.17	3.8	14.4	11.6	33
K391	7.6	1.70	3.2	23.3	15.0	47

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K82

SITE INFORMATION

Classification: USTIC TORRIORTHENT, FINE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: August 25, 1982
Authors: J. King
Location: 1/2km south of Bayt Aamer about 30km north of Sana on the Sana-Amran road
Elevation: 2310m
Physiographic position: Foot of low volcanic hill
Topography of surrounding country: Rolling
Microtopography: Nil
Slope: 5^0 or 9%
Land use: Light grazing
Climate: No information

SOIL INFORMATION

Parent material: Basalt and calcareous loess
Drainage class: Class 4, well drained
Moisture conditions: Profile moist throughout
Depth to groundwater: Not known, but no effect on profile
Surface stones or outcrops: Class 5, rubble land
Evidence of erosion: Exposure of rock outcrops indicates constant erosion of surface materials. There are fine materials caught down between the rocks.
Salt content: None
Human influence: Nil

GENERAL DESCRIPTION OF THE PROFILE: This profile is located in a basalt flow. It consists of a recent deposition of loess over material of volcanic origin. There is an apparent accumulation of organic matter in the upper horizon, which lies just below a very recent deposition of fine materials.

Profile Description

C 0-9cm K392	Dark yellowish-brown, 10YR 4/4 (moist); sandy loam; moderate fine subangular blocky to crumb structure; plastic (wet); nonsticky (moist); soft (dry); common fine tubular pores; few fresh sharp gravel to stones of volcanic origin; moderately calcareous; common fine roots; smooth, gradual boundary.

IIA11b 9-26cm K393	Dark brown, 7.5YR 3/3 (moist); loam; moderate medium subangular blocky to crumb structure; plastic (wet); nonsticky (moist); soft (dry); few very fine tubular pores; frequent slightly weathered sharp gravel to stones of volcanic origin; moderately calcareous; common fine roots; smooth, gradual boundary.
IIA12 26-58cm K394	Dark brown, 7.5YR 3/3 (moist); loam; moderate medium to fine subangular blocky structure; friable (wet); plastic (moist); very slightly sticky (dry); few fine tubular pores; frequent weathered sharp gravel to boulders of volcanic origin; moderately calcareous; few fine roots; smooth, gradual boundary.
IIIC 58-93cm K395	Strong brown, 7.5YR 5/6 (moist); loam; moderate coarse to fine subangular blocky structure; plastic (wet); slightly sticky (moist); friable (dry); common very fine tubular pores; frequent sharp slightly weathered gravel to boulders of volcanic origin; moderately calcareous; few fine roots; smooth, abrupt boundary.
IVC 93-128+cm K396	Red, 2.5YR 4/8 (moist); silt loam; moderate coarse to fine subangular blocky structure; plastic (wet); slightly sticky (moist); friable (dry); common fine tubular pores; large flat white irregular calcareous nodules; moderately calcareous; few fine roots; smooth, abrupt boundary.

ANALYTICAL DATA FOR SITE K82

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K392	0-9	C	f	g,s	54	35	11	sl
K393	9-26	IIA11b	fr	g,s	36	47	17	l
K394	26-58	IIA12	fr	g,s,b	38	35	27	l
K395	58-93	IIIC	fr	g,s,b	30	5	25	l
K396	93-128+	IVC	-	-	38	51	11	sil

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K392	7.7	0.87	2.1	18.9	9	37
K393	7.6	1.10	5.8	7.1	9	50
K394	7.7	0.12	2.1	9.6	8	55
K395	7.6	0.35	1.3	8.5	11.6	50
K396	8.1	0.48	1.10	8.3	10	48

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K83

SITE INFORMATION

Classification: VERTIC HAPLUSTOLL, COARSE SILTY, MIXED, ISOTHERMIC FAMILY
Date and time described: August 25, 1982
Authors: J. King
Location: In the northern Amran valley, 3km northwest of Rayda, and right next to a VW foundation Al Boun Farm weather station
Elevation: 2150m
Physiographic position: Valley
Topography of surrounding country: Flat
Microtopography: Nil
Slope: 1/2° or 1%
Land use: Water harvesting
Climate: Similar to that of the Al Boun farm

SOIL INFORMATION

Parent material: Calcareous loess
Drainage class: Class 3, moderately well drained
Moisture conditions: Dry throughout
Depth to groundwater: Not known, but no effect on profile
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: None
Human influence: Land is kept clear and bunded for water harvesting

GENERAL DESCRIPTION OF THE PROFILE: This profile is a buried vertic Calciustoll. The upper part of the buried mollic epipedon has been mixed by cracking and swelling with material from the overlying silt cap. A strongly expressed calcic horizon lies beneath the buried mollic epipedon.

Profile Description

IC 0-14cm K397	Yellowish-brown, 10YR 5/4 (moist) and light yellowish-brown, 10YR 6/4 (dry); silt loam; weak fine platy structure; plastic (wet); slighty sticky (moist); soft and friable (dry); common fine tubular pores; no mineral fragments; strongly calcareous; few fine roots; abrupt, smooth boundary.

IIC 14-30cm K398	Yellowish-brown, 10YR 5/4 (moist) and light yellowish-brown, 10YR 6/4 (dry); silt loam; moderate medium to fine subangular blocky structure; plastic (wet); slighty sticky (moist); friable and firm (dry); common fine tubular pores; common calcareous pseudomycelia; strongly calcareous; common fine roots; gradual, smooth boundary.
IIA1b 30-86cm K399	Very dark greyish-brown, 10YR 3/2 (moist) and dark greyishbrown, 10YR 4/2 (dry); silt; strong coarse subangular blocky structure; plastic (wet); slighty sticky (moist); friable and firm (dry); some slickenslides, very few fine tubular pores; common calcium pseudomycelium; strongly calcareous; few fine roots; gradual, smooth boundary.
IIICca 86-160+cm K400	Very pale brown, 10YR 7/3 (moist) and white, 10YR 8/2 (dry); silt loam; strong coarse to medium subangular blocky structure; slightly plastic (wet); slightly sticky (moist); firable and firm (dry); few fine tubular pores; no mineral fragments; strongly calcareous; no roots; gradual, smooth boundary.

ANALYTICAL DATA FOR SITE K83

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K397	0-14	IC	-	-	25	52	23	sil
K398	14-30	IIC	-	-	18	69	13	sil
K399	30-86	IIA1b	-	-	13	82	5	si
K400	86-160+	IIICca	-	-	19	76	5	sil

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K397	8.1	0.35	2.1	24.5	14.0	39
K398	7.9	0.27	0.9	20.5	12.6	37
K399	7.9	2.70	2.2	23.4	11.6	38
K400	7.5	1.50	1.1	24.6	10.0	30

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K84

SITE INFORMATION

Classification: TYPIC TORRIORTHENT, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: August 25, 1982
Authors: J. King
Location: 1km north of Rahda in the Qu' Al Rayadah in the Amran Valley
Elevation: 2150m
Physiographic position: Foot slope
Topography of surrounding country: Mountainous
Microtopography: Nil
Slope: 17^0 or 30%
Land use: None
Climate: Similar to Albone farm

SOIL INFORMATION

Parent material: Calcareous loess and limestone rocks
Drainage class: Class 4, well drained
Moisture conditions: Dry throughout
Depth to groundwater: Unknown, but no effect on profile
Surface stones or outcrops: Class 5, rubble land
Evidence of erosion: Moderate sheet erosion
Salt content: None
Human influence: Nil

GENERAL DESCRIPTION OF THE PROFILE: Profile is uniform throughout and consists of colluvial materials at the base of a limestone mountain.

Profile Description

C 0-20cm K401	Dark yellowish-brown, 10YR 4/4 (moist) and yellowish-brown, 10YR 5/4 (dry); loam; structureless; plastic (wet); slightly sticky (moist); loose (dry); no pores; frequent fresh limestone gravel and stone origin; strongly calcareous; no roots; no boundary.
IIC 80-100cm K402	Dark yellowish-brown, 10YR 4/4 (moist) and yellowish-brown, 10YR 5/4 (dry); loam; structureless; plastic (wet); slightly sticky (moist); loose (dry); no pores; frequent fresh limestone gravel to stone limestone origin; strongly calcareous; no roots; no boundary.

IIIC 120-140cm K403	Dark yellowish-brown, 10YR 4/4 (moist) and yellowish-brown, 10YR 5/4 (dry); loam; structureless; plastic (wet); slightly sticky (moist); loose (dry); no pores; frequent fresh limestone gravel to stone origin; strongly calcareous; no roots; no boundary.

ANALYTICAL DATA FOR SITE K84

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K401	0-20	C	fr	g,s	49	36	15	l
K402	80-100	IIC	fr	g,s	47	38	15	l
K403	120-140	IIIC	fr	g,s	47	42	11	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K401	8.1	0.53	2.6	22.0	26	18
K402	7.7	0.67	2.4	24.3	25	20
K403	7.8	0.68	2.3	24.5	25	19

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K85

SITE INFORMATION

Classification: TYPIC HAPLUSTOLL, COARSE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: August 25, 1982
Authors: J. King
Location: Excavated area on Al Boun farm, 1km west from Menjidda in the Amran Valley
Elevation: 2150m
Physiographic position: Valley
Topography of surrounding country: Flat
Microtopography: Nil
Slope: 1^0 or 2%
Land use: Light grazing
Climate: Will be obtained from the Al Boun farm

SOIL INFORMATION

Parent material: Wind-blown sand and calcareous loess
Drainage class: Class 4, well drained
Moisture conditions: Profile dry throughout
Depth to groundwater: Not known, but no effect on profile
Surface stones or outcrops: None
Evidence of erosion:
Salt content: None
Human influence: Nil

GENERAL DESCRIPTION OF THE PROFILE: A Mollisol developed in loess over sand.

Profile Description

A1 0-20cm K404	Dark yellowish-brown, 10YR 4/4 (moist) and yellowish-brown, 10YR 5/4 (dry); sandy loam; strong very coarse angular blocky structure; slighty sticky (wet); plastic (moist); friable and hard (dry); no pores; common calcareous pseudomycelia; strongly calcareous; no roots; smooth, gradual boundary.
IIA1b 20-54cm K405	Very dark brown, 10YR 2/2 (moist) and very dark grey, 10YR 3/1 and very dark greyish-brown, and 10YR 3/2 (dry); sandy loam; strong coarse prismatic to very

coarse subangular blocky structure; slighty sticky (wet); plastic (moist); friable (dry); few fine tubular pores; frequent calcareous pseudomycelia; strongly calcareous; no roots; smooth, gradual boundary.

B 54-81cm K406	Dark yellowish-brown, 10YR 4/4 (moist) and yellowish-brown, 10YR 5/6 (dry); loamy sand; moderate medium subangular blocky structure; nonsticky (wet); slightly hard (moist); friable (dry); few fine tubular pores; few calcareous mycelia; strongly calcareous; no roots; smooth, gradual boundary.
IIC 81-171cm K407	Brown, 10YR 4/3 (moist) and pale brown, 10YR 6/3 (dry); loamy; weak medium subangular blocky structure; nonplastic (wet); nonsticky (moist); soft (dry); few fine tubular pores; no mineral fragments; strongly calcareous; no roots;

ANALYTICAL DATA FOR SITE K85

No.	Depth (cm) 2 mm	Horizon Frag.	Coarse Frag. 2-.05 *	Size Coarse .05- **	Total Sand <.002 mm	Total Silt <2 mm .002mm	Total Clay mm	Texture ***
K404	0-20	A1	-	-	67	18	15	sl
K405	20-54	IIA1b	-	-	66	20	14	sl
K406	54-81	IIB	-	-	78	16	6	ls
K407	81-171	IIC	-	-	90	8	2	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K404	7.1	0.22	1.4	6.5	9	18
K405	7.2	0.20	1.1	6.7	8	23
K406	7.3	0.15	1.3	6.0	4	15
K407	7.5	0.14	1.0	16.0	4	46

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K86

SITE INFORMATION

Classification: TYPIC USTIFLUVENT, FINE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: August 26, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 1/2km north of Rass Al Nagel in the Al Golan subprovince in the mountains just north of the Amran Valley
Elevation: 2460m
Physiographic position: Depression in exposed bedrock
Topography of surrounding country: Mountainous
Microtopography: Nil
Slope. Flat on the terrace, 1^0 or 2% between terraces
Land use: Used for growing chic peas, barley, and peas
Climate: No information.

SOIL INFORMATION

Parent material: Reworked calcareous loess
Drainage class: Class 4, well drained
Moisture conditions: Moist throughout
Depth to groundwater: Not known, but no effect on profile
Surface stones or outcrops: None
Evidence of erosion: None
Salt content: None
Human influence: Terracing and cropping

GENERAL DESCRIPTION OF THE PROFILE: In a form brown silty material over a mollic epipedon. The horizon immediately above the buried mollic epipedon shows evidence of biologic activity, apparently earthworms bring material from the buried A1 up in to the overlying horizon immediately above it.

Profile Description

IC 0-57cm K408	Dark yellowish-brown, 10YR 4/4 (moist); silt loam; moderate medium subangular blocky structure; sticky (wet); plastic, friable (moist); slighty hard (dry); many very fine to fine tubular pores; no mineral fragments; strongly calcareous; common very fine and medium roots; clear, smooth boundary.

ICca 57-76cm K409	Dark yellowish-brown, 10YR 4/4 (moist); loam; moderate medium to fine subangular blocky structure; sticky (wet); plastic (moist); friable (dry); many very fine to fine tubular pores; common calcareous pseudomycelia; strongly calcareous; common very fine and medium roots; clear, smooth boundary.
IIC 76-89cm K410	Dark yellowish-brown, 10YR 4/4 (moist); loam; moderate medium to fine subangular blocky structure; slighty sticky (wet); plastic (moist); friable (dry); many very fine to fine pores; common calcareous pseudomycelia; strongly calcareous; common very fine and medium roots; clear, gradual boundary.
IIA11b 89-107 K411	Dark brown, 10YR 4/3 (moist); loam; moderate medium to fine subangular blocky structure; sticky (wet); plastic (moist); friable (dry); common very fine to fine tubular pores; dark soil from underlying horizon filling small tubular channels; strongly calcareous; few fine roots; clear, gradual boundary.
IIA12b 107-128cm K412	Very dark greyish-brown, 10YR 3/2 (moist); silt loam; strong coarse subangular blocky structure; sticky (wet); plastic (moist); friable (dry); common very fine to fine tubular pores; dark soil from underlying horizon filling small tubular channels; strongly calcareous; few fine roots; clear, gradual boundary.

ANALYTICAL DATA FOR SITE K86

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K408	0-57	IC	-	-	30	50	20	sil
K409	57-76	ICca	-	-	30	46	24	l
K410	76-89	IIC	-	-	32	44	24	l
K411	89-107	IIA11b	-	-	30	48	22	l
K412	107-128	IIA12b	-	-	30	68	2	sil

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K408	7.8	0.25	1.9	20.3	11.6	19
K409	7.9	0.16	1.9	18.7	7.0	26
K410	7.9	0.16	1.7	13.5	7.0	35
K411	7.9	0.24	2.5	16.7	7.0	30
K412	7.1	0.16	2.4	17.3	6.0	45

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K87

SITE INFORMATION

Classification: TYPIC USTORTHENT, FINE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: August 27, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 6km southeast of Shiban on the Shiban-Sana road
Elevation: 2370m
Physiographic position: Man-made terrace on concave slope
Topography of surrounding country: Steeply dissected
Microtopography: Terracing
Slope: 18° or 33% between terraces
Land use: Cropping wheat and alfalfa
Climate: No information

SOIL INFORMATION

Parent material: Calcareous loess and basaltic rock
Drainage class: Class 4, well drained
Moisture conditions: Profile moist throughout
Depth to groundwater: Not known but no effect on profile
Surface stones or outcrops: Class 1, fairly stony, but 60% of surface covered with gravel or stones
Evidence of erosion: Some slight gully erosion where terraces are not maintained
Salt content: None
Human influence: Terracing and cropping

GENERAL DESCRIPTION OF THE PROFILE:

Profile Description

Ap 0-13cm K413	Dark brown, 10YR 4/3 (moist); slightly gravelly loam; weak medium subangular blocky to crumb structure; slighty sticky (wet); plastic (moist); friable, soft (dry); few fine tubular pores; very few fresh sharp gravel of volcanic origin; moderately calcareous; common fine roots; clear, smooth boundary.
IIA1b 13-32cm K414	Dark brown, 10YR 4/3 (moist); slightly gravelly loam; moderate medium prismatic to moderate medium subangular blocky structure; slighty sticky (wet); plastic (moist); friable (dry); few fine tubular pores; few

fresh gravel of volcanic origin; strongly calcareous; few fine roots; gradual, smooth boundary.

IIC 32-78cm K415	Dark yellowish-brown, 10YR 3/4 (moist); slightly gravelly loam; moderate coarse prismatic structure; slighty sticky (wet); plastic (moist); friable (dry); few fine tubular pores; few fresh gravel of volcanic origin, some pottery fragments; strongly calcareous; few medium to fine roots; clear, smooth boundary.
IIICca 78-141cm K416	Very dark brown, 10YR 2/2 (moist); slightly gravelly to stony loam; moderate coarse prismatic to moderate coarse subangular blocky structure; slighty sticky (wet); plastic (moist); friable (dry); few fine tubular pores; few fresh gravel to stones of volcanic origin, numerous calcareous pseudomycelia; strongly calcareous; no roots; clear, smooth boundary.

ANALYTICAL DATA FOR SITE K87

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K413	0-13	Ap	f	g	40	44	16	l
K414	13-32	I-IIA1b	f	g	38	42	20	l
K415	32-78	IIC	f	g	40	38	22	l
K416	78-141	IIICca	f	g,s	38	42	20	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K413	7.8	0.22	1.7	7.5	14	45.0
K414	7.5	0.13	1.5	9.0	5	46.5
K415	7.6	0.27	1.5	9.0	5	50.5
K416	7.7	0.25	2.0	8.7	5	48.0

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K88

SITE INFORMATION

Classification: VERTIC HAPLUSTOLL, FINE LOAMY, MIXED, ISOMESIC FAMILY
Date and time described: August 27, 1982
Authors: J. King and A. E. Abu Ghanem
Location: Northeast on Sana, 15km from Shiban on the Sana-Shiban road.
Elevation: 2510m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: Low terracing
Slope: 2^0 or 4%
Land use: Sorgum
Climate: No information

SOIL INFORMATION

Parent material: Calcareous loess and volcanic rocks
Drainage class: Class 4, well drained
Moisture conditions: Moist below 90cm
Depth to groundwater: Not known, but no effect on profile
Surface stones or outcrops: Class 0, no stones
Evidence of erosion: Slight sheet eroison
Salt content: None
Human influence: Cropping and terracing

GENERAL DESCRIPTION OF THE PROFILE: A buried soil showing strong development with organic matter accumulation in a buried A1. Then an underlying horizon with red hue and clay skins over a horizon with brighter chroma and finally a strongly expressed Ca horizon.

Profile Description

Ap 0-18cm K417	Dark brown, 10YR 3/4 (moist) and strong brown, 7.5YR 4/6 (dry); loam; moderate medium subangular blocky to crumb structure; slighty sticky (wet); plastic (moist); friable and slightly hard (dry); no pores; few fresh sharp gravel to stones of volcanic origin; strongly calcareous; few fine roots; clear, smooth boundary.
C 18-43cm K418	Dark brown, 7.5YR 3/4 (moist) and brown, 7.5YR 5/4 (dry); loam; moderate medium to fine subangular blocky structure; slightly sticky (wet); plastic (moist);

slightly hard and friable (dry); no pores; very few fresh gravel to stones of volcanic origin; strongly calcareous; few fine roots; clear, smooth boundary.

ICca
43-57cm
K419

Dark brown, 7.5YR 3/4 (moist) and strong brown, 7.5YR 4/6 (dry); loam; strong coarse subangular blocky structure; slightly sticky (wet); plastic (moist); friable and slightly hard (dry); no pores; no mineral fragments; strongly calcareous; few fine roots; clear, smooth boundary.

IIA1b
57-80cm
K420

Dark brown, 7.5YR 3/4 (moist) and dark brown, 7.5YR 3/2 (dry); clay loam; strong medium prismatic to strong medium subangular blocky structure; slightly sticky (wet); plastic (moist); friable, slightly hard (dry); few fine tubular pores; common fine small irregular white calcareous nodules; strongly calcareous; few fine to medium roots; gradual, smooth boundary.

IIBtb
80-109cm
K421

Dark reddish-brown, 5YR 3/4 (moist) and dark brown, 7.5YR 3/2 (dry); clay loam; moderate medium subangular blocky structure; slightly sticky (wet); plastic (moist); firm (dry); no pores; few large irregular white calcareous nodules; strongly calcareous; no roots; gradual, smooth boundary.

IIIB
109-137cm
K422

Strong brown, 7.5YR 4/6 (moist) and dark brown, 7.5YR 3/2 (dry); sandy clay loam; moderate medium subangular blocky structure; slightly sticky (wet); plastic (moist); friable (dry); few fine tubular pores; few large irregular white calcareous nodules; strongly calcareous; no roots; clear, smooth boundary.

IIICca
137-139cm
K423

Reddish-brown, 5YR 4/4 (moist) and light brown, 7.5YR 6/4 (dry); sandy clay loam; moderate medium subangular blocky structure; --(wet); plastic (moist); friable (dry); common fine tubular pores; frequent weathered gravel to stones of volcanic origin; strongly calcareous; no roots; clear, smooth boundary.

ANALYTICAL DATA FOR SITE K88

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K417	0-18	Ap	-	-	50	34	16	l
K418	18-43	C	-	-	46	38	16	l
K419	43-57	ICca	-	-	50		16	l
K420	57-80	IIA1b	-	-	30	30	40	cl
K421	80-109	IIBtb	-	-	26	36	38	cl
K422	109-137	IIIB	-	-	38	38	24	l
K423	137-139	IIICca	-	-	46	42	12	l

No.	pH 1:1	EC mmhos	Organic Matter (%)	CaCO3 (%)	Avail. P (ppm)	C E C meq/100g
K417	7.4	0.25	2.2	10.0	7	31.5
K418	7.8	0.14	1.7	9.6	11.6	32.5
K419	7.8	0.23	1.6	8.7	7	26
K420	7.7	0.42	1.7	10.8	1	45.5
K421	7.5	1.60	1.2	7.9	1	40
K422	7.5	0.43	1.7	7.7	2	41
K423	7.3	0.55	1.4	1.3	1	43

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

SOIL PROFILE SITE K89

SITE INFORMATION

Classification: USTOLLIC CALCIORTHID, FINE LOAMY, MIXED, ISOTHERMIC FAMILY
Date and time described: August 27, 1982
Authors: J. King and A. E. Abu Ghanem
Location: 16km southeast of Shiban on the Sana-Shiban road.
Elevation: 2520m
Physiographic position: Plain
Topography of surrounding country: Flat
Microtopography: Low terraces
Slope: 1^0 or 2%
Land use: Light grazing
Climate (calculated): No information

SOIL INFORMATION

Parent material: Calcareous loess and volcanic rocks
Drainage class: Class 4, well drained
Moisture conditions: Dry throughout
Depth to groundwater: Unknown, but no effect on profile
Surface stones or outcrops: Class 0, very slightly stony
Evidence of erosion: Slight sheet erosion
Salt content: None
Human influence: Terracing and cropping

GENERAL DESCRIPTION OF THE PROFILE: Calciorthid with strongly expressed calcic horizon and silt cap.

Profile Description

Ap 0-13cm K424	Dark yellowish-brown, 10YR 4/4 (moist) and yellowish-brown, 10YR 5/6 (dry); sandy loam; weak medium subangular blocky structure; slightly sticky (wet); slightly plastic (moist); friable, soft (dry); very few fine tubular pores; few fresh sharp gravel and stones of volcanic origin; strongly calcareous; few fine roots; clear, smooth boundary.
IIA1 13-50cm K425	Dark brown, 10YR 4/4 (moist) and brown, 7.5YR 5/4 (dry); clay loam; moderate medium prismatic to moderate medium subangular blocky structure; slightly sticky

(wet); plastic (moist); friable, hard (dry); very few tubular pores; very few fresh gravel to stones, common calcareous pseudomycelia; strongly calcareous; very few medium roots and common very fine roots; clear, wavy boundary.

IICca 50-100cm K426	Very pale brown, 10YR 8/3 (moist) and white, 10YR 8/1 (dry); silt loam; moderate medium subangular blocky structure; slightly sticky (wet); plastic (moist); friable (dry); very few very fine tubular pores; very few fresh gravel to stones; strongly calcareous; very few very fine roots; clear, wavy boundary.

ANALYTICAL DATA FOR SITE K89

No.	Depth (cm)	Horizon	Coarse Frag. >2 mm *	Size Coarse Frag. **	Total Sand 2-.05 mm	Total Silt .05-.002mm	Total Clay <.002 mm	Texture Class <2 mm ***
K414	0-13	IAp	f	g,s	64	28	8	sl
K415	13-50	IIA1	vf	g,s	32	36	32	cl
K416	50-100	IICca	vf	g,s	22	60	18	sil

No.	pH 1:1	EC mmhos	Organic Matter (%)	$CaCO^3$ (%)	Avail P (ppm)	C E C meq/100g
K424	7.4	0.11	1.9	14.3	2	22
K425	7.6	0.96	1.9	12.8	2	65
K426	7.6	0.61	1.94	21.5	5	20

*vf-very few (<5% by volume)
f-few (5-15% by volume)
fr-frequent (15-40% by volume)
vfr-very frequent (40-80% by volume)

** g-gravel (2-75mm)
s-stones (75-250mm)
b-boulders (>250mm)

(from Guidelines for Soil Profile Description, FAO, 1977)

*** c-clay s-sand
l-loam si-silt

Appendix II

CALCULATED SOIL CLIMATE REGIMES

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NOTE

To classify soils according to Soil Taxonomy (1975), estimates of the soil climate regimes are necessary. A computer program following Newhall's model (1972) processes monthly air temperature and precipitation data to make these estimates. However, these data, especially temperature data, are scarce in Yemen. In order to make estimates of the soil climate regimes, nine stations for which temperature data are available were used to correlate temperature with elevation. This relationship is used to estimate the soil temperature regime and calculate potential evapotranspiration. Available precipitation data are then used to estimate soil moisture regimes.

Section 1

THE USE OF SOIL TEMPERATURE AND MOISTURE REGIMES IN SOIL CLASSIFICATION

The definitions of the taxa in Soil Taxonomy (1975) include a number of climatic parameters of soils which are used at different categorical levels.

The primary reason for using soil climates is that they are the causes of many other properties. Climate is one of the major pedogenic factors. Furthermore, some soil characteristics are only meaningful when they are considered in an area restricted to a defined soil climate; therefore soil climate has a powerful differentiating effect and climatic regimes are often more suitable than other properties for creating kingdoms within the classification system.

Another no less important reason for the use of soil climatic data is to make the taxa meaningful for interpretation purposes by defining units in such a way that major soil limitations for plant growth are implied in the system.

A third advantage of introducing soil climate data into classification is that uniform, extensive geographic areas may be recognized on small-scale maps. This facilitates the preparation of generalized soil maps that can be easily interpreted, particularly for crops which are restricted by climate to certain areas.

In spite of these reasons for introducing soil climatic properties into the system, many disadvantages exist. The difficulties are mainly operational and relate to the limited amount of information on climate usually available to soil surveyors. Field observations of soil temperature and moisture conditions are often lacking and many criteria for differentiating soil climate regimes depend on seasonally changing variables which require observations for extended periods of time.

However, the lack of precision in the data on soil moisture regimes should not be a barrier to prevent existing information, although sketchy, from reaching users who must make decisions on land use. The purpose of using incomplete data is to reduce the risks of making errors, not to eliminate them completely. Information with known limitations may perhaps lead to better decisions than those made with no information at all. The objective of this study is to extract from climatic observations what is useful for predicting soil moisture regimes and to delineate the geographic areas where comparable soil climatic conditions may occur.

One of the methods used to achieve this purpose is based on mathematical models which simulate the water movement in soils under changing weather conditions.

FRANKLIN NEWHALL'S MODEL OF COMPUTATION OF SOIL MOISTURE REGIMES

The model which is used to compute moisture regimes according to Soil Taxonomy is practically identical to the model developed by Dr. Franklin Newhall (1972). It considers an hydrological profile retaining 200ml of available water divided into eight layers. The second and the third layer form what is called the moisture control section.

Newhall's system is designed to serve the preliminary identification of moisture regimes in areas where climatic data are limited and where information on temperature and rainfall are available only on a monthly basis. Potential evapotranspiration is introduced into the model following Thornthwaite's method for its calculation.

The lack of detailed input data does not allow accurate estimates of soil potentials for crop production. The model cannot predict crop growth during various development stages. These prediction models need almost daily or hourly inputs.

Newhall's model nevertheless provides an approximate method to determine moisture regimes, especially for areas where only preliminary estimates are needed. It should be pointed out that the criteria and the soil moisture regime classes are only intended to be used for subdividing soil taxa at different levels of Soil Taxonomy, and not to create a new climatic classification.

LIMITATIONS OF THE MODEL

In the present computations, Thornthwaite's (1948) potential evapotranspiration was used to estimate the removal of water from the soil. In all instances the soil temperature was calculated by adding 2.5°C to the mean annual air temperature. This is often considered inadequate for soils of arid regions, and figures as high as 4-5°C have been proposed as appropriate for these regions. The amplitude of temperature variation at 50cm depth between winter and summer was reduced by 33% of the difference between air temperatures for the same seasons. The season's months were December, January, and February for winter and June, July, and August for summer.

Temperature amplitude variations between winter and summer are critical values in distinguishing between "iso-" and "non-iso" (temperate) temperature regimes. However, the relationship between seasonal air temperature and soil temperature variations is not well understood and the method applied here to relate them may not be the most accurate. It is used because studies on the geography of soil

climates have shown that it produces a close, although not perfect, correlation with the separation between summer and winter rainfall in regions with little topographic relief, and because the non-iso limit often corresponds with the distribution of plants which need seasonal chilling for optimum production. For these reasons the limit given on the map between iso and non-iso should be considered a first approximation. Note that this criterion separates Xeric moisture regimes (Mediterranean) from subtropical areas with Ustic moisture regimes.

There are other limitations. Thornthwaite's method may have several drawbacks, particularly in tropical areas and in regions where elevation has a marked influence on air temperature. However, since Newhall's model was originally calibrated with Thornthwaite's method for moisture regime classifications in Soil Taxonomy, no correction factors for evapotranspiration have been introduced in the model.

Moisture regimes are defined on the basis of conditions existing in the moisture control section which is located well below the surface horizons in the profile. The topsoil is not considered. For this reason, immediate interpretation on the availability of water for plants at a certain time of the year is not recommended without additional information on the moisture conditions prevailing in the topsoil. In other cases, consideration of deep horizons from which crops may extract water is essential to determine the water-supplying power of soils; they have not been considered in this mathematical model.

The calculations are made for deep soils in which root penetration is not restricted by pans or contacts at shallow depth. As a rule the model uses a profile deep enough to store 200mm of water between permanent wilting point and field capacity.

The calculated moisture regime is only valid for soils which are well drained, i.e. where water can freely percolate through the profiles. No aquic moisture regimes are considered by the model because it does not include information on poor drainage conditions. Where these exist in the field, they may modify the calculated moisture regime drastically.

The model assumes that all rainfall is effective and percolation of water through the profiles is unrestricted. Storage of water as snow on top of the soil is not considered in the model.

The mathematical model assumes all rainfall enters the soil as long as the moisture profile is below field capacity. Rainfall in excess of moisture storage capacity is considered runoff and ignored. The model does not consider gains by inflow. In semi-arid and arid environments with little vegetation, such as Yemen, runoff may considerably change the moisture conditions in the soils, making them drier than the model calculations would indicate. On the other hand, inflow in water-harvesting situations may considerably shift the actual moisture conditions to more humid regimes than the ones

obtained in the calculations. Therefore, moisture regimes implied in the names of the soils given in the soils legend may differ significantly from the calculated ones. The "field" conditions always prevail with respect to the estimations resulting from the calculations.

The computation assumes that all months have 30 days and that a year only has a total of 360 days.

Section 2

CLASSES OF SOIL TEMPERATURE REGIMES (SOIL TAXONOMY, 1975)

The following soil temperature regimes are used in defining classes at various categorical levels. All definitions are taken verbatim from Soil Taxonomy (1975). Only those regimes which are likely to occur in Yemen are listed here.

If the name of a soil temperature regime has the prefix iso, the mean summer and winter soil temperature for June, July, and August and for December, January, and February differ by less than 5°C at a depth of 50cm or at a lithic or paralithic contact, whichever is shallower.

A tentative soil temperature regime called megathermic has been proposed to the ICOMMORT committee (which oversees tropical climate amendments to Soil Taxonomy) by J. Comerma for soils of Venezuela. A megathermic regime has a mean annual soil temperature of 28°C or higher. It has been used in some of the classifications here for recognizing classes in soil temperature regimes in Yemen, particularly for soils of the Tihama. The computer program on which this publication is based did not recognize the megathermic or isomegathermic regimes and in its calculations, they are grouped with the hyperthermic and the isohyperthermic.

MESIC

The mean annual soil temperature is 8°C or higher but lower than 15°C (59°F) and the difference between mean summer and mean winter soil temperature is more than 5°C at a depth of 50cm or at a lithic or paralithic contact, whichever is shallower.

THERMIC

The mean annual soil temperature is 15°C (59°F) or higher but lower than 22°C (72°F), and the difference between mean summer and mean winter soil temperature is more than 5°C at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

HYPERTHERMIC

The mean annual soil temperature is 22°C (72°F) or higher, and the difference between mean summer and mean winter soil temperature is more than 5°C at a depth of 50cm or at a lithic or paralithic contact, whichever is shallower.

ISOMESIC

The mean annual soil temperature is 8°C or higher but lower than 15°C (59°F), and the difference between the mean winter and summer temperatures is less than or equal to 5°C.

ISOTHERMIC

The mean annual soil temperature is 15°C or higher but lower than 22°C (72°F), and the difference between the mean winter and summer temperatures is less than or equal to 5°C.

ISOHYPERTHERMIC

The mean annual soil temperature is 22°C or higher, and the difference between the mean winter and summer temperatures is less than or equal to 5°C.

Section 3

CLASSES OF SOIL MOISTURE REGIMES (SOIL TAXONOMY, 1975)

The following descriptions of the soil moisture regime classes are taken verbatim from Soil Taxonomy (1975). The computation does not consider soils that have restricted drainage and therefore the aquic moisture regime is not included in this study.

"The moisture regimes are defined in terms of the groundwater level and in terms of the presence or absence of water held at a tension <15 bars in the moisture control section by periods of the year. It is assumed in the definitions that the soil supports whatever vegetation it is capable of supporting. In other words, it is in crops, grass, or native vegetation; it is not being fallowed to increase the amount of stored moisture, nor is it being irrigated by man. These cultural practices affect the soil moisture condition as long as they are continued.

"It has been conventional to think in terms of three soil moisture regimes. In one, the soil is saturated. In another, the amount of water is enough to cause leaching, and in the third, no leaching occurs. In the leaching regime some water moves through the soil at some time during the year and moves on down to the moist substratum. In the nonleaching regime, water moves into the soil but is withdrawn by evapotranspiration, leaving precipitated carbonates and more soluble salts. Between these two regimes there is another possible one in which there is alternation from year to year; leaching occurs in some years but not in all. For consideration of the losses of soluble materials or their accumulation in ca, cs, or sa horizons, these concepts are adequate. For the understanding of biological processes, they leave much to be desired. A soil can be subject to leaching in the winter when it is too cold for optimum biologic activity, and it can be too dry in most of the summer for significant biologic activity. The result is a relatively wide carbon-nitrogen ratio.

"The soil moisture regime, as the term is used here, refers to the presence or absence either of groundwater or of water held at a tension <15 bars in the soil or in specific horizons by periods of the year. Water held at a tension of 15 bars or more is not available to keep most mesophytic plants alive. The availability of water also is affected by dissolved salts. A soil may be saturated with water that is too salty to be available to most plants, but it would seem better to call such a soil salty rather than dry. Consequently, we consider a horizon to be dry when the moisture tension is 15 bars or more. If water is held at a tension of <15 bars but more than zero, we consider

the horizon to be moist. A soil may be continuously moist in some or all horizons throughout the year or for some part of the year. It may be moist in winter and dry in summer or the reverse. In the northern hemisphere, summer refers to the months of June, July, and August, and winter means December, January and February. A soil or a horizon is considered to be saturated with water when water stands in an unlined borehole close enough to the soil surface or to the horizon in question that the capillary fringe reaches the surface or the top of the horizon."

AQUIC

Although the aquic moisture regime is not considered in this study, its definition from Soil Taxonomy (1975) is given below.

"The aquic (L. aqua, water) moisture regime implies a reducing regime that is virtually free of dissolved oxygen because the soil is saturated by groundwater or by water of the capillary fringe. An aquic regime must be a reducing one. Some soil horizons, at times, are saturated with water while dissolved oxygen is present, either because the water is moving or because the environment is unfavorable for micro-organisms. For example, if the temperature is <1°C such a regime is not considered aquic."

ARIDIC AND TORRIC

"These terms are used for the same moisture regime but in different categories of the taxonomy.

"In the aridic (torric) moisture regime, the moisture control section in most years is 1. Dry in all parts more than half the time (cumulative) that the soil temperature at a depth of 50 cm is above 5°C; and 2. Never moist in some or all parts for as long as 90 consecutive days when the soil temperature at a depth of 50 cm is above 8°C.

"Soils that have an aridic or a torric moisture regime are normally in arid climates. A few are in semiarid climates and either have physical properties that keep them dry, such as a crusty surface that virtually precludes infiltration of water, or they are very shallow over bedrock. There is little or no leaching in these moisture regimes, and soluble salts accumulate in the soil if there is a source of them.

"The limits of soil temperature exclude from these moisture regimes the very cold and dry regions of Greenland and adjacent islands. Such fragmentary data are available on the soils of those regions that no provision is made for their moisture regimes in this taxonomy."

UDIC

"The udic (L. udus, humid) moisture regime implies that in most years the soil moisture control section is not dry in any part for as long as 90 days (cumulative). If the mean annual soil temperature is lower than 22°C and if the mean winter and mean summer soil temperatures at a depth of 50 cm differ by 5°C or more, the soil moisture control section is not dry in all parts for as long as 45 consecutive days in the 4 months that follow the summer solstice in 6 or more years out of 10. In addition, the udic moisture regime requires, except for short periods, a three-phase system, solid-liquid-gas, in part, but not necessarily in all, of the soil when the soil temperature is above 5°C.

"The udic moisture regime is common to the soils of humid climates that have well-distributed rainfall or that have enough rain in summer that the amount of stored moisture plus rainfall is approximately equal to or exceeds the amount of evapotranspiration. Water moves down through the soil at some time in most years.

"If precipitation exceeds evapotranspiration in all months of most years, there are occasional brief periods when some stored moisture is used, but the moisture tension rarely becomes as great as 1 bar in the soil moisture control section. The water moves through the soil in all months that it is not frozen. This extremely wet moisture regime is called perudic (L. per, throughout in time, L. udus, moist). The formative element ud is used in the names of most taxa to indicate either a udic or a perudic regime. The term perudic is not used in names of taxa, but is used in the text if it is relevant to the genesis of the soils.

"Note that on the monthly basis, the perudic regime shows a surplus every month of the year. Obviously, if calculations were made on a daily basis, there would be short periods of withdrawal."

USTIC

"The ustic (L. ustus, burnt, implying dryness) moisture regime is intermediate between the aridic and the udic regime. The concept is one of limited moisture, but the moisture is present at a time when conditions are suitable for plant growth. The ustic moisture regime is not applied to soils that have cryic or pergelic temperature regimes, which are defined later.

"If the mean annual soil temperature is 22°C or higher or if the mean summer and winter soil temperatures differ by <5°C at a depth of 50 cm, the soil moisture control section in the ustic moisture regime is dry in some or all parts for 90 or more cumulative days in most years. But the moisture control section is moist in some part for more than 180 cumulative days, or it is continuously moist in some part for at least 90 consecutive days.

"If the mean annual soil temperature is lower than 22° C and if the mean summer and winter soil temperatures differ by 5°C or more at a depth of 50 cm, the soil moisture control section in the ustic regime is dry in some or all parts for 90 or more cumulative days in most years. But it is not dry in all parts for more than half the time that the soil temperature is higher than 5°C at a depth of 50 cm (the aridic and torric regimes). Also, it is not dry in all parts for as long as 45 consecutive days in the 4 months that follow the summer solstice in 6 or more years out of 10 if the moisture control section is moist in all parts for 45 or more consecutive days in the 4 months that follow the winter solstice in 6 or more years out of 10 (xeric regime).

"In tropical and subtropical regions that have either one or two dry seasons, summer and winter have little meaning. In those regions, the ustic regime is that typified in a monsoon climate that has at least one rainy season of 3 months or more. In temperate regions of subhumid or semiarid climates, the rainy seasons are usually spring and summer or spring and fall, but never winter. Native plants are mostly annuals or they have a dormant period while the soil is dry."

XERIC

"The xeric moisture regime (Gr. xeros, dry) is that typified in Mediterranean climates, where winters are moist and cool and summers are warm and dry. The moisture, coming in winter when potential evapotranspiration is at a minimum, is particularly effective for leaching. In a xeric moisture regime, the soil moisture control section is dry in all parts for 45 or more consecutive days within the 4 months that follow the summer solstice in 6 or more years out of 10. It is moist in all parts for 45 or more consecutive days within the 4 months that follow the winter solstice in 6 or more years out of 10. The moisture control section is moist in some part more than half the time, cumulative, that the soil temperature at a depth of 50 cm is higher than 5°C, or in 6 or more years out of 10 it is moist in some part for at least 90 consecutive days when the soil temperature at a depth of 50 cm is continuously higher than 8°C. In addition, the mean annual soil temperature is lower than 22°C, and mean summer and mean winter soil temperatures differ by 5°C or more at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower."

Section 4

SOIL CLIMATE REGIME ESTIMATIONS FOR YEMEN

The estimation of soil moisture and soil temperature regimes in Yemen is crucial for the correct classification of soils according to Soil Taxonomy (USDA-SCS, 1975). Newhall (1972) developed a computer program to make these estimates, using monthly temperature and rainfall data. However, these data are scarce. Monthly rainfall data are available for a few years at forty sites in Yemen, while monthly temperature data have been recorded at nine sites only (Table II.1). An average annual rainfall map made using these data is shown in Figure II.2. To make full use of the data available, the sites with temperature data were used to correlate temperature with elevation, and this relationship was applied to estimate soil temperatures at sites with known elevations.

ESTIMATION OF SOIL TEMPERATURE REGIMES BY ELEVATION OF SITE

Nine stations in Yemen have mean annual air temperature and elevation data available (Table II.1). The mean annual soil temperature was estimated from the mean annual air temperature by adding 2.5°C. These data were statistically processed and regression equations were determined for elevation and mean annual soil temperature.

The highest R (+/- 96%) value was achieved with an equation involving elevation and elevation squared terms. This equation is $T=32.1-0.068E-0.022E^2$, where T is the mean annual soil temperature in degrees Celsius and E is elevation in hectometers (=100m). However, this equation was found to result in altitude boundaries for temperature regimes at elevations that were clearly out of line with field experience in Yemen. The most important reason for this was probably the lack of data in the 100-2000m elevation range--only Taizz data at 1500m are available.

In order to select the best regression equation the Yemen climatic situation was considered. The temperature decrease with elevation is primarily a result of adiabatic cooling as winds from the Red Sea and Gulf of Aden rise over the mountains. The adiabatic cooling rate (also known as the lapse rate) is linear, depending on the amount of moisture in the air mass. For dry air masses, the adiabatic lapse rate is 1°C per 100 meters elevation. For wet air masses, the lapse rate can be as low as 0.4°C/100m (Petterssen, 1940). The adiabatic heating rate (when an air mass descends into a valley) is the same for both wet and dry air masses, and it is the dry adiabatic lapse rate, 1.0°C/100m.

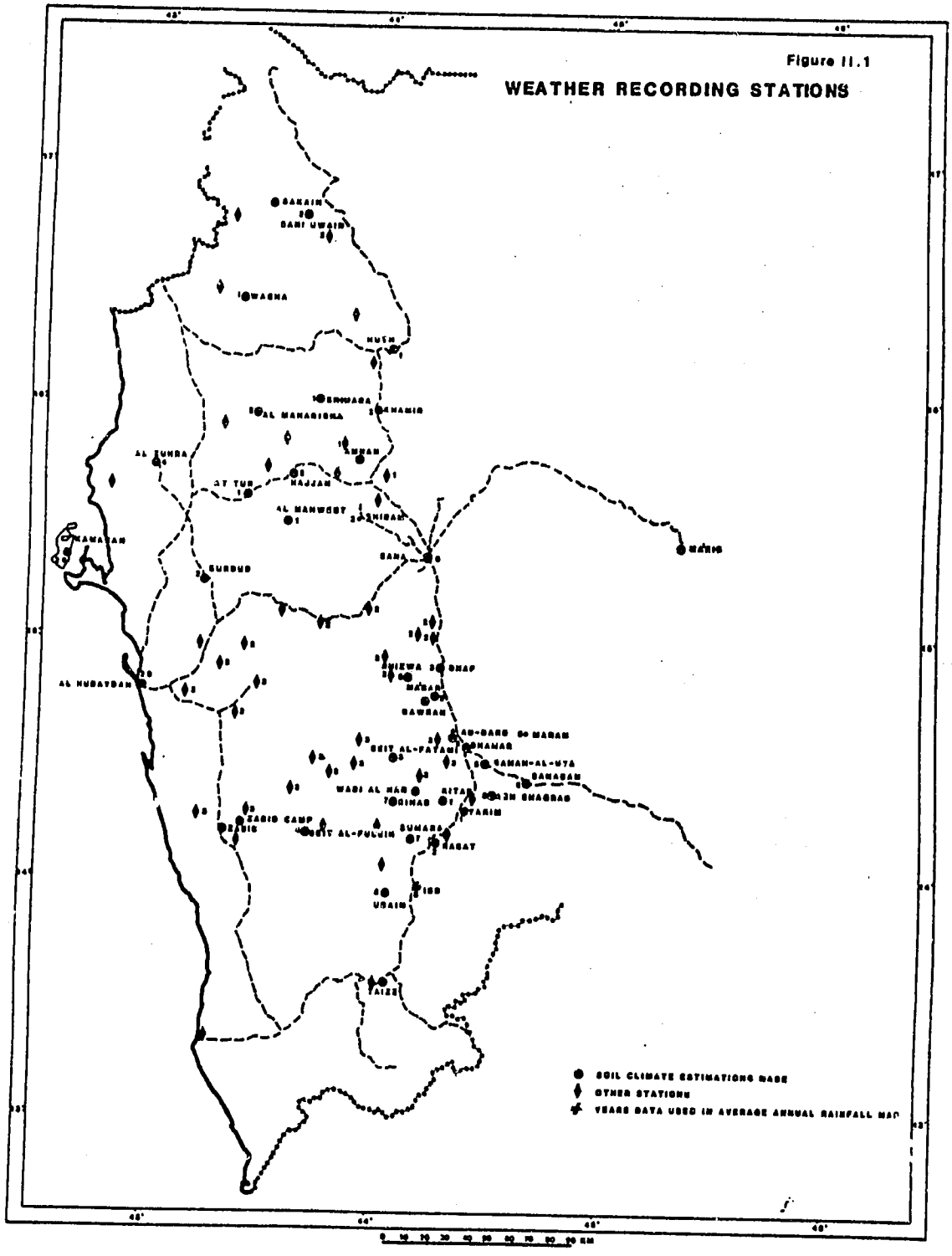


Figure II.1
WEATHER RECORDING STATIONS
SAKAIN
SANI UWAIN
WASNA
HUTH
AL MAHABISHA
AL ZUHRA
AT TUR
HAJJAN
AL MANWOST
SANA
SURDUD
AL HUDAYDAH
SAWRAN
SEIUT AL-FAYAM
WADI AL MAR
SUMARA
HABAT
URAIN
TAIZZ
SOIL CLIMATE ESTIMATIONS MADE
OTHER STATIONS
YEARS DATA USED IN AVERAGE ANNUAL RAINFALL MAP

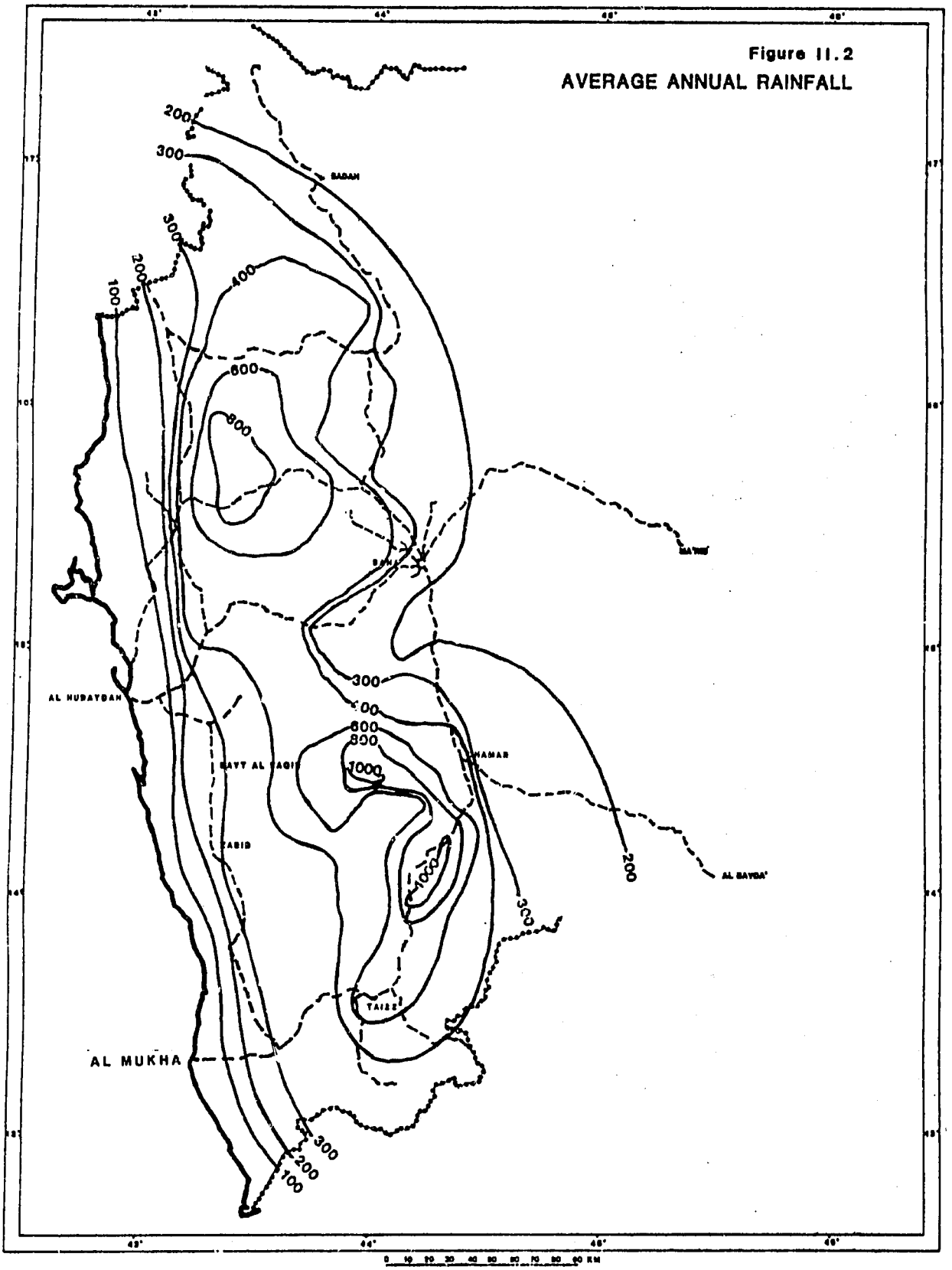


Figure II.2
AVERAGE ANNUAL RAINFALL
SADAH
AL HUDAYDAH
BAYT AL FAQIH
ZABID
HAMAR
TAIZZ
AL MUKHA
AL BAYDA'
200
300
400
600
800
1000
100
0 10 20 30 40 50 60 70 80 90 KM

Table II.1: Observed annual air temperature, estimated mean annual soil temperature and elevation for nine stations in Yemen.

Stations	Observed mean annual air temp. (°C)	Estimated mean annual soil temp. (°C)	Elevation (m)	Source	Years of data
Al Hudaydah	29.6	32.1	13	1	26
Kamaran	29.6	32.1	20	1	26
Al Zuhra	30.0	32.5	70	5	6
Taizz	23.6	26.1	1500	3	10+
Amran	14.6	17.1	2190	4	1
Sana	15.1	17.6	2300	2	6
Kitab	10.9	13.4	2550	4	1
Ma'Bar	15.3	17.8	2583	2	2
Rabat	11.4	13.9	2743	2	2

Sources: 1-Naval Weather Services. 1974. Worldwide Airfield Summaries.
2-Land Resources Development Centre. 1979. Montane Plains and Wadi Rima Project Report.
3-Wernstedt, F. 1972. World Climatic Data.
4-Gibb, Sir Alexander and Partners. 1979. Development of Wadis Bana and Rasyan, Stage I.
5-Tipton and Kalmbach, Inc. 1979. Development of Wadi Mawr. Appendix B.

Applied to this situation, the adiabatic lapse rates suggest that a linear rate would serve satisfactorily as a general lapse rate for Yemen. This linear approximation is best for areas along the mountain front, where adiabatic cooling is most important. It is less accurate for highland areas, particularly in areas of steep relief. In these areas, adiabatic heating and cooling take place at varying rates as the air rises and falls over the topography.

A linear equation was used to approximate the lapse rate for Yemen. The equation is $T=32.9-0.657E$ where T= estimated annual soil temperature in degrees Celsius and E is elevation in hectometers. The lapse rate is 0.657°C/100m. This is about midway between the wet and dry adiabatic lapse rates (Figure II.3). The correlation coefficent for the linear regression is 94%.

The equation given above was used to assign soil temperatures to elevations. Thus soil temperature regimes can be assigned to elevation ranges. These elevation ranges are given in Table II.2. Using Table II.2, soil temperature regimes can be estimated for sites where only elevations are known. A soil temperature regime map based on this table is given in Figure II.4.

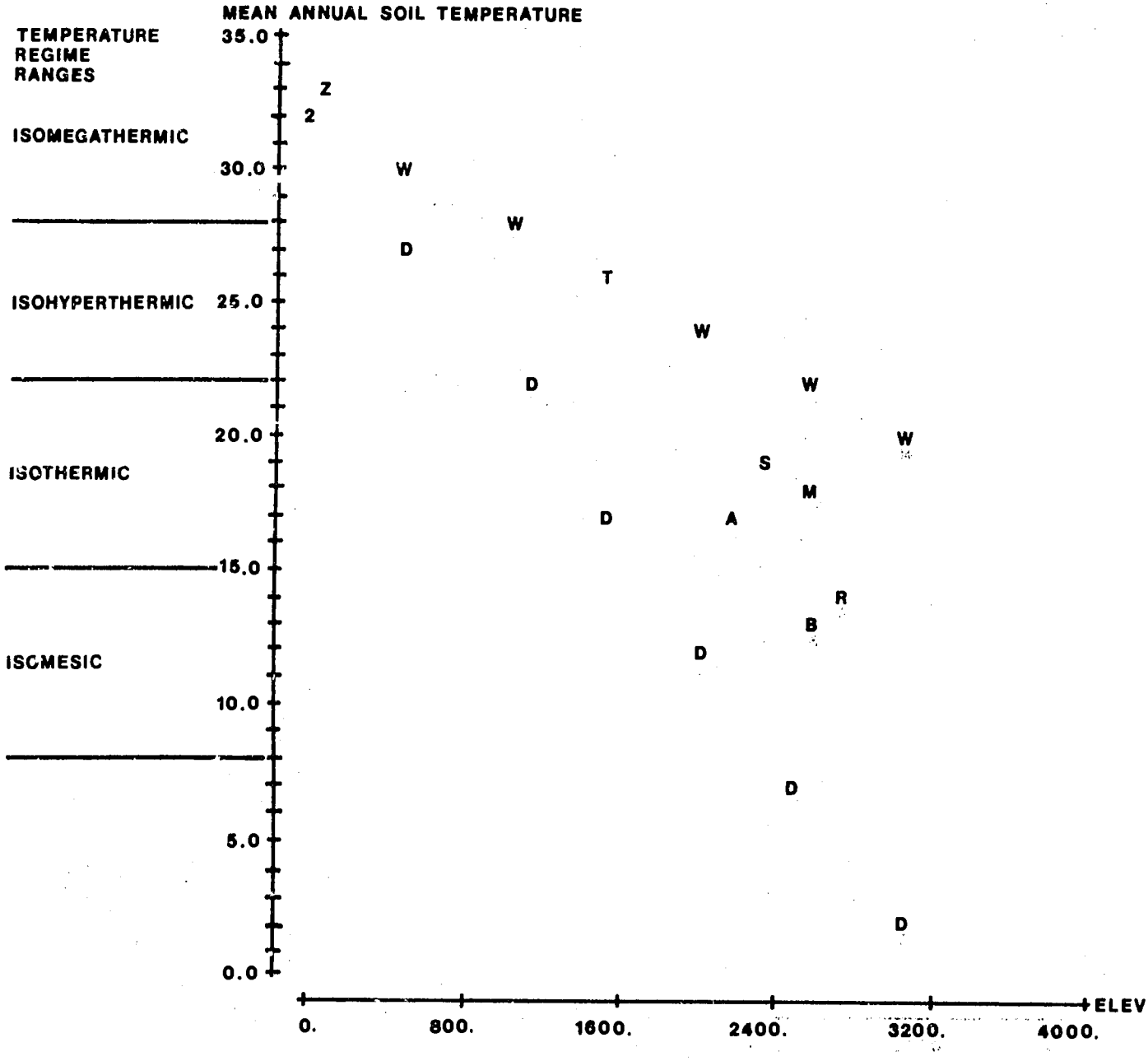


Figure II.3: Graph of mean annual soil temperature (°C) versus elevation (m) for nine stations in Yemen. Also shown are the dry adiabatic (D) and wet adiabatic (W) lapse rates and the boundaries of the temperature regimes.

Key: 2-Al Hudaydah and Kamaran
Z-Al Zuhra
T-Taizz
A-Amran
S-Sana
M-Ma'bar
B-Kitab
R-Rabat

Table II.2: Elevation ranges for iso-temperature regimes (Soil Taxonomy, 1975) appropriate for the classification of soils in Yemen.

Temperature regime	Range of mean annual soil temperature (°C)	Estimated range of elevations (m)
Isomesic	8-15	3790-2725
Isothermic	15-22	2725-1660
Isohyperthermic	22-28	1660-745
Isomegathermic*	>28	745 and below

* proposed new soil temperature regime

Using this table, the elevation of Kitab suggests that Kitab should be isothermic. However, the results for the year for which data are available show Kitab as isomesic. Kitab is known for its unusually cold temperatures. This may be a result of the immediate topography around Kitab. This points out the care with which these estimates should be used. The generalizations made here need to be interpreted in the light of each individual situation.

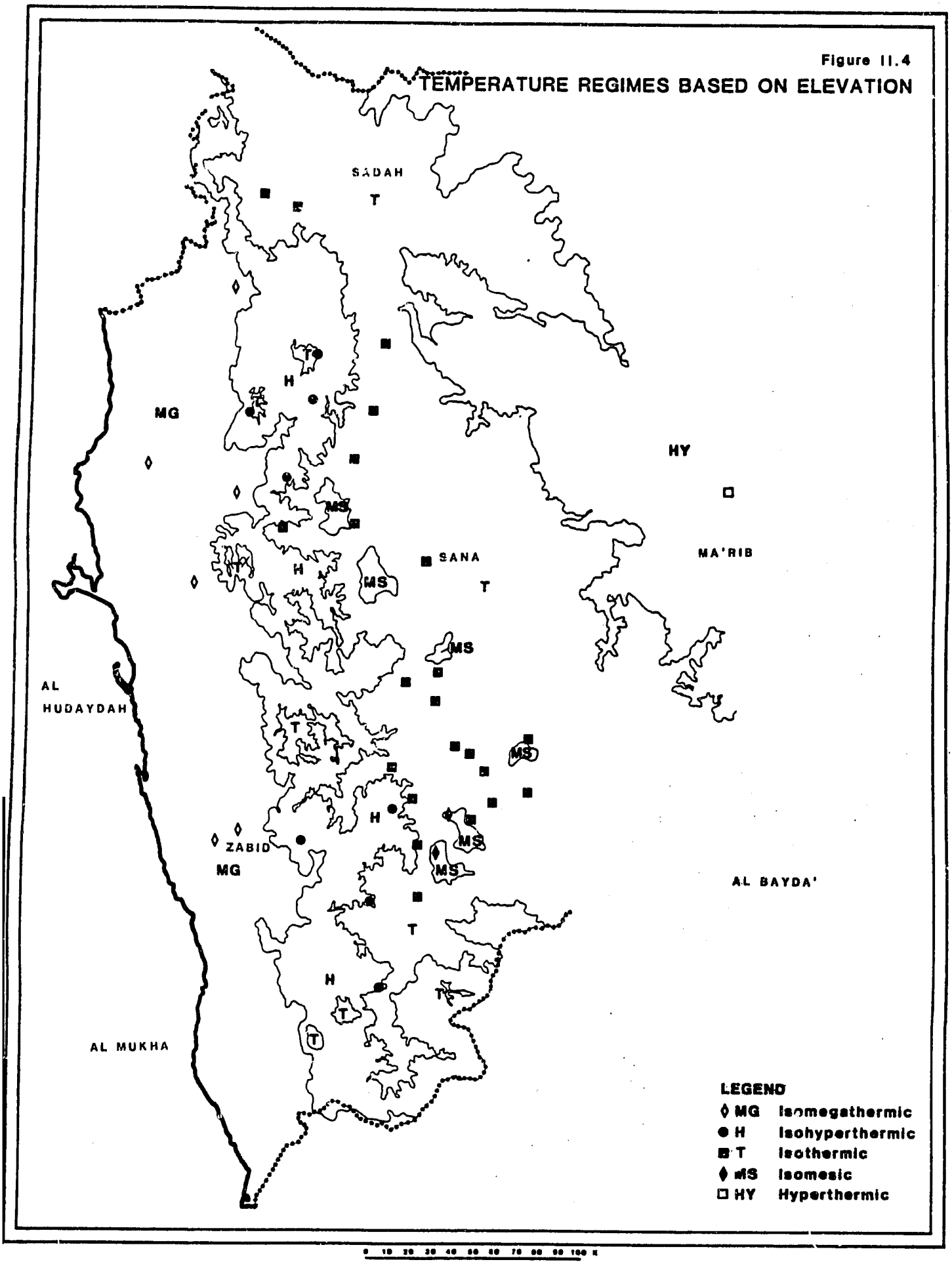
For most stations for which average monthly temperature data were available, the temperature regimes calculated are iso-temperature regimes. This means that there is little seasonal difference (less than 5°C between winter and summer) in the soil temperature. Al Zuhra, for which monthly temperatures for individual years were available, was iso- two years and non-iso another two years. Ma'rib, for which data are a combination of observed data and data derived from the patterns of nearby stations (Agrar und Hydrotechnik, 1980) is also non-iso, as are nearby stations in Saudi Arabia and South Yemen. The computer output for these stations is given in Section 5, Climate Table Set G. These data suggest that latitude and location either east or west of the mountains are the primary influences on whether or not an area is iso or non-iso. However, insufficient data make it difficult to clearly delineate the boundary in Yemen. For the purposes here, it is assumed that all temperature regimes to the west of the eastern thermic/hyperthermic boundary are iso-, while the area to the east of this boundary are not.

ESTIMATION OF SOIL MOISTURE REGIMES

Two computer programs were available to estimate soil moisture regimes for Yemen. The first uses mean monthly temperature and rainfall data averaged over a number of years to estimate a single soil temperature and moisture regime for that set of years. The second uses data from each of several years individually to produce a separate temperature and moisture regime estimate for each year. Both programs print out soil moisture calendars for the years for which they estimate temperature and moisture regimes. The second program also gives an overall estimate of the temperature and moisture regimes for the years given based on a "truth table," which tests the moisture

Figure II.4

TEMPERATURE REGIMES BASED ON ELEVATION



calendars for the probability of occurrence of moisture conditions specified in the definitions of Soil Taxonomy. These conditions are given at the end of this appendix.

Monthly rainfall and elevation data were available for the stations listed in Table II.4. The mean monthly air temperatures were calculated by producing linear regression equations for each of the twelve months in the manner described for annual soil temperatures. The calculated temperatures were then used in estimating the soil moisture and temperature regimes.

A summary of the estimated temperature and moisture regimes are given in Tables II.3 and II.4. Table II.3 gives results for stations for which observed temperature data are available, and Table II.4 gives results for stations for which temperature data were calculated on the basis of elevation. A map of the estimated moisture regimes is given in Figure II.5.

Table II.3: Results for sites with observed rainfall and precipitation data.

Site	Estimated temperature regime	Estimated moisture regime
Al Hudaydah	Isohyperthermic	Aridic
Al Zuhra	Isohyperthermic	Aridic
Amran	Isothermic	Aridic
Kamaran	Isohyperthermic	Aridic
Kitab	Isomesic	Udic
Ma'bar	Isothermic	Ustic
Rabat	Isomesic	Udic
Sana	Isothermic	Aridic
Taizz	Isohyperthermic	Aridic

LIMITATIONS OF THE MODEL IN YEMEN

The Newhall model used in making the soil climate estimations has several important limitations when applied to Yemen. It assumes that there are no significant gains or losses of rainfall due to runoff or inflow. This is commonly not the case in Yemen, particularly along the Tihama mountain front and along wadis in the mountains. Much of the precipitation along the Tihama mountain front probably flows onto the Tihama before it can infiltrate into the subsoil. Therefore, the ustic areas along the mountain front may be drier than predicted by the model and the wadi areas near the front are probably more moist.

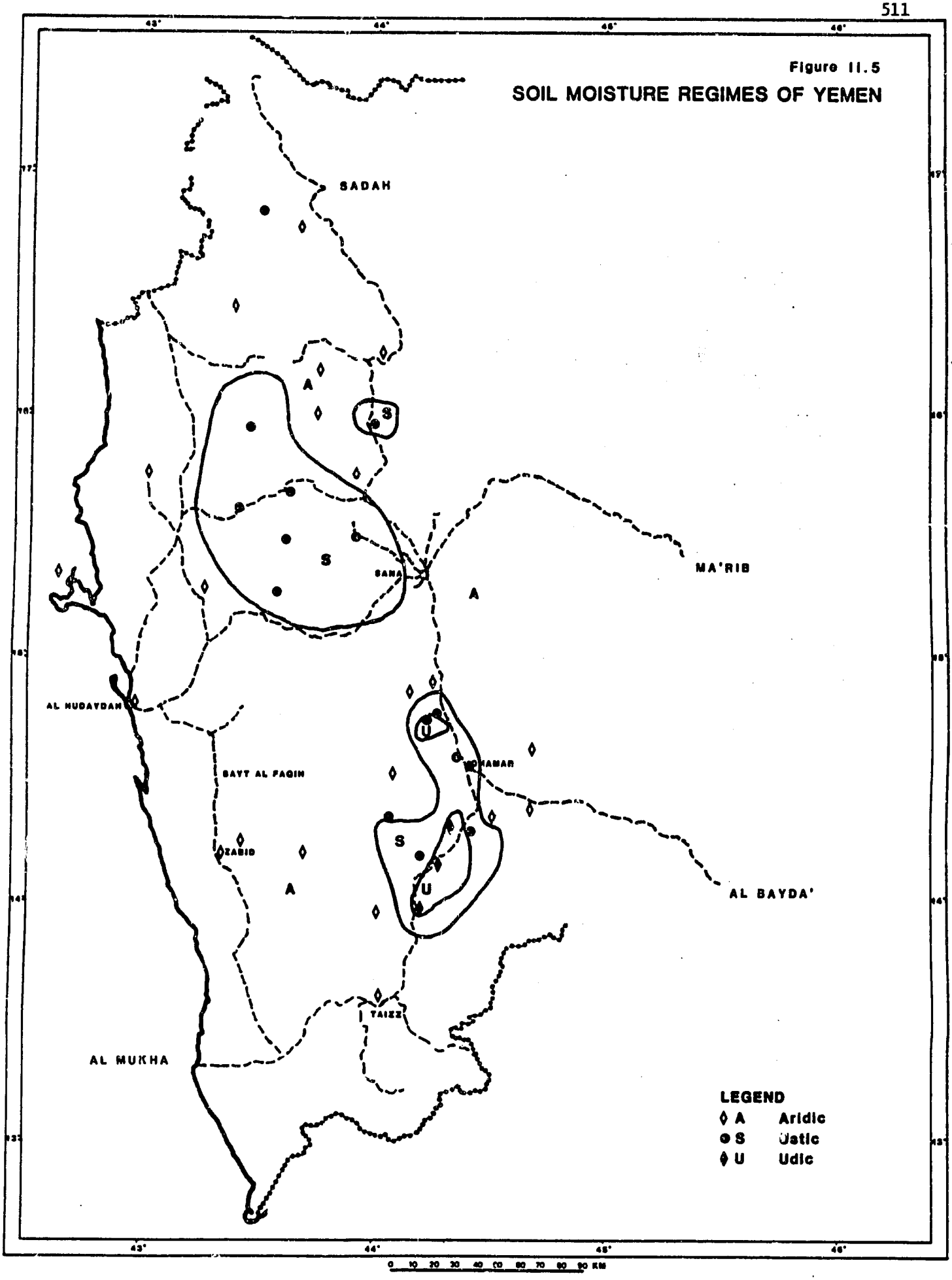
The same may be true in areas along mountain wadis. However, in the mountains, water runoff is significantly affected by terracing. Water remains in the terraces more readily than it would on an unterraced slope. The computer-estimated moisture regimes probably are more accurate in terraced areas because the precipitation is made more effective by the terraces. In water-harvesting situations, terraced areas may be moister than predicted by the computer model.

Table II.4: Elevation and estimated soil moisture regimes for sites with monthly rainfall data in Yemen.

Site	Elevation (m)	Number of years of data	Calculated mean annual soil temperature	Estimated temperature regime	Estimated moisture regime
Ad-Darb	2750	4	15.0	Isomesic	Ustic
Al Mahabisha	1600	2	22.5	Isohyperth.	Ustic
Al Mahweet	2100	1	19.3	Isothermic	Ustic
Ash-Shagrab	2770	5	14.9	Isomesic	Aridic
At Tur	200	2	31.8	Isohyperth.	Ustic
Bani Uwair	2100	2	19.3	Isothermic	Aridic
Beit Al Fatami	2000	5	19.9	Isothermic	Aridic
Beit Al Fuleih	800	4	27.8	Isohyperth.	Aridic
Dawran	2900	2	14.0	Isomesic	Udic
Dhaf	2625	3	15.8	Isothermic	Aridic
Dhamar	2770	5	14.9	Isomesic	Ustic
Hajjah	1650	2	22.2	Isohyperth.	Ustic
Huth	1850	2	20.9	Isothermic	Aridic
Ibb	1800	8	21.2	Isothermic	Udic
Khamir	2350	2	17.6	Isothermic	Ustic
Maram	2375	5	17.4	Isothermic	Aridic
Rhizwa	2400	5	17.3	Isothermic	Aridic
Rihab	1500	7	23.2	Isohyperth.	Aridic
Sakain	2230	2	18.4	Isothermic	Ustic
Samah-Al-Uya	2500	5	16.4	Isothermic	Aridic
Sanaban	2300	5	16.6	Isothermic	Aridic
Shibam	2650	2	15.6	Isothermic	Ustic
Shihara	1250	1	24.8	Isohyperth.	Aridic
Sumara	1800	7	21.1	Isothermic	Ustic
Surdud	250	2	31.5	Isohyperth.	Aridic
Udain	1500	6	23.2	Isohyperth.	Aridic
Wadi Al Har	2300	1	17.9	Isothermic	Aridic
Washa	500	1	29.8	Isohyperth.	Aridic
Yarim	2400	8	17.3	Isothermic	Ustic
Zabid	240	6	31.5	Isohyperth.	Aridic
Zabid Camp	240	10	31.5	Isohyperth.	Aridic

Figure 11.5

SOIL MOISTURE REGIMES OF YEMEN



Section 5

CLIMATE TABLE SETS

CLIMATE TABLE SET A: COMPUTATION TABLES BASED ON OBSERVED MONTHLY AVERAGES

The A set of tables gives the results of climatic regime estimations for the nine stations listed in Table II.1. The data used in making these tables are rainfall and temperature observations averaged over the number of years given in Table II.1. The results are given as a single estimation for an average year for each station. Also given is a soil moisture calendar for each station for the average year.

STATIONS:

Al Hudaydah	Ma'bar
Al Zuhra	Rabat
Amran	Sana
Kamaran	Taizz
Kitab	

```
              STATION : AL HUDAYDAH      LATITUDE : 14°  44'  N

INPUT DATA:      JAN   FEB   MAR   APR   MAY   JUN   JUL   AUG   SEP   OCT   NOV   DEC
PRECIPITATION:    5.0   5.0   2.5   2.5   2.5   1.3  12.7   2.5   2.5   2.5  10.1  22.9
TEMPERATURE  :   25.5  25.8  27.5  28.9  31.3  32.5  33.0  32.7  32.5  30.8  28.1  26.1
**************************************************************************************
OUTPUT    :      CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE
                 98.6  95.2 148.0 156.3 181.4 185.8 191.4 187.6 178.8 168.5 144.8 109.7
              ANNUAL RAINFALL :  72.0mm        ANNUAL EVAPOTRANSPIRATION :1346.2mm

        SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
       BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66
    ******************************************************************************
    *   MEAN SOIL TEMPERATURES  * SEASONS WHEN SOIL TEMPERATURE *                *
    *    (DEGREES CENTIGRADES)  *          IS HIGHER THAN       *                *
    *************************** FIVE DEGREES * EIGHT DEGREES *    REGIME      *
    *                     DIF-  *              *                *                *
    *ANNUAL SUMMER WINTER FEREN ***************************************************
    *                      CE   *BEGIN  LENGTH  *BEGIN  LENGTH  *                *
    *                           *       (DAYS)  *       (DAYS)  *                *
    * 32.1    34.1   29.5   4.6 *         360   *         360   *  ISOHYPERTH.*
    ******************************************************************************

                          MOISTURE CONDITION CALENDAR
                   (1 = DRY      2 = PARTLY DRY      3 = MOIST)
                  MONTH   1-------->11-------->21------>30  DAYS
                   JAN    1111111111 1111111111 1111111111
                   FEB    1111111111 1111111111 1111111111
                   MAR    1111111111 1111111111 1111111111
                   APR    1111111111 1111111111 1111111111
                   MAY    1111111111 1111111111 1111111111
                   JUN    1111111111 1111111111 1111111111
                   JUL    1111111111 1111111111 1111111111
                   AUG    1111111111 1111111111 1111111111
                   SEP    1111111111 1111111111 1111111111
                   OCT    1111111111 1111111111 1111111111
                   NOV    1111111111 1111111111 1111111111
                   DEC    1111111111 1111111111 1111111111

      ************************************************************************
      *NUMBER OF CUMULATIVE DAYS THAT * HIGHEST NUMBER OF CONSE-*              *
      *THE MOISTURE CONTROL SECTION    *SECUTIVE DAYS THAT MCS IS*              *
      *********************************************************                *
      *DURING ONE YEAR*WHEN SOIL TEMP.* MOIST IN  * DRY  *MOIST * MOISTURE *
      *       IS      *  ABOVE 5 DEG. *SOME PARTS *AFTER *AFTER *              *
      *********************************************************   REGIME     *
      * DRY MOIST MOI * DRY MOIST MOI * IN      WHEN*SUMMER*WINTER*              *
      *      OR    ST *       OR   ST * ONE     TEMP* SOL- * SOL- *              *
      *     DRY       *      DRY      *YEAR    > 8 *STICE *STICE *              *
      ************************************************************************
      * 360    0    0 * 360    0    0 *    0 *    0 * 120  *    0 *  ARIDIC  *
      ************************************************************************
      COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976            DATE :03/25/82
```

```
                STATION : AL ZUHRA            LATITUDE : 15° 44' N

INPUT DATA:      JAN   FEB   MAR   APR   MAY   JUN   JUL   AUG   SEP   OCT   NOV   DEC
PRECIPITATION:   5.2   4.7   0.5   1.6   9.8   4.7  38.4  34.1  13.2  42.9   8.9   0.1
TEMPERATURE  :  25.7  26.3  28.0  30.6  32.8  34.1  33.7  33.7  32.7  31.2  28.6  26.4
****************************************************************************************
OUTPUT    :     CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE
                93.4  99.3 152.2 171.8 194.6 194.9 200.5 193.3 178.8 169.7 144.1 108.0
              ANNUAL RAINFALL : 164.1mm        ANNUAL EVAPOTRANSPIRATION :1900.6mm

     SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
    BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66
*****************************************************************************
*   MEAN SOIL TEMPERATURES    * SEASONS WHEN SOIL TEMPERATURE *             *
*    (DEGREES CENTIGRADES)    *        IS HIGHER THAN         *             *
*******************************                               *             *
*                             *  FIVE DEGREES * EIGHT DEGREES *   REGIME    *
*                        DIF- *               *               *             *
*ANNUAL SUMMER WINTER FEREN   *************************************************
*                        CE   *BEGIN  LENGTH  *BEGIN  LENGTH  *             *
*                             *       (DAYS)  *       (DAYS)  *             *
* 32.8   35.0   29.9    5.1   *         360   *         360   *  HYPERTH.   *
*****************************************************************************

                     MOISTURE CONDITION CALENDAR
              (1 = DRY       2 = PARTLY DRY      3 = MOIST)
             MONTH   1--------->11--------->21------>30  DAYS
              JAN    1111111111 1111111111 1111111111
              FEB    1111111111 1111111111 1111111111
              MAR    1111111111 1111111111 1111111111
              APR    1111111111 1111111111 1111111111
              MAY    1111111111 1111111111 1111111111
              JUN    1111111111 1111111111 1111111111
              JUL    1111111111 1111111111 1111111111
              AUG    1111111111 1111111111 1111111111
              SEP    1111111111 1111111111 1111111111
              OCT    1111111111 1111111111 1111111111
              NOV    1111111111 1111111111 1111111111
              DEC    1111111111 1111111111 1111111111

*************************************************************************
*NUMBER OF CUMULATIVE DAYS THAT * HIGHEST NUMBER OF CONSE-*              *
*THE MOISTURE CONTROL SECTION   *SECUTIVE DAYS THAT MCS IS*              *
**********************************************************              *
*DURING ONE YEAR*WHEN SOIL TEMP.* MOIST IN * DRY  *MOIST *  MOISTURE    *
*     IS        * ABOVE 5 DEG.  *SOME PARTS *AFTER *AFTER *              *
**********************************************************   REGIME     *
* DRY MOIST MOI * DRY MOIST MOI * IN     WHEN*SUMMER*WINTER*             *
*     OR    ST  *     OR    ST  * ONE    TEMP* SOL- * SOL- *             *
*     DRY       *     DRY       *YEAR    > 8 *STICE *STICE *             *
*************************************************************************
* 360    0    0 * 360    0    0 *    0 *    0 * 120  *   0  *  ARIDIC    *
*************************************************************************
COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976              DATE :03/25/82
```

STATION : AMRAN LATITUDE : 15° 45' N

INPUT DATA:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRECIPITATION:	0.0	14.9	65.4	56.1	49.0	4.5	14.0	63.2	5.5	0.0	10.0	0.0
TEMPERATURE :	10.8	13.4	15.8	15.6	17.6	18.3	18.9	17.9	14.9	12.3	10.0	9.2

OUTPUT : CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE

35.2	45.3	65.2	64.6	82.3	84.8	92.2	82.1	59.3	44.3	30.8	27.8

ANNUAL RAINFALL : 282.6mm ANNUAL EVAPOTRANSPIRATION : 714.0mm

SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66

MEAN SOIL TEMPERATURES (DEGREES CENTIGRADES)				SEASONS WHEN SOIL TEMPERATURE IS HIGHER THAN			
ANNUAL	SUMMER	WINTER	DIF-FERENCE	FIVE DEGREES BEGIN	FIVE DEGREES LENGTH (DAYS)	EIGHT DEGREES BEGIN	EIGHT DEGREES LENGTH (DAYS)	REGIME
17.1	18.6	14.9	4.8		360		360	ISOTHERMIC

MOISTURE CONDITION CALENDAR
(1 = DRY 2 = PARTLY DRY 3 = MOIST)

MONTH	1--------->11	--------->21	------->30	DAYS
JAN	1111111111	1111111111	1111111111	
FEB	1111111111	1111111111	1111111111	
MAR	1111111111	1111122222	2222222222	
APR	2222222222	2222222222	2222222222	
MAY	2222222222	2211111111	1111111111	
JUN	1111111111	1111111111	1111111111	
JUL	1111111111	1111111111	1111111111	
AUG	1111111111	1111122222	2222222222	
SEP	2222222211	1111111111	1111111111	
OCT	1111111111	1111111111	1111111111	
NOV	1111111111	1111111111	1111111111	
DEC	1111111111	1111111111	1111111111	

NUMBER OF CUMULATIVE DAYS THAT THE MOISTURE CONTROL SECTION DURING ONE YEAR IS			WHEN SOIL TEMP. ABOVE 5 DEG.			MOIST IN SOME PARTS	DRY AFTER	MOIST AFTER	HIGHEST NUMBER OF CONSECUTIVE DAYS THAT MCS IS WHEN SUMMER TEMP > 8	WINTER SOL-STICE		MOISTURE REGIME
DRY OR DRY	MOIST OR DRY	MOI ST	DRY OR DRY	MOIST OR DRY	MOI ST	IN ONE YEAR						
280	80	0	280	80	0	57	57	52		0		ARIDIC

COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976 DATE :03/25/82

STATION : KAMARAN LATITUDE : 15° 20' N

INPUT DATA:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRECIPITATION:	5.0	5.0	2.5	2.5	2.5	1.3	12.7	17.8	2.5	2.5	10.1	22.9
TEMPERATURE :	25.5	25.8	27.5	28.9	31.3	32.5	33.0	32.7	32.5	30.8	28.1	26.1

OUTPUT : CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE

95.7	95.2	148.0	157.8	186.5	180.3	198.5	189.3	178.8	166.9	140.4	107.5

ANNUAL RAINFALL : 87.3mm ANNUAL EVAPOTRANSPIRATION : 1353.8mm

SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66

MEAN SOIL TEMPERATURES (DEGREES CENTIGRADES)				SEASONS WHEN SOIL TEMPERATURE IS HIGHER THAN			
				FIVE DEGREES		EIGHT DEGREES	REGIME
ANNUAL	SUMMER	WINTER	DIF-FERENCE	BEGIN	LENGTH (DAYS)	BEGIN	LENGTH (DAYS)	
32.1	34.1	29.5	4.6		360		360	ISOHYPERTH.

MOISTURE CONDITION CALENDAR
(1 = DRY 2 = PARTLY DRY 3 = MOIST)

MONTH	1--------->11--------->21------->30 DAYS
JAN	1111111111 1111111111 1111111111
FEB	1111111111 1111111111 1111111111
MAR	1111111111 1111111111 1111111111
APR	1111111111 1111111111 1111111111
MAY	1111111111 1111111111 1111111111
JUN	1111111111 1111111111 1111111111
JUL	1111111111 1111111111 1111111111
AUG	1111111111 1111111111 1111111111
SEP	1111111111 1111111111 1111111111
OCT	1111111111 1111111111 1111111111
NOV	1111111111 1111111111 1111111111
DEC	1111111111 1111111111 1111111111

NUMBER OF CUMULATIVE DAYS THAT THE MOISTURE CONTROL SECTION IS DURING ONE YEAR			WHEN SOIL TEMP. ABOVE 5 DEG.			MOIST IN SOME PARTS			HIGHEST NUMBER OF CONSECUTIVE DAYS THAT MCS IS						MOISTURE REGIME
DRY OR DRY	MOIST	MOI ST	DRY OR DRY	MOIST	MOI ST	IN ONE YEAR	WHEN TEMP > 8	SUMMER SOL- STICE	WINTER SOL- STICE						
360	0	0	360	0	0	0	0	120	0	ARIDIC					

COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976 DATE :03/25/82

STATION : KIFAB LATITUDE : 14° 19' N

INPUT DATA:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRECIPITATION:	0.0	0.0	36.0	99.0	23.0	6.0	139.0	221.0	73.0	0.0	2.0	16.0
TEMPERATURE :	6.9	9.6	11.7	11.6	14.1	13.9	13.7	13.2	12.7	9.2	7.8	6.9

OUTPUT : CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE

29.5	39.0	55.2	54.7	71.5	69.1	69.3	65.8	60.0	41.7	33.2	29.2

ANNUAL RAINFALL : 615.0mm ANNUAL EVAPOTRANSPIRATION : 618.3mm

SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66

MEAN SOIL TEMPERATURES (DEGREES CENTIGRADES)				SEASONS WHEN SOIL TEMPERATURE IS HIGHER THAN				
ANNUAL	SUMMER	WINTER	DIFFERENCE	BEGIN	LENGTH (DAYS)	BEGIN	LENGTH (DAYS)	REGIME
				FIVE DEGREES		EIGHT DEGREES		
13.4	15.1	11.3	3.8	360		12 FEB	284	ISOMESIC

SOIL TEMPERATURE CALENDAR (_: T<5 ; 5: 5<T<8 ; 8: T>8)

DAYS 1-------->	11-------->	21------>	30	MONTH
5555555555	5555555555	5555555555		JAN
5555555555	5888888888	8888888888		FEB
8888888888	8888888888	8888888888		MAR
8888888888	8888888888	8888888888		APR
8888888888	8888888888	8888888888		MAY
8888888888	8888888888	8888888888		JUN
8888888888	8888888888	8888888888		JUL
8888888888	8888888888	8888888888		AUG
8888888888	8888888888	8888888888		SEP
8888888888	8888888888	8888888888		OCT
8888888888	8888888888	8888855555		NOV
5555555555	5555555555	5555555555		DEC

MOISTURE CONDITION CALENDAR (1=DRY 2=PARTIALLY DRY 3=MOIST)

1-------->	11-------->	21------>	30
3333333333	3333333333	3333333333	
3333333333	3333333333	3333332222	
2222222222	2222222222	2222222222	
2222222222	2222233333	3333333333	
3333333333	3333333333	3333333333	
3333322222	2222222222	2222222222	
2222222222	2222233333	3333333333	
3333333333	3333333333	3333333333	
3333333333	3333333333	3333333333	
3333333333	3333333333	3333333333	
3333333333	3333333333	3333333333	

NUMBER OF CUMULATIVE DAYS THAT THE MOISTURE CONTROL SECTION DURING ONE YEAR IS			WHEN SOIL TEMP. ABOVE 5 DEG.			HIGHEST NUMBER OF CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS			DRY AFTER	MOIST AFTER	MOISTURE REGIME
DRY OR DRY	MOIST OR DRY	MOI ST	DRY OR DRY	MOIST OR DRY	MOI ST	IN ONE YEAR	WHEN TEMP > 8	SUMMER SOL-STICE	WINTER SOL-STICE		
0	89	271	0	89	271	360	284	0	56		UDIC

COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976 DATE :03/25/82

```
                 STATION : MA'BAR                 LATITUDE : 14°  47'  N

INPUT DATA:        JAN   FEB   MAR   APR   MAY   JUN   JUL   AUG   SEP   OCT   NOV   DEC
PRECIPITATION:     2.0   7.0  55.0  61.0  39.0   4.0  40.0  97.0   6.0 116.0  37.0   0.0
TEMPERATURE   :   11.5  12.8  15.2  16.7  17.6  18.2  18.8  18.2  16.8  14.7  12.1  11.3
*****************************************************************************************
OUTPUT     :      CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE
                  37.4  40.1  59.1  68.3  77.6  80.2  85.9  81.0  68.3  55.6  39.6  36.0
               ANNUAL RAINFALL : 464.0mm        ANNUAL EVAPOTRANSPIRATION : 729.2mm

      SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
     BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66
*****************************************************************************
*   MEAN SOIL TEMPERATURES  * SEASONS WHEN SOIL TEMPERATURE *               *
*    (DEGREES CENTIGRADES)  *           IS HIGHER THAN      *               *
***************************** FIVE DEGREES * EIGHT DEGREES *     REGIME    *
*                     DIF-  *              *                *               *
*ANNUAL SUMMER WINTER FEREN *************************************************
*                     CE    *BEGIN  LENGTH *BEGIN  LENGTH   *               *
*                           *       (DAYS) *       (DAYS)   *               *
* 17.8   19.8   15.5   4.3  *         360  *         360    *   ISOTHERMIC  *
*****************************************************************************

                  MOISTURE CONDITION CALENDAR
           (1 = DRY       2 = PARTLY DRY       3 = MOIST)
          MONTH    1--------->11--------->21------->30  DAYS
           JAN     2222222222 2222222222 2222222222
           FEB     2222222222 2111111111 1111111111
           MAR     1111111111 1111122222 2222222222
           APR     2222222222 2222222222 2222222222
           MAY     2222222222 1111111111 1111111111
           JUN     1111111111 1111111111 1111111111
           JUL     1111111111 1111111111 1111111111
           AUG     1111111111 1111122222 2222222222
           SEP     2222222222 2222222222 2221111111
           OCT     1111111111 1111122222 2222222222
           NOV     2222222222 2222222222 2222222222
           DEC     2222222222 2222222222 2222222222

*****************************************************************************
*NUMBER OF CUMULATIVE DAYS THAT * HIGHEST NUMBER OF CONSE-*                 *
*THE MOISTURE CONTROL SECTION   *SECUTIVE DAYS THAT MCS IS*                 *
**********************************************************                 *
*DURING ONE YEAR*WHEN SOIL TEMP.* MOIST IN  * DRY   *MOIST *  MOISTURE     *
*      IS       * ABOVE 5 DEG.  *SOME PARTS *AFTER  *AFTER *               *
**********************************************************     REGIME     *
* DRY MOIST MOI * DRY MOIST MOI * IN         WHEN*SUMMER*WINTER*            *
*       OR   ST *       OR   ST * ONE        TEMP* SOL-  * SOL- *           *
*      DRY      *      DRY      *YEAR        > 8 *STICE  *STICE *           *
*****************************************************************************
* 151  209    0 * 151  209    0 * 116 * 116 *  45  *   0  *  USTIC          *
*****************************************************************************
COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976                  DATE :03/25/82
```

STATION : RABAT LATITUDE : 14° 47' N

INPUT DATA:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRECIPITATION:	6.0	18.0	46.0	109.0	70.0	23.0	70.0	166.0	44.0	106.0	45.0	14.0
TEMPERATURE :	7.9	8.5	11.4	11.5	13.9	14.5	14.8	13.8	13.5	11.1	8.7	7.7

OUTPUT : CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE

	32.8	32.5	51.9	52.4	68.6	70.8	73.8	67.4	62.6	49.8	35.9	31.5

ANNUAL RAINFALL : 717.0mm ANNUAL EVAPOTRANSPIRATION : 629.9mm

SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66

MEAN SOIL TEMPERATURES (DEGREES CENTIGRADES)				SEASONS WHEN SOIL TEMPERATURE IS HIGHER THAN			
ANNUAL	SUMMER	WINTER	DIFFERENCE	FIVE DEGREES BEGIN	LENGTH (DAYS)	EIGHT DEGREES BEGIN	LENGTH (DAYS)	REGIME
13.9	15.8	11.6	4.2	360		5 FEB	316	ISOMESIC

SOIL TEMPERATURE CALENDAR (_: T<5 ; 5: 5<T<8 ; 8: T>8)

DAYS 1-------->11--------->21------>30	MONTH
5555555555 5555555555 5555555555	JAN
5555888888 8888888888 8888888888	FEB
8888888888 8888888888 8888888888	MAR
8888888888 8888888888 8888888888	APR
8888888888 8888888888 8888888888	MAY
8888888888 8888888888 8888888888	JUN
8888888888 8888888888 8888888888	JUL
8888888888 8888888888 8888888888	AUG
8888888888 8888888888 8888888888	SEP
8888888888 8888888888 8888888888	OCT
8888888888 8888888888 8888888888	NOV
8888888888 8888888888 5555555555	DEC

MOISTURE CONDITION CALENDAR (1=DRY 2=PARTIALLY DRY 3=MOIST)

1-------->11--------->21------>30
3333333333 3333333333 3333333333
3333333333 3333333333 3333333333
3333333333 3333333333 3333333333
3333333333 3333333333 3333333333
3333333333 3333333333 3333333333
3333333333 3333333333 3333333333
3333333333 3333333333 3333333333
3333333333 3333333333 3333333333
3333333333 3333333333 3333333333
3333333333 3333333333 3333333333
3333333333 3333333333 3333333333
3333333333 3333333333 3333333333

NUMBER OF CUMULATIVE DAYS THAT THE MOISTURE CONTROL SECTION DURING ONE YEAR IS			WHEN SOIL TEMP. ABOVE 5 DEG.			MOIST IN SOME PARTS OF ONE YEAR	HIGHEST NUMBER OF CONSECUTIVE DAYS THAT MCS IS DRY		MOIST AFTER SUMMER SOL-STICE	MOIST AFTER WINTER SOL-STICE	MOISTURE REGIME
DRY	MOIST	MOI ST	DRY	MOIST	MOI ST						
0	0	360	0	0	360	360	316	0	120		UDIC

COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976 DATE :03/25/82

STATION : SANA LATITUDE : 15° 24' N

INPUT DATA:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRECIPITATION:	2.7	6.7	15.9	86.7	54.6	7.0	87.4	80.4	2.6	0.0	25.7	9.7
TEMPERATURE :	12.8	15.0	16.6	16.9	18.8	20.5	20.5	19.8	18.8	15.5	14.0	11.6

OUTPUT : CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE

38.0	46.6	62.7	65.2	83.4	94.0	97.5	88.6	76.7	54.7	43.3	32.1

ANNUAL RAINFALL : 379.4mm ANNUAL EVAPOTRANSPIRATION : 782.8mm

SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66

MEAN SOIL TEMPERATURES (DEGREES CENTIGRADES)				SEASONS WHEN SOIL TEMPERATURE IS HIGHER THAN				
ANNUAL	SUMMER	WINTER	DIFFERENCE	FIVE DEGREES BEGIN	FIVE DEGREES LENGTH (DAYS)	EIGHT DEGREES BEGIN	EIGHT DEGREES LENGTH (DAYS)	REGIME
19.2	21.6	16.8	4.7		360		360	ISOTHERMIC

MOISTURE CONDITION CALENDAR
(1 = DRY 2 = PARTLY DRY 3 = MOIST)

MONTH	1-------->11-------->21------->30 DAYS
JAN	1111111111 1111111111 1111111111
FEB	1111111111 1111111111 1111111111
MAR	1111111111 1111111111 1111111111
APR	1111111111 1111122222 2222222222
MAY	2222222222 2222222222 2222222222
JUN	2222221111 1111111111 1111111111
JUL	1111111111 1111122222 2222222222
AUG	2222222222 2222222222 2222222222
SEP	2222222222 2211111111 1111111111
OCT	1111111111 1111111111 1111111111
NOV	1111111111 1111111111 1111111111
DEC	1111111111 1111111111 1111111111

NUMBER OF CUMULATIVE DAYS THAT THE MOISTURE CONTROL SECTION DURING ONE YEAR			WHEN SOIL TEMP. ABOVE 5 DEG.	HIGHEST NUMBER OF CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS OF ONE YEAR			DRY AFTER WHEN SOIL TEMP. > 8	MOIST AFTER WINTER STICE	MOISTURE REGIME
DRY OR DRY	MOIST OR DRY	MOI ST	DRY OR DRY	MOIST OR DRY	MOI ST				
252	108	0	252	108	0	57	57	48	0	ARIDIC

COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976 DATE :03/25/82

STATION : TAIZZ LATITUDE : 13° 40' N

INPUT DATA:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRECIPITATION:	1.5	8.1	17.0	88.7	117.9	86.9	64.5	47.7	83.8	84.6	5.6	12.9
TEMPERATURE :	19.2	22.3	23.7	24.8	25.9	26.9	26.3	26.1	24.7	22.8	20.9	19.8

OUTPUT : CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE

53.5	75.0	101.3	115.5	137.3	143.1	143.5	139.0	113.0	89.7	67.0	57.9

ANNUAL RAINFALL : 619.2mm ANNUAL EVAPOTRANSPIRATION :1235.8mm

SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66

MEAN SOIL TEMPERATURES (DEGREES CENTIGRADES)				SEASONS WHEN SOIL TEMPERATURE IS HIGHER THAN			
ANNUAL	SUMMER	WINTER	DIFFERENCE	FIVE DEGREES BEGIN	FIVE DEGREES LENGTH (DAYS)	EIGHT DEGREES BEGIN	EIGHT DEGREES LENGTH (DAYS)	REGIME
26.1	27.9	24.0	4.0	360		360		ISOHYPERTH.

MOISTURE CONDITION CALENDAR
(1 = DRY 2 = PARTLY DRY 3 = MOIST)

MONTH	1-------->11-------->21------->30 DAYS
JAN	1111111111 1111111111 1111111111
FEB	1111111111 1111111111 1111111111
MAR	1111111111 1111111111 1111111111
APR	1111111111 1111122222 2222222222
MAY	2222222211 1111122222 2222222222
JUN	2222222222 2221122222 2222222222
JUL	2111111111 1111122222 2222221111
AUG	1111111111 1111111111 1111111111
SEP	1111111111 1111122222 2222222222
OCT	2222222222 2211122222 2222222222
NOV	2222222222 2222111111 1111111111
DEC	1111111111 1111112111 1111111111

NUMBER OF CUMULATIVE DAYS THAT DURING ONE YEAR IS	WHEN SOIL TEMP. ABOVE 5 DEG.	MOIST IN SOME PARTS	DRY AFTER	MOIST AFTER	HIGHEST NUMBER OF CONSECUTIVE DAYS THAT MCS IS			MOISTURE REGIME
DRY OR DRY	MOIST OR DRY	MOI ST	IN ONE YEAR	WHEN TEMP > 8	SUMMER SOL- STICE	WINTER SOL- STICE		
226	134	0	226	134	0	29	29	49	0	ARIDIC

COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976 DATE :03/25/82

CLIMATE TABLE SET B: COMPUTATION TABLES BASED ON OBSERVED RAINFALL AND CALCULATED TEMPERATURES FOR INDIVIDUAL YEARS

The B set of tables lists the results of estimations made on the basis of observed rainfall data for individual years and temperature observations averaged over a period of years. The estimations, truth tables and moisture calenders are given on an individual year basis.

STATIONS:

Ma'bar
Rabat
Sana

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:MABAR

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX. CONSECUTIVE DAYS THAT MCS IS MOIST IN ONE YEAR	MAX. CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1975	17.8	19.8	ISOTHERMIC	124	156	80	124	156	80	156	156	15	0	USTIC
1976	17.8	19.8	ISOTHERMIC	258	102	0	258	102	0	79	79	52	0	ARIDIC
1977	17.8	19.8	ISOTHERMIC	258	102	0	258	102	0	75	75	105	0	ARIDIC
1979	17.8	19.8	ISOTHERMIC	264	96	0	264	96	0	40	40	51	0	ARIDIC
1980	17.8	19.8	ISOTHERMIC	314	46	0	314	46	0	46	46	45	0	ARIDIC
MEAN	17.8	19.8		243	100	16	243	100	16	79	79	53	0	
STAND.DEV.	0.0	0.0		70	38	35	70	38	35	46	46	32	0	
COEFF.VAR.				29	38	223	29	38	223	58	58	60	0	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81 DATE 03/25/82

STATION :MABAR

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1975		T			T	T		T	T		T		T	T	USTIC
1976	T		T		T			T	T		T		T	T	ARIDIC
1977	T		T		T			T	T		T		T	T	ARIDIC
1979	T		T		T			T	T		T		T	T	ARIDIC
1980	T		T		T			T	T	T	T		T	T	ARIDIC
FREQ.	80	20	80	0	100	20	0	100	100	20	100	0	100	100	
COND.	T		T		T			T	T		T		T	T	ARIDIC

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81 DATE 03/25/82

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

MOISTURE CONDITION CALENDARS
STATION:MABAR

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

YEAR 1975
(USTIC)

DAYS ---------->11--------->21------->30		
1111111111	1111111111	1111111111
1111111111	1111111111	1111111111
1111111111	1111122222	2222222222
2222222222	2222222222	2222222222
2222222222	2222222222	2222222222
2222211111	1111111111	1111111111
1111111111	1111122222	2222222222
2222222222	2222233333	3333333333
3333333333	3333333333	3333333333
3333333333	3333333333	3333333333
3333322222	2222222222	2222222222
2222222222	2222222222	2111111111

YEAR 1976
(ARIDIC)

	DAYS ---------->11--------->21------->30		
JAN	1111111111	1111111111	1111111111
FEB	1111111111	1111111111	1111111111
MAR	1111111111	1111122222	2222222222
APR	2222222222	2222222222	2222222222
MAY	2222222222	2222222222	2222222222
JUN	2222111111	1111111111	1111111111
JUL	1111111111	1111111111	1111111111
AUG	1111111111	1111122222	2222222222
SEP	2222222211	1111111111	1111111111
OCT	1111111111	1111111111	1111111111
NOV	1111111111	1111111111	1111111111
DEC	1111111111	1111111111	1111111111

YEAR 1977
(ARIDIC)

1111111111	1111111111	1111111111	
1111111111	1111111111	1111111111	
1111111111	1111111111	1111111111	
1111111111	1111111111	1111111111	
1111111111	1111122222	2222222222	
2222222222	2211111111	1111111111	
1111111111	1111111111	1111111111	
1111111111	1111111111	1111111111	
1111111111	1111111111	1111111111	
1111111111	1111122222	2222222222	
2222222222	2222222222	2222222222	
2222222222	2222222222	2222222222	

YEAR 1979
(ARIDIC)

JAN	2222222211	1111111111	1111111111
FEB	1111111111	1111111111	1111111111
MAR	1111111111	1111122222	2222222222
APR	2222222221	1111111111	1111111111
MAY	1111111111	1111122222	2222222222
JUN	2222222222	2222222222	2222211111
JUL	1111111111	1111111111	1111111111
AUG	1111111111	1111122222	2222222222
SEP	2222222221	1111111111	1111111111
OCT	1111111111	1111111111	1111111111
NOV	1111111111	1111111111	1111111111
DEC	1111111111	1111111111	1111111111

YEAR 1980
(ARIDIC)

JAN	1111111111	1111111111	1111111111
FEB	1111111111	1111111111	1111111111
MAR	1111111111	1111111111	1111111111
APR	1111111111	1111111111	1111111111
MAY	1111111111	1111111111	1111111111
JUN	1111111111	1111111111	1111111111
JUL	1111111111	1111111111	1111111111
AUG	1111111111	1111122222	2222222222
SEP	2222222222	2222222222	2222222222
OCT	2111111111	1111111111	1111111111
NOV	1111111111	1111111111	1111111111
DEC	1111111111	1111111111	1111111111

THE CLASSIFICATION FOR 5 YEARS BETWEEN 1975 AND 1980 IS:APIDIC
COMPUTED BY PROGRAM VW 18,NOV 81
DATE:03/25/82

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:RABAT

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	CUMULATIVE DAYS MCS IN ONE YEAR IS M/D	CUMULATIVE DAYS MCS IN ONE YEAR IS MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 M/D	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS WHEN SOIL TEMP > 8	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS DRY AFTER SUMMER SOLST.	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1975	13.9	15.8	ISOMESIC	0	102	258	0	102	258	360	316	0	46	USTIC
1976	13.9	15.8	ISOMESIC	0	22	338	0	22	338	360	316	0	53	UDIC
1977	13.9	15.8	ISOMESIC	0	35	325	0	35	325	360	316	0	70	UDIC
MEAN	13.9	15.8		0	53	307	0	53	307	360	316	0	56	
STAND.DEV.	0.0	0.0		0	42	42	0	42	42	0	0	0	12	
COEFF.VAR.				0	81	13	0	81	13	0	0	0	21	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81 DATE 03/25/82

STATION :RABAT

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1975		T		T	T	T		T			T		T	T	USTIC
1976		T		T		T					T		T	T	UDIC
1977		T		T		T					T		T	T	UDIC
FREQ.	0	100	0	100	33	100	0	33	0	0	100	0	100	100	
COND.		T		T		T					T		T	T	UDIC

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81 DATE 03/25/82

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

MOISTURE CONDITION CALENDARS
STATION: RABAT

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

YEAR 1975
(USTIC)

DAYS ---------->11--------->21------->30			
3333333333	3333333333	3333333333	JAN
3333333333	3333332222	2222222222	FEB
2222222222	2222222222	2222222222	MAR
2222222222	2222233333	3333333333	APR
3333333333	3333333333	3333333333	MAY
3322222222	2222222222	2222222222	JUN
2222222222	2222233333	3333333333	JUL
3333333333	3333333333	3333333333	AUG
3333333333	3333333333	3333333333	SEP
3333333333	3333333333	3333333333	OCT
3333333333	3333333333	3333333333	NOV
3333333333	3333333333	3333333333	DEC

YEAR 1976
(UDIC)

DAYS ---------->11--------->21------->30			
3333333333	3333333333	3333333333	JAN
3333333333	3333333333	3332222222	FEB
2222222222	2222233333	3333333333	MAR
3333333333	3333333333	3333333333	APR
3333333333	3333333333	3333333333	MAY
3333333333	3333333333	3333333333	JUN
3333333333	3333333333	3333333333	JUL
3333333333	3333333333	3333333333	AUG
3333333333	3333333333	3333333333	SEP
3333333333	3333333333	3333333333	OCT
3333333333	3333333333	3333333333	NOV
3333333333	3333333333	3333333333	DEC

YEAR 1977
(UDIC)

JAN	3333333333	3333333333	3333333333
FEB	3333333333	3333333333	3333333333
MAR	3333333333	2222222222	2222222222
APR	2222222222	2222233333	3333333333
MAY	3333333333	3333333333	3333333333
JUN	3333333333	3333333333	3333333333
JUL	3333333333	3333333333	3333333333
AUG	3333333333	3333333333	3333333333
SEP	3333333333	3333333333	3333333333
OCT	3333333333	3333333333	3333333333
NOV	3333333333	3333333333	3333333333
DEC	3333333333	3333333333	3333333333

THE CLASSIFICATION FOR 3 YEARS BETWEEN 1975 AND 1977 IS:UDIC
COMPUTED BY PROGRAM VW 18,NOV 81
DATE:03/25/82

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:SANA

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN ONE YEAR	MOIST IN SOME PARTS WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1972	19.2	21.6	ISOTHERMIC	328	32	0	328	32	0	32	32	120	0	ARIDIC
1973	19.2	21.6	ISOTHERMIC	326	34	0	326	34	0	34	34	45	0	ARIDIC
1974	19.2	21.6	ISOTHERMIC	333	27	0	333	27	0	27	27	120	0	ARIDIC
1975	19.2	21.6	ISOTHERMIC	246	114	0	246	114	0	74	74	31	0	ARIDIC
1976	19.2	21.6	ISOTHERMIC	360	0	0	360	0	0	0	0	120	0	ARIDIC
1977	19.2	21.6	ISOTHERMIC	215	70	75	215	70	75	75	75	45	0	ARIDIC
MEAN	19.2	21.6		301	46	12	301	46	12	40	40	80	0	
STAND.DEV.	0.0	0.0		57	40	30	57	40	30	29	29	43	0	
COEFF.VAR.				18	85	244	18	86	244	72	72	54	0	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81

DATE 03/25/82

STATION :SANA

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1972	T		T		T			T	T	T	T		T	T	ARIDIC
1973	T		T		T			T	T	T	T		T	T	ARIDIC
1974	T		T		T			T	T	T	T		T	T	ARIDIC
1975	T				T			T	T		T		T	T	ARIDIC
1976	T		T		T			T	T	T	T		T	T	ARIDIC
1977	T		T		T			T	T		T		T	T	ARIDIC
FREQ.	100	0	83	0	100	0	0	100	100	67	100	0	100	100	
COND.	T		T		T			T	T	T	T		T	T	ARIDIC

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81

DATE 03/25/82

MOISTURE CONDITION CALENDARS
STATION:SANA

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

```
---------->11-------->21------>30 DAYS  ---------->11-------->21------>30
          YEAR 1972                                YEAR 1973
          (ARIDIC  )                               (ARIDIC  )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  APR  1111111111 1111111111 1111111111
2222222222 2222222111 1111111111  MAY  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUL  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  AUG  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  SEP  2222222222 2222222221 1111111111
1111111111 1111111111 1111111111  OCT  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  NOV  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC  1111111111 1111111111 1111111111

          YEAR 1974                                YEAR 1975
          (ARIDIC  )                               (ARIDIC  )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  APR  1111111111 1111122222 2222222222
1111111111 1111122222 2222222222  MAY  2222222222 2222222222 2222211111
2222222222 2211111111 1111111111  JUN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUL  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  AUG  2222222222 2222222222 2222222222
1111111111 1111111111 1111111111  SEP  2222222222 2222222222 2222222221
1111111111 1111111111 1111111111  OCT  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  NOV  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC  1111111111 1111111111 1111111111

          YEAR 1976                                YEAR 1977
          (ARIDIC  )                               (ARIDIC  )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  APR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAY  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  JUN  2222222222 2221111111 1111111111
1111111111 1111111111 1111111111  JUL  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  AUG  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  SEP  2222222222 2222222222 2222222111
1111111111 1111111111 1111111111  OCT  1111111111 1111133333 3333333333
1111111111 1111111111 1111111111  NOV  3333333333 3333333333 3333333333
1111111111 1111111111 1111111111  DEC  3333333333 3333333333 3333333333
```

THE CLASSIFICATION FOR 6 YEARS BETWEEN 1972 AND 1977 IS:APIDIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

CLIMATE TABLE SET C: COMPUTATION TABLES BASED ON OBSERVED RAINFALL AND TEMPERATURE DATA FOR INDIVIDUAL YEARS

The C set of tables includes only Al Zuhra. For Al Zuhra, observed monthly rainfall and temperature data are available for four different years (1973 and 1976-1978). The results are separate estimations and moisture calendars for each of the four years.

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:AL ZUHRA

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	WHEN SOIL TEMP >5 DPY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DPY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1973	32.6	34.8	ISOH ERTH.	360	0	0	360	0	0	0	0	120	0	ARIDIC
1976	32.8	35.0	HYPERTH.	360	0	0	360	0	0	0	0	120	0	ARIDIC
1977	33.2	35.5	HYPERTH.	316	44	0	316	44	0	22	22	45	0	ARIDIC
1978	33.0	34.5	ISOHYPERTH.	330	7	23	330	7	23	30	30	75	0	ARIDIC
MEAN	32.9	35.0		341	12	5	341	12	5	13	13	90	0	ARIDIC
STAND.DEV.	0.3	0.4		22	21	11	22	21	11	15	15	36	0	
COEFF.VAR.				6	165	200	6	165	200	118	118	40	0	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81

DATE 03/25/82

STATION :AL ZUHRA

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1973	T		T		T			T	T	T			T	T	ARIDIC
1976	T		T		T			T	T	T		T	T	T	ARIDIC
1977	T		T		T			T	T	T		T	T	T	ARIDIC
1978	T		T		T			T	T	T			T	T	ARIDIC
FREQ.	100	0	100	0	100	0	0	100	100	100	0	50	100	100	
COND.	T		T		T			T	T	T		T	T	T	ARIDIC

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81

DATE 03/25/82

MOISTURE CONDITION CALENDARS
STATION:AL ZUHRA

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

```
DAYS                                          DAYS
--------->11-------->21------>30              --------->11-------->21------>30
          YEAR 1973                 MONTHS                YEAR 1976
          (ARIDIC  )                                      (ARIDIC  )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  APR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAY  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUL  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  AUG  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  SEP  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  OCT  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  NOV  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC  1111111111 1111111111 1111111111

          YEAR 1977                                       YEAR 1978
          (ARIDIC  )                                      (ARIDIC  )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  APR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAY  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUL  1111111111 1111133333 3333333333
1111111111 1111122222 2222222222  AUG  3333333322 2222211111 1111111111
2222222111 1111111111 1111111111  SEP  1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  OCT  1111111111 1111111111 1111111111
2222222111 1111111111 1111111111  NOV  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC  1111111111 1111111111 1111111111
```

THE CLASSIFICATION FOR 4 YEARS BETWEEN 1973 AND 1978 IS:ARIDIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

CLIMATE TABLE SET D: COMPUTATION TABLES BASED ON ONE YEAR OF OBSERVED RAINFALL AND CALCULATED TEMPERATURE DATA

The D set of tables includes stations for which one year of rainfall data only is available. For these stations, temperatures were calculated on the basis of elevation and the rainfall data were used to produce an estimate for the available year. The result is a climatic regime estimate and moisture calendar for the year of data.

STATIONS:

Al Mahweet	Wadi Al Har
Shihara	Washa

```
              STATION : AL MAHWEET        LATITUDE : 15  31  N

INPUT DATA:      JAN    FEB    MAR    APR    MAY    JUN    JUL    AUG    SEP    OCT    NOV    DEC
PRECIPITATION:   0.0    0.0    0.0    0.0    0.0   33.8   45.1  423.7    0.0  151.4    0.0    0.0
TEMPERATURE  :  12.7   14.5   16.6   17.2   19.1   19.9   20.0   19.4   18.3   16.2   13.6   13.6
****************************************************************************************************
OUTPUT     :     CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE
                 37.5   44.0   62.7   67.2   85.7   89.4   93.5   85.6   73.2   59.0   41.2   42.1
               ANNUAL RAINFALL : 654.0 MM        ANNUAL EVAPOTRANSPIRATION : 781.2 MM

      SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
     BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66
    ******************************************************************************
    *   MEAN SOIL TEMPERATURES   * SEASONS WHEN SOIL TEMPERATURE *               *
    *    (DEGREES CENTIGRADES)   *         IS HIGHER THAN        *               *
    **************************** FIVE DEGREES * EIGHT DEGREES *    REGIME     *
    *                      DIF- *               *               *               *
    *ANNUAL SUMMER WINTER FEREN ************************************************
    *                       CE  *BEGIN  LENGTH  *BEGIN  LENGTH  *               *
    *                           *        (DAYS) *        (DAYS) *               *
    * 19.3   21.2   17.1    4.1 *          360  *          360  *  ISOTHERMIC  *
    ******************************************************************************

                     MOISTURE CONDITION CALENDAR
              (1 = DRY      2 = PARTLY DRY      3 = MOIST)
             MONTH    1--------->11--------->21------>30  DAYS
              JAN     3333333333 3333333333 3333333333
              FEB     3333333333 3333333333 3333332222
              MAR     2222222222 2222222222 2222222222
              APR     2222222222 2222222221 1111111111
              MAY     1111111111 1111111111 1111111111
              JUN     1111111111 1111111111 1111111111
              JUL     1111111111 1111111111 1111111111
              AUG     1111112222 2222233333 3333333333
              SEP     3333333333 3333333333 3333333333
              OCT     3333333333 3333333333 3333333333
              NOV     3333333333 3333333333 3333333333
              DEC     3333333333 3333333333 3333333333

    ***************************************************************************
    *NUMBER OF CUMULATIVE DAYS THAT * HIGHEST NUMBER OF CONSE-*               *
    *THE MOISTURE CONTROL SECTION   *SECUTIVE DAYS THAT MCS IS*               *
    **********************************************************               *
    *DURING ONE YEAR*WHEN SOIL TEMP.* MOIST IN  * DRY  *MOIST * MOISTURE     *
    *      IS       *  ABOVE 5 DEG. *SOME PARTS *AFTER *AFTER *               *
    **********************************************************   REGIME     *
    * DRY MOIST MOI * DRY MOIST MOI * IN     WHEN*SUMMER*WINTER*               *
    *      OR    ST *      OR    ST * ONE    TEMP* SOL- * SOL- *               *
    *      DRY      *      DRY      *YEAR    > 8 *STICE *STICE *               *
    ***************************************************************************
    * 107   62  191 * 107   62  191 * 253 * 253 *  36  *  56  *  USTIC       *
    ***************************************************************************
    COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976                DATE :03/25/82
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SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

STATION : SHIHARA LATITUDE : 16 0 N

INPUT DATA:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRECIPITATION:	0.0	0.0	44.6	62.3	19.5	43.4	107.4	91.7	99.3	0.0	0.0	0.0
TEMPERATURE :	18.1	19.5	21.4	22.5	24.5	25.5	25.6	25.2	24.2	22.4	19.8	19.7

OUTPUT : CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE

48.8	55.6	80.1	92.2	122.8	132.6	138.9	128.5	109.3	88.5	60.4	60.8

ANNUAL RAINFALL : 468.2 MM ANNUAL EVAPOTRANSPIRATION :1118.4 MM

SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP. DATA
BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66

MEAN SOIL TEMPERATURES (DEGREES CENTIGRADES)				SEASONS WHEN SOIL TEMPERATURE IS HIGHER THAN FIVE DEGREES		EIGHT DEGREES		REGIME
ANNUAL	SUMMER	WINTER	DIF-FERENCE	BEGIN	LENGTH (DAYS)	BEGIN	LENGTH (DAYS)	
24.9	26.9	22.7	4.2		360		360	ISOHYPERTH.

MOISTURE CONDITION CALENDAR
(1 = DRY 2 = PARTLY DRY 3 = MOIST)

MONTH	1--------->11	--------->21	------>30	DAYS
JAN	1111111111	1111111111	1111111111	
FEB	1111111111	1111111111	1111111111	
MAR	1111111111	1111111111	1111111111	
APR	1111111111	1111122222	2222222222	
MAY	2211111111	1111111111	1111111111	
JUN	1111111111	1111111111	1111111111	
JUL	1111111111	1111122222	2222222222	
AUG	2222222222	1111122222	2222222222	
SEP	2222222211	1111122222	2222222222	
OCT	2222222222	2111111111	1111111111	
NOV	1111111111	1111111111	1111111111	
DEC	1111111111	1111111111	1111111111	

NUMBER OF CUMULATIVE DAYS THAT THE MOISTURE CONTROL SECTION IS				HIGHEST NUMBER OF CONSECUTIVE DAYS THAT MCS IS				MOISTURE REGIME
DURING ONE YEAR	WHEN SOIL TEMP. ABOVE 5 DEG.			MOIST IN SOME PARTS		DRY AFTER	MOIST AFTER	
DRY OR DRY	MOIST OR DRY	MOI ST	DRY OR DRY	MOIST OR DRY	MOI ST	IN ONE YEAR	WHEN TEMP > 8	SUMMER SOL-STICE	WINTER SOL-STICE	
269	91	0	269	91	0	26	26	19	0	ARIDIC

COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976 DATE :03/25/82

STATION : WADI-AL-HAR LATITUDE : 14 21 N

INPUT DATA:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRECIPITATION:	12.6	34.7	25.2	44.1	65.5	0.0	110.8	69.2	23.4	0.0	17.4	32.8
TEMPERATURE :	11.4	13.3	15.5	16.0	17.8	18.6	18.7	18.0	16.9	14.8	12.2	12.1

OUTPUT : CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE

36.5	42.2	60.5	63.6	78.6	82.6	84.9	79.3	68.5	55.8	39.8	39.7

ANNUAL RAINFALL : 435.7 MM ANNUAL EVAPOTRANSPIRATION : 732.0 MM

SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66

MEAN SOIL TEMPERATURES (DEGREES CENTIGRADES)				SEASONS WHEN SOIL TEMPERATURE IS HIGHER THAN			
ANNUAL	SUMMER	WINTER	DIFFERENCE	BEGIN	LENGTH (DAYS)	BEGIN	LENGTH (DAYS)	REGIME
17.9	19.9	15.8	4.1		360		360	ISOTHERMIC

FIVE DEGREES / EIGHT DEGREES

MOISTURE CONDITION CALENDAR
(1 = DRY 2 = PARTLY DRY 3 = MOIST)

MONTH	1-------->11-------->21------>30 DAYS
JAN	1111111111 1111111111 1111111111
FEB	1111111111 1111111111 1111111111
MAR	1111111111 1111111111 1111111111
APR	1111111111 1111111111 1111111111
MAY	1111111111 1111122222 2222222222
JUN	2222222111 1111111111 1111111111
JUL	1111111111 1111122222 2222222222
AUG	2222222222 2222222222 2222222222
SEP	2222222222 2222222222 2222222222
OCT	2222222111 1111111111 1111111111
NOV	1111111111 1111111111 1111111111
DEC	1111111111 1111111111 1111111111

NUMBER OF CUMULATIVE DAYS THAT THE MOISTURE CONTROL SECTION DURING ONE YEAR IS				WHEN SOIL TEMP. ABOVE 5 DEG.				HIGHEST NUMBER OF CONSECUTIVE DAYS THAT MCS IS SOME PARTS OR DRY				MOIST IN ONE YEAR				MOISTURE REGIME
DRY	MOIST	MOI	ST	DRY	MOIST	MOI	ST	DRY	MOIST	MOI	ST	WHEN TEMP > 8	SUMMER SOL-STICE	WINTER SOL-STICE		
256	104	0		256	104	0		82	82	23	0					ARIDIC

COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976 DATE :03/25/82

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

STATION : WASHA LATITUDE : 16 5 N

INPUT DATA:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRECIPITATION:	48.3	0.0	11.6	212.1	64.7	8.5	13.3	2.4	38.3	0.0	67.0	0.0
TEMPERATURE :	22.9	23.9	25.6	27.1	29.3	30.4	30.5	30.3	29.5	27.8	25.2	25.2

OUTPUT : CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE

70.5 78.5 117.3 145.1 172.5 175.1 185.0 175.1 162.1 145.1 101.5 103.7

ANNUAL RAINFALL : 466.2 MM ANNUAL EVAPOTRANSPIRATION :1631.4 MM

SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66

MEAN SOIL TEMPERATURES (DEGREES CENTIGRADES)				SEASONS WHEN SOIL TEMPERATURE IS HIGHER THAN				
				FIVE DEGREES		EIGHT DEGREES		REGIME
ANNUAL	SUMMER	WINTER	DIFFERENCE	BEGIN	LENGTH (DAYS)	BEGIN	LENGTH (DAYS)	
29.8	31.8	27.6	4.2		360		360	ISOHYPERTH.

MOISTURE CONDITION CALENDAR
(1 = DRY 2 = PARTLY DRY 3 = MOIST)

MONTH	1--------->11--------->21------->30 DAYS
JAN	1111111111 1111111111 1111111111
FEB	1111111111 1111111111 1111111111
MAR	1111111111 1111111111 1111111111
APR	1111111111 1111133333 3333333333
MAY	3333333333 3333333333 3333333222
JUN	2222211111 1111111111 1111111111
JUL	1111111111 1111111111 1111111111
AUG	1111111111 1111111111 1111111111
SEP	1111111111 1111111111 1111111111
OCT	1111111111 1111111111 1111111111
NOV	1111111111 1111122222 2222222222
DEC	2221111111 1111111111 1111111111

NUMBER OF CUMULATIVE DAYS THAT THE MOISTURE CONTROL SECTION DURING ONE YEAR IS			WHEN SOIL TEMP. ABOVE 5 DEG.	MOIST IN SOME PARTS	DRY AFTER	MOIST AFTER	MOISTURE REGIME
DRY OR	MOIST OR DRY	MOIST ST	IN ONE YEAR	WHEN TEMP > 8	SUMMER SOL-STICE	WINTER SOL-STICE	
292	26	42	292	26	42	50	50	120	15	ARIDIC

COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976 DATE :03/25/82

CLIMATE TABLE SET E: COMPUTATION TABLES BASED ON TWO OR THREE YEARS O OBSERVED RAINFALL AND CALCULATED TEMPERATURE DATA

The E set of tables includes stations for which either two or thre years of rainfall data was available. For these stations, it was no considered appropriate to produce the truth tables and moistur calenders for individual years as is done for the F set of tables However, estimates are made of the climatic regimes for each of th years for which rainfall data is available, and an overall estimate i given. Temperature data is estimated on the basis of elevation.

STATIONS:

Al Mahabisha	Huth
At Tur	Khamir
Bani Uwair	Sakain
Dawran	Shibam
Dhaf	Surdud
Hajjah	

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:AL MAHABISHA

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1975	22.5	24.5	ISOHYPERTH.	0	22	338	0	22	338	360	360	0	82	UDIC
1976	22.5	24.5	ISOHYPERTH.	0	100	260	0	100	260	360	360	0	42	USTIC
MEAN	22.5	24.5		0	61	299	0	61	299	360	360	0	62	USTIC
STAND.DEV.	0.0	0.0		0	55	55	0	55	55	0	0	0	28	
COEFF.VAR.				0	90	18	0	90	18	0	0	0	45	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81

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DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5;. SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:AT TUR

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	CUMULATIVE DAYS MCS IN ONE YEAR IS M/D	CUMULATIVE DAYS MCS IN ONE YEAR IS MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 M/D	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS WHEN SOIL TEMP > 8	MAX.CONSECUTIVE DAYS THAT MCS IS DRY AFTER SUMMER SOLST.	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1976	31.8	33.8	ISOHYPERTH.	245	94	21	245	94	21	28	28	21	0	AFIDIC
1977	31.8	33.8	ISOHYPERTH.	171	57	132	171	57	132	108	108	25	0	USTIC
MEAN	31.8	33.8		208	75	76	208	75	76	66	66	23	0	USTIC
STAND.DEV.	0.0	0.0		52	26	78	52	26	78	59	59	2	0	
COEFF.VAR.				25	34	102	25	34	102	89	89	12	0	

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SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:BANI UWAIR

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1975	19.3	21.2	ISOTHERMIC	272	88	0	272	88	0	46	46	45	0	ARIDIC
1976	19.3	21.2	ISOTHERMIC	360	0	0	360	0	0	0	0	120	0	ARIDIC
MEAN	19.3	21.2		316	44	0	316	44	0	23	23	82	0	ARIDIC
STAND.DEV.	0.0	0.0		62	62	0	62	62	0	32	32	53	0	
COEFF.VAR.				19	141	0	19	141	0	141	141	64	0	

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DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:DAWRAN

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1975	14.0	15.9	ISOMESIC	0	19	341	0	19	341	360	293	0	56	UDIC
1977	14.0	15.9	ISOMESIC	0	21	339	0	21	339	360	293	0	54	UDIC
MEAN	14.0	15.9		0	20	340	0	20	340	360	293	0	55	UDIC
STAND.DEV.	0.0	0.0		0	1	1	0	1	1	0	0	0	1	
COEFF.VAR.				0	7	0	0	7	0	0	0	0	2	

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SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:DHAP

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	CUMULATIVE DAYS MCS IN ONE YEAR IS M/D	CUMULATIVE DAYS MCS IN ONE YEAR IS MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 M/D	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS WHEN SOIL TEMP > 8	MAX.CONSECUTIVE DAYS THAT MCS IS DRY AFTER SUMMER SOLST.	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1978	15.8	17.7	ISOTHERMIC	310	50	0	310	50	0	50	50	120	0	ARIDIC
1979	15.8	17.7	ISOTHERMIC	281	79	0	281	79	0	29	29	50	0	ARIDIC
1980	15.8	17.7	ISOTHERMIC	325	35	0	325	35	0	35	35	45	0	ARIDIC
MEAN	15.8	17.7		305	54	0	305	54	0	38	38	71	0	ARIDIC
STAND.DEV.	0.0	0.0		22	22	0	22	22	0	10	10	41	0	
COEFF.VAR.				7	40	0	7	40	0	28	28	58	0	

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DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:HAJJAH

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	CUMULATIVE DAYS MCS IN ONE YEAR IS M/D	CUMULATIVE DAYS MCS IN ONE YEAR IS MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 M/D	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 MOI	MAX. CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	MAX. CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS WHEN SOIL TEMP > 8	MAX. CONSECUTIVE DAYS THAT MCS IS DRY AFTER SUMMER SOLST.	MAX. CONSECUTIVE DAYS THAT MCS IS MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1975	22.2	24.2	ISOHYPERTH.	150	123	87	150	123	87	167	167	15	0	USTIC
1976	22.2	24.2	ISOHYPERTH.	73	53	234	73	53	234	287	287	0	15	USTIC
MEAN	22.2	24.2		111	88	160	111	88	160	227	227	7	7	USTIC
STAND.DEV.	0.0	0.0		54	49	103	54	49	103	84	84	10	10	
COEFF.VAR.				48	56	64	48	56	64	37	37	141	141	

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SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:HUTH

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	CUMULATIVE DAYS MCS IN ONE YEAR IS M/D	CUMULATIVE DAYS MCS IN ONE YEAR IS MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 M/D	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS WHEN SOIL TEMP > 8	MAX.CONSECUTIVE DAYS THAT MCS IS DRY AFTER SUMMER SOLST.	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1975	20.9	22.9	ISOTHERMIC	360	0	0	360	0	0	0	0	120	0	ARIDIC
1976	20.9	22.9	ISOTHERMIC	324	36	0	324	36	0	36	36	120	0	ARIDIC
MEAN	20.9	22.9		342	18	0	342	18	0	18	18	120	0	ARIDIC
STAND.DEV.	0.0	0.0		25	25	0	25	25	0	25	25	0	0	
COEFF.VAR.				7	141	0	7	141	0	141	141	0	0	

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DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:KHAMIR

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY M/D	CUMULATIVE DAYS MCS IN ONE YEAR IS MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY M/D	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS OF ONE YEAR	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST WHEN SOIL TEMP > 8	MAX.CONSECUTIVE DAYS THAT MCS IS DRY AFTER SUMMER SOLST.	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1975	15.6	17.6	ISOTHERMIC	92 121 147	92 121 147			268	268	0	15	USTIC
1976	15.6	17.6	ISOTHERMIC	243 117 0	243 117 0			63	63	42	0	APIDIC
MEAN	15.6	17.6		167 119 73	167 119 73			165	165	21	7	USTIC
STAND.DEV.	0.0	0.0		106 2 103	106 2 103			144	144	29	10	
COEFF.VAR.				63 2 141	63 2 141			87	87	141	141	

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SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION: SAKAIN

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1975	18.4	20.4	ISOTHERMIC	98	114	148	98	114	148	262	262	0	15	USTIC
1976	18.4	20.4	ISOTHEEMIC	309	51	0	309	51	0	38	38	92	0	ARIDIC
MEAN	18.4	20.4		203	82	74	203	82	74	150	150	46	7	USTIC
STAND.DEV.	0.0	0.0		149	44	104	149	44	104	158	158	65	10	
COEFF.VAR.				73	53	141	73	53	141	105	105	141	141	

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DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:SHIBAM

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN YEAR IS ONE DRY	M/D	MOI	WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1975	15.6	17.6	ISOTHERMIC	0	141	219	0	141	219	360	360	0	16	USTIC
1976	15.6	17.6	ISOTHERMIC	20	209	131	20	209	131	340	340	5	16	USTIC
MEAN	15.6	17.6		10	175	175	10	175	175	350	350	2	16	USTIC
STAND.DEV.	0.0	0.0		14	48	62	14	48	62	14	14	3	0	
COEFF.VAR.				141	27	35	141	27	35	4	4	141	0	

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DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:SURDUD

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1973	31.5	33.5	ISOHYPERTH.	320	40	0	320	40	0	20	20	45	0	ARIDIC
1976	31.5	33.5	ISOHYPERTH.	325	35	0	325	35	0	12	12	75	0	ARIDIC
MEAN	31.5	33.5		322	37	0	322	37	0	16	16	60	0	ARIDIC
STAND.DEV.	0.0	0.0		3	3	0	3	3	0	5	5	21	0	
COEFF.VAR.				1	9	0	1	9	0	35	35	35	0	

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CLIMATE TABLE SET F: COMPUTATION TABLES BASED ON OVER THREE YEARS OF OBSERVED RAINFALL AND CALCULATED TEMPERATURE DATA

The F set of tables includes stations for which rainfall data was available for more than three years. For these stations, estimations of the climatic regimes, truth tables and soil moisture calendars are produced for each year. Temperature data was estimated on the basis of elevation.

STATIONS:

Ad-Darb	Rihab
Ash-Shagrab	Samah-Al-Uya
Beit Al Fatami	Sanaban
Beit Al Fuleih	Sumara
Dhamar	Udayn
Ibb	Yerim
Maram	Zabid
Rhizwa	Zabid Camp

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:AD-DARB

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1977	15.0	16.9	ISOMESIC	230	130	0	230	130	0	89	89	45	0	ARIDIC
1978	15.0	16.9	ISOMESIC	160	200	0	160	200	0	83	83	38	0	USTIC
1979	15.0	16.9	ISOMESIC	142	218	0	142	218	0	106	106	15	0	USTIC
1980	15.0	16.9	ISOMESIC	258	102	0	258	102	0	51	51	47	0	ARIDIC
MEAN	15.0	16.9		197	162	0	197	162	0	82	82	36	0	USTIC
STAND.DEV.	0.0	0.0		55	55	0	55	55	0	22	22	14	0	
COEFF.VAR.				28	34	0	28	34	0	27	27	40	0	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81 DATE 03/25/82

STATION :AD-DARB

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1977	T		T		T			T	T		T		T	T	ARIDIC
1978					T	T		T	T		T		T	T	USTIC
1979		T			T	T		T	T		T		T	T	USTIC
1980	T		T		T			T	T		T		T	T	ARIDIC
FREQ.	50	25	50	0	100	50	0	100	100	0	100	0	100	100	
COND.	T				T	T		T	T		T		T	T	USTIC

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81 DATE 03/25/82

MOISTURE CONDITION CALENDARS
STATION:AD-DARB

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

DAYS ---------->11--------->21------->30	YEAR 1977 (ARIDIC)		MONTHS	DAYS ---------->11--------->21------->30	YEAR 1978 (USTIC)	
2222222222	2222222222	2222222222	JAN	2222222222	2222222222	2222222222
2222222222	2222111111	1111111111	FEB	2222222222	2222222222	2222222222
1111111111	1111111111	1111111111	MAR	2222222211	1111122222	2222222222
1111111111	1111111111	1111111111	APR	2222222222	1111111111	1111111111
1111111111	1111111111	1111111111	MAY	1111111111	1111122222	2222222222
1111111111	1111111111	1111111111	JUN	2222222222	1111111111	1111111111
1111111111	1111111111	1111111111	JUL	1111111111	1111122222	2222222222
1111111111	1111122222	2222222222	AUG	2222222222	2222222222	2222222222
2222222222	2222222222	2222221111	SEP	2222222222	2222222222	2211111111
1111111111	1111111111	1111111111	OCT	1111111111	1111111111	1111111111
1111111111	1111122222	2222222222	NOV	1111111111	1111111111	1111111111
2222222222	2222222222	2222222222	DEC	1111111111	1111122222	2222222222

	YEAR 1979 (USTIC)				YEAR 1980 (ARIDIC)	
2222222222	2222222222	2222222222	JAN	1111111111	1111111111	1111111111
2222222222	2221111111	1111111111	FEB	1111111111	1111111111	1111111111
1111111111	1111122222	2222222222	MAR	1111111111	1111122222	2222222222
2222222222	2222222222	2222222111	APR	2222222222	2222222222	2222222222
1111111111	1111122222	2222222222	MAY	2222221111	1111111111	1111111111
2222222222	2211111111	1111111111	JUN	1111111111	1111111111	1111111111
1111111111	1111122222	2222222222	JUL	1111111111	1111122222	2222222222
2222222222	2222222222	2222222222	AUG	2222222211	1111122222	2222222222
2222222222	2222222222	2222222222	SEP	2222222222	2221111111	1111111111
2222222222	2222222222	2222222222	OCT	1111111111	1111111111	1111111111
2111111111	1111111111	1111111111	NOV	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	DEC	1111111111	1111111111	1111111111

THE CLASSIFICATION FOR 4 YEARS BETWEEN 1977 AND 1980 IS:USTIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:ASH-SHAGRAB

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1976	14.9	16.8	ISOMESIC	308	52	0	308	52	0	52	52	120	0	ARIDIC
1977	14.9	16.8	ISOMESIC	292	68	0	292	68	0	68	68	105	0	ARIDIC
1978	14.9	16.8	ISOMESIC	334	26	0	334	26	0	26	26	109	0	ARIDIC
1979	14.9	16.8	ISOMESIC	323	37	0	323	37	0	37	37	45	0	ARIDIC
1980	14.9	16.8	ISOMESIC	337	23	0	337	23	0	23	23	82	0	ARIDIC
MEAN	14.9	16.8		318	41	0	318	41	0	41	41	92	0	ARIDIC
STAND.DEV.	0.0	0.0		18	18	0	18	18	0	18	18	29	0	
COEFF.VAR.				5	45	0	5	45	0	45	45	32	0	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81 DATE 03/25/82

STATION :ASH-SHAGRAB

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1976	T		T		T			T	T	T	T		T	T	ARIDIC
1977	T		T		T			T	T	T	T		T	T	ARIDIC
1978	T		T		T			T	T	T	T		T	T	ARIDIC
1979	T		T		T			T	T	T	T		T	T	ARIDIC
1980	T		T		T			T	T	T	T		T	T	ARIDIC
FREQ.	100	0	100	0	100	0	0	100	100	100	100	0	100	100	
COND.	T		T		T			T	T	T	T		T	T	ARIDIC

COMPUTED BY FORTRAN PROGRAN VW18, NOV. 81 DATE 03/25/82

MOISTURE CONDITION CALENDARS
STATION:ASH-SHAGPAB

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

```
DAYS                                          DAYS
---------->11-------->21------>30             ---------->11-------->21------>30
           YEAR 1976                MONTHS                YEAR 1977
           (ARIDIC  )                                     (ARIDIC  )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  APR  1111111111 1111111111 1111111111
2222222222 2222222222 2222222222  MAY  1111111111 1111111111 1111111111
2222222111 1111111111 1111111111  JUN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUL  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  AUG  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  SEP  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  OCT  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  NOV  2222222222 2222222222 2222222222
1111111111 1111111111 1111111111  DEC  2222222222 2222222222 2221111111

           YEAR 1978                                      YEAR 1979
           (ARIDIC  )                                     (ARIDIC  )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  APR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAY  1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  JUN  1111111111 1111111111 1111111111
2222222222 2111111111 1111111111  JUL  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  AUG  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  SEP  2222222222 2222222222 2211111111
1111111111 1111111111 1111111111  OCT  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  NOV  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC  1111111111 1111111111 1111111111

                                 YEAR 1980
                                 (ARIDIC  )
                     JAN  1111111111 1111111111 1111111111
                     FEB  1111111111 1111111111 1111111111
                     MAR  1111111111 1111111111 1111111111
                     APR  1111111111 1111111111 1111111111
                     MAY  1111111111 1111111111 1111111111
                     JUN  1111111111 1111111111 1111111111
                     JUL  1111111111 1111122222 2222222222
                     AUG  2222222211 1111111111 1111111111
                     SEP  1111111111 1111111111 1111111111
                     OCT  1111111111 1111111111 1111111111
                     NOV  1111111111 1111111111 1111111111
                     DEC  1111111111 1111111111 1111111111
```

THE CLASSIFICATION FOR 5 YEARS BETWEEN 1976 AND 1980 IS:ARIDIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:BEIT AL-FATAMI

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1970	19.9	21.9	ISOTHERMIC	285	71	0	289	71	0	71	71	34	0	ARIDIC
1971	19.9	21.9	ISOTHERMIC	242	118	0	242	118	0	63	63	35	0	ARIDIC
1972	19.9	21.9	ISOTHERMIC	336	24	0	336	24	0	24	24	51	0	ARIDIC
1973	19.9	21.9	ISOTHERMIC	360	0	0	360	0	0	0	0	120	0	ARIDIC
1977	19.9	21.9	ISOTHERMIC	179	136	45	179	136	45	105	105	41	0	USTIC
MEAN	19.9	21.9		281	70	9	281	70	9	53	53	56	0	ARIDIC
STAND.DEV.	0.0	0.0		73	58	20	73	58	20	41	41	36	0	
COEFF.VAR.				25	82	222	25	82	222	86	86	61		

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81 DATE 03/25/82

STATION :BEIT AL-FATAMI

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1970	T				T			T	T	T	T		T	T	ARIDIC
1971	T				T			T	T		T		T	T	ARIDIC
1972	T		T		T			T	T	T	T		T	T	ARIDIC
1973	T		T		T			T	T	T	T		T	T	ARIDIC
1977		T			T	T		T	T		T		T	T	USTIC
FREQ.	80	20	40	0	100	20	0	100	100	60	100	0	100	100	
COND.	T				T			T	T	T	T		T	T	ARIDIC

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81 DATE 03/25/82

MOISTURE CONDITION CALENDARS
STATION:BEIT AL-FATAMI

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

```
---------->11-------->21------>30 DAYS  ---------->11-------->21------>30
           YEAR 1970            MONTHS             YEAR 1971
           (ARIDIC  )                              (ARIDIC  )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  APR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAY  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  JUN  2222222222 2222222222 2222222222
1111111111 1111122222 2222222222  JUL  2222222222 1111111111 1111111111
2222222222 2222222222 2222222222  AUG  1111111111 1111122222 2222222222
2222222222 2222222222 2222221111  SEP  2222222222 2222222222 2222222222
1111111111 1111111111 1111111111  OCT  2222222222 2222222211 1111111111
1111111111 1111111111 1111111111  NOV  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC  1111111111 1111111111 1111111111

           YEAR 1972                               YEAR 1973
           (ARIDIC  )                              (ARIDIC  )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  APR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAY  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUL  1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  AUG  1111111111 1111111111 1111111111
2222222221 1111111111 1111111111  SEP  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  OCT  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  NOV  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC  1111111111 1111111111 1111111111

                                  YEAR 1977
                                  (USTIC   )
                JAN  1111111111 1111111111 1111111111
                FEB  1111111111 1111111111 1111111111
                MAR  1111111111 1111111111 1111111111
                APR  1111111111 1111111111 1111111111
                MAY  1111111111 1111122222 2222222222
                JUN  2222222222 2211122222 2222222222
                JUL  2222222222 2222222222 2222222222
                AUG  2222111111 1111111111 1111111111
                SEP  1111111111 1111122222 2222222222
                OCT  2222222222 2222222222 2222222222
                NOV  2222222222 2222233333 3333333333
                DEC  3333333333 3333333333 3333333333
THE CLASSIFICATION FOR  5 YEARS BETWEEN 1970 AND 1977 IS:ARIDIC
COMPUTED BY PROGRAM VW 18,NOV 1981                        DATE 03/25/82
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MOISTURE CONDITION CALENDARS
STATION:BEIT AL-FULEIH

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

```
DAYS                                          DAYS
--------->11-------->21------>30              --------->11-------->21------>30
          YEAR 1970                                     YEAR 1971
          (ARIDIC  )                                    (ARIDIC  )

3333333333 3333333333 3333333333  JAN   1111111111 1111111111 1111111111
3332222222 2222222222 2222222111  FEB   1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  MAR   1111111111 1111111111 1111111111
2222222222 2222233333 3333333333  APR   1111111111 1111111111 1111111111
3333333333 3333333333 3333322222  MAY   1111111111 1111122222 2222222222
2222211111 1111122222 2222111111  JUN   2211111111 1111111111 1111111111
1111111111 1111122222 2222222111  JUL   1111111111 1111122222 2211111111
1111111111 1111122222 2222222222  AUG   1111111111 1111122222 2222222222
2222211111 1111111111 1111111111  SEP   2222222222 2222222222 2222222222
1111111111 1111111111 1111111111  OCT   2222111111 1111111111 1111111111
1111111111 1111111111 1111111111  NOV   1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC   1111111111 1111111111 1111111111

       YEAR 1972                                      YEAR 1973
       (ARIDIC  )                                     (ARIDIC  )
1111111111 1111111111 1111111111  JAN   1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB   1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR   1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  APR   1111111111 1111111111 1111111111
2211111111 1111122222 2222211111  MAY   1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUN   1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUL   1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  AUG   1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  SEP   2221111111 1111122222 2222111111
1111111111 1111111111 1111111111  OCT   1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  NOV   1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC   1111111111 1111111111 1111111111
```

THE CLASSIFICATION FOR 4 YEARS BETWEEN 1970 AND 1973 IS:ARIDIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:DHAMAR

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1976	14.9	16.8	ISOMESIC	102	132	126	102	132	126	217	217	8	15	USTIC
1977	14.9	16.8	ISOMESIC	135	21	204	135	21	204	225	225	0	0	USTIC
1978	14.9	16.8	ISOMESIC	86	154	120	86	154	120	247	247	15	34	USTIC
1979	14.9	16.8	ISOMESIC	161	199	0	161	199	0	128	128	15	0	USTIC
1980	14.9	16.8	ISOMESIC	205	88	67	205	88	67	126	126	15	0	USTIC
MEAN	14.9	16.8		137	118	103	137	118	103	188	188	10	9	USTIC
STAND.DEV.	0.0	0.0		47	67	75	47	67	75	57	57	6	15	
COEFF.VAR.				34	57	73	34	57	73	30	30	62	153	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81

DATE 03/25/82

STATION :DHAMAR

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1976		T			T	T		T	T		T		T	T	USTIC
1977		T			T	T		T			T		T	T	USTIC
1978		T			T	T		T	T		T		T	T	USTIC
1979		T			T	T		T	T		T		T	T	USTIC
1980	T	T			T			T	T		T		T	T	USTIC
FREQ.	20	100	0	0	100	80	0	100	80	0	100	0	100	100	
COND.		T			T	T		T	T		T		T	T	USTIC

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81

DATE 03/25/82

MOISTURE CONDITION CALENDARS
STATION:DHAMAR

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

```
DAYS                                          DAYS
--------->11-------->21------>30              --------->11-------->21------>30
          YEAR 1976                MONTHS                YEAR 1977
          (USTIC   )                                     (USTIC   )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  MAR  1111111111 1111111111 1111111111
2222222222 2222233333 3333333333  APR  1111111111 1111111111 1111111111
3333333333 3333333333 3333333333  MAY  1111111111 1111133333 3333333333
3333333333 3333333333 3333333333  JUN  3333333333 3333333333 3333333333
3333333332 2222222222 2222222222  JUL  3333333333 3333333333 3333222222
2222222222 2222233333 3333333333  AUG  2222222222 2222233333 3333333333
3333333333 3333333333 3333333222  SEP  3333333333 3333333333 3333333333
2222222222 2222222222 2211111111  OCT  3333333333 3333333333 3333333333
1111111111 1111122222 2222222222  NOV  3333333333 3333333333 3333333333
2222222222 2222222222 2222221111  DEC  3333333333 3333333333 3333333333

          YEAR 1978                                      YEAR 1979
          (USTIC   )                                     (USTIC   )
3333333333 3333333333 3333333333  JAN  2222222222 2222222222 2222222222
3333222222 2222222222 2222222222  FEB  2222222222 2222222211 1111111111
2222222222 2222222222 2211111111  MAR  1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  APR  1111111111 1111111111 1111111111
2222222222 2211111111 1111111111  MAY  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  JUN  2222222211 1111111111 1111111111
1111111111 1111122222 2222222222  JUL  1111111111 1111122222 2222222222
2222222222 2222233333 3333333333  AUG  2222222222 2222222222 2222222222
3333333333 3333333333 3333333333  SEP  2222222222 2222222222 2222222222
3333333333 3333333333 3333333333  OCT  2222222222 2222222222 2222222222
3333333333 3222222222 2222222222  NOV  2222222222 2222222222 2221111111
2222222222 2222222222 2222222222  DEC  1111111111 1111111111 1111111111

                         YEAR 1980
                         (USTIC   )
                JAN  1111111111 1111111111 1111111111
                FEB  1111111111 1111111111 1111111111
                MAR  1111111111 1111122222 2222222222
                APR  2222222222 2222111111 1111111111
                MAY  1111111111 1111111111 1111111111
                JUN  1111111111 1111111111 1111111111
                JUL  1111111111 1111122222 2222222222
                AUG  2222222222 2222233333 3333333333
                SEP  3333333333 3333333333 3333333333
                OCT  3333333333 3333333333 3322222222
                NOV  2222222222 2222222222 2111111111
                DEC  1111111111 1111111111 1111111111
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THE CLASSIFICATION FOR 5 YEARS BETWEEN 1976 AND 1980 IS:USTIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:IBB

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	CUMULATIVE DAYS MCS IN ONE YEAR IS M/D	CUMULATIVE DAYS MCS IN ONE YEAR IS MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 M/D	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 MOI	MAX.CONSECUTIVE DAYS THAT MCS IS IN SOME PARTS IN ONE YEAR	MAX.CONSECUTIVE DAYS THAT MCS IS WHEN SOIL TEMP > 8	MAX.CONSECUTIVE DAYS THAT MCS IS DRY AFTER SUMMER SOLST.	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1970	21.2	23.2	ISOTHERMIC	0	97	263	0	97	263	360	360	0	38	USTIC
1971	21.2	23.2	ISOTHERMIC	0	98	262	0	98	262	360	360	0	37	USTIC
1972	21.2	23.2	ISOTHERMIC	0	76	284	0	76	284	360	360	0	29	UDIC
1973	21.2	23.2	ISOTHERMIC	0	1	359	0	1	359	360	360	0	104	UDIC
1974	21.2	23.2	ISOTHERMIC	0	40	320	0	40	320	360	360	0	45	UDIC
1975	21.2	23.2	ISOTHERMIC	0	0	360	0	0	360	360	360	0	120	UDIC
1976	21.2	23.2	ISOTHERMIC	0	34	326	0	34	326	360	360	0	45	UDIC
1977	21.2	23.2	ISOTHERMIC	0	0	360	0	0	360	360	360	0	120	UDIC
MEAN	21.2	23.2		0	38	321	0	38	321	360	360	0	73	UDIC
STAND.DEV.	0.0	0.0		0	42	42	0	42	42	0	0	0	41	
COEFF.VAR.				0	109	13	0	109	13	0	0	0	56	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81

DATE 03/25/82

STATION :IBB

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1970		T			T	T		T			T		T	T	USTIC
1971		T			T	T		T			T		T	T	USTIC
1972		T				T					T		T	T	UDIC
1973		T		T		T					T		T	T	UDIC
1974		T		T		T					T		T	T	UDIC
1975		T		T		T					T		T	T	UDIC
1976		T		T		T					T		T	T	UDIC
1977		T		T		T					T		T	T	UDIC
FREQ.	0	100	0	63	25	100	0	25	0	0	100	0	100	100	
COND.		T		T		T					T		T	T	UDIC

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81

DATE 03/25/82

MOISTURE CONDITION CALENDARS
STATION:IBB

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

```
DAYS                                                DAYS
--------->11-------->21------>30                    --------->11-------->21------>30
          YEAR 1970                MONTHS                     YEAR 1971
          (USTIC   )                                          (USTIC   )
3333333333 3333333333 3333333333  JAN  3333333333 3333333333 3333333333
3333333322 2222222222 2222222222  FEB  3333333222 2222222222 2222222222
2222222222 2222222222 2222222222  MAR  2222222222 2222222222 2222222222
2222222222 2222222222 2222222222  APR  2222222222 2222222222 2222222222
2222222222 2222233333 3333333333  MAY  2222222222 2222233333 3333333333
3333333333 3333333333 3333333333  JUN  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  JUL  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  AUG  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  SEP  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  OCT  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  NOV  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  DEC  3333333333 3333333333 3333333333

          YEAR 1972                                           YEAR 1973
          (UDIC    )                                          (UDIC    )
3333333333 3333333333 3333333332  JAN  3333333333 3333333333 3333333333
2222222222 2222222222 2222222222  FEB  3333333333 3333333333 3333333333
2222222222 2222222222 2222222222  MAR  3333333333 3333333333 3333333333
2222222222 2222233333 3333333333  APR  3333333333 3333233333 3333333333
3333333333 3333333333 3333333333  MAY  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  JUN  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  JUL  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  AUG  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  SEP  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  OCT  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  NOV  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  DEC  3333333333 3333333333 3333333333

          YEAR 1974                                           YEAR 1975
          (UDIC    )                                          (UDIC    )
3333333333 3333333333 3333333333  JAN  3333333333 3333333333 3333333333
3333322222 2222222222 2222222222  FEB  3333333333 3333333333 3333333333
2222222222 2222233333 3333333333  MAR  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  APR  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  MAY  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  JUN  3333233333 3333333333 3333333333
3333333333 3333333333 3333333333  JUL  3333332333 3333333333 3333333333
3333333333 3333333333 3333333333  AUG  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  SEP  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  OCT  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  NOV  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  DEC  3333333333 3333333333 3333333333
```

COMPUTED BY PROGRAM VW 18,NOV 1981 DATE03/25/82

MOISTURE CONDITION CALENDARS ACCORDING TO
MATHEMATICAL MODEL OF F.NEWHALL(1972)

STATION:IBB

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

DAYS ---------->11--------->21------->30 YEAR 1976 (UDIC)			MONTHS	DAYS ---------->11--------->21------->30 YEAR 1977 (UDIC)		
3333333333	3333333333	3333333333	JAN	3333333333	3333333333	3333333333
3333333333	3222222222	2222222222	FEB	3333333333	3333333333	3333333333
2222222222	2222233333	3333333333	MAR	3333333333	3333333333	3333333333
3333333333	3333333333	3333333333	APR	3333333333	3333333333	3333333333
3333333333	3333333333	3333333333	MAY	3333333333	3333333333	3333333333
3333333333	3333333333	3333333333	JUN	3333333333	3333333333	3333333333
3333333333	3333333333	3333333333	JUL	3333333333	3333333333	3333333333
3333333333	3333333333	3333333333	AUG	3333333333	3333333333	3333333333
3333333333	3333333333	3333333333	SEP	3333333333	3333333333	3333333333
3333333333	3333333333	3333333333	OCT	3333333333	3333333333	3333333333
3333333333	3333333333	3333333333	NOV	3333333333	3333333333	3333333333
3333333333	3333333333	3333333333	DEC	3333333333	3333333333	3333333333

THE CLASSIFICATION FOR 8 YEARS BETWEEN 1970 AND 1977 IS:UDIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:MARAM

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	CUMULATIVE DAYS MCS IN ONE YEAR IS M/D	CUMULATIVE DAYS MCS IN ONE YEAR IS MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 M/D	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS WHEN SOIL TEMP > 8	MAX.CONSECUTIVE DAYS THAT MCS IS DRY AFTER SUMMER SOLST.	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1976	17.4	19.4	ISOTHERMIC	282	78	0	282	78	0	78	78	120	0	ARIDIC
1977	17.4	19.4	ISOTHERMIC	220	140	0	220	140	0	56	56	45	0	ARIDIC
1978	17.4	19.4	ISOTHERMIC	309	51	0	309	51	0	51	51	54	0	ARIDIC
1979	17.4	19.4	ISOTHERMIC	338	22	0	338	22	0	22	22	120	0	ARIDIC
1980	17.4	19.4	ISOTHERMIC	312	48	0	312	48	0	48	48	57	0	ARIDIC
MEAN	17.4	19.4		292	67	0	292	67	0	51	51	79	0	ARIDIC
STAND.DEV.	0.0	0.0		44	44	0	44	44	0	20	20	37	0	
COEFF.VAR.				15	66	0	15	66	0	39	39	47	0	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81 DATE 03/25/82

STATION :MARAM

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1976	T		T		T			T	T	T	T		T	T	ARIDIC
1977	T		T		T			T	T		T		T	T	ARIDIC
1978	T		T		T			T	T	T	T		T	T	ARIDIC
1979	T		T		T			T	T	T	T		T	T	ARIDIC
1980	T		T		T			T	T	T	T		T	T	ARIDIC
FREQ.	100	0	100	0	100	0	0	100	100	80	100	0	100	100	
COND.	T		T		T			T	T	T	T		T	T	ARIDIC

COMPUTED BY FORTRAN PROGRAN VW18, NOV. 81 DATE 03/25/82

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

MOISTURE CONDITION CALENDARS
STATION:MARAM

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

DAYS
---------->11-------->21------>30

YEAR 1976
(ARIDIC)

1111111111	1111111111	1111111111	JAN
1111111111	1111111111	1111111111	FEB
1111111111	1111122222	2222222222	MAR
2222222222	2222222222	2222222222	APR
2222222222	2222222222	2222222222	MAY
2221111111	1111111111	1111111111	JUN
1111111111	1111111111	1111111111	JUL
1111111111	1111111111	1111111111	AUG
1111111111	1111111111	1111111111	SEP
1111111111	1111111111	1111111111	OCT
1111111111	1111111111	1111111111	NOV
1111111111	1111111111	1111111111	DEC

DAYS
---------->11-------->21------>30

YEAR 1977
(ARIDIC)

1111111111	1111111111	1111111111	JAN
1111111111	1111111111	1111111111	FEB
1111111111	1111111111	1111111111	MAR
1111111111	1111111111	1111111111	APR
1111111111	1111122222	2222222222	MAY
2222222222	2222222222	2222222221	JUN
1111111111	1111111111	1111111111	JUL
1111111111	1111122222	2222222222	AUG
2222222222	2222222222	2222211111	SEP
1111111111	1111122222	2222222222	OCT
2222222222	2222222222	2222222222	NOV
2222222222	2111111111	1111111111	DEC

YEAR 1978
(ARIDIC)

1111111111	1111111111	1111111111	JAN
1111111111	1111111111	1111111111	FEB
1111111111	1111111111	1111111111	MAR
1111111111	1111111111	1111111111	APR
1111111111	1111111111	1111111111	MAY
1111111111	1111111111	1111111111	JUN
1111111111	1111122222	2222222222	JUL
2222222222	2222222222	2222222222	AUG
2222211111	1111111111	1111111111	SEP
1111111111	1111111111	1111111111	OCT
1111111111	1111111111	1111111111	NOV
1111111111	1111111111	1111111111	DEC

YEAR 1979
(ARIDIC)

1111111111	1111111111	1111111111	JAN
1111111111	1111111111	1111111111	FEB
1111111111	1111122222	2222222222	MAR
2222222111	1111111111	1111111111	APR
1111111111	1111111111	1111111111	MAY
1111111111	1111111111	1111111111	JUN
1111111111	1111111111	1111111111	JUL
1111111111	1111111111	1111111111	AUG
1111111111	1111111111	1111111111	SEP
1111111111	1111111111	1111111111	OCT
1111111111	1111111111	1111111111	NOV
1111111111	1111111111	1111111111	DEC

YEAR 1980
(ARIDIC)

1111111111	1111111111	1111111111	JAN
1111111111	1111111111	1111111111	FEB
1111111111	1111111111	1111111111	MAR
1111111111	1111111111	1111111111	APR
1111111111	1111111111	1111111111	MAY
1111111111	1111111111	1111111111	JUN
1111111111	1111122222	2222222222	JUL
2222222222	2222222222	2222222222	AUG
2221111111	1111111111	1111111111	SEP
1111111111	1111111111	1111111111	OCT
1111111111	1111111111	1111111111	NOV
1111111111	1111111111	1111111111	DEC

THE CLASSIFICATION FOR 5 YEARS BETWEEN 1976 AND 1980 IS:ARIDIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:RHIZWA

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1976	17.3	19.3	ISOTHERMIC	179	181	0	179	181	0	100	100	45	0	USTIC
1977	17.3	19.3	ISOTHERMIC	69	118	173	69	118	173	291	291	0	0	USTIC
1978	17.3	19.3	ISOTHERMIC	311	49	0	341	49	0	29	29	120	0	ARIDIC
1979	17.3	19.3	ISOTHERMIC	287	73	0	287	73	0	46	46	45	0	ARIDIC
1980	17.3	19.3	ISOTHERMIC	243	117	0	243	117	0	73	73	45	0	ARIDIC
MEAN	17.3	19.3		217	107	34	217	107	34	107	107	51	0	ARIDIC
STAND.DEV.	0.0	-0.0		97	50	77	97	50	77	105	105	43	0	
COEFF.VAR.				44	46	223	44	46	223	98	98	84	0	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81 DATE 03/25/82

STATION :RHIZWA

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1976		T	T		T	T		T	T		T		T	T	USTIC
1977		T			T	T		T			T		T	T	USTIC
1978	T		T		T			T	T	T	T		T	T	ARIDIC
1979	T		T		T			T	T	T	T		T	T	ARIDIC
1980	T		T		T			T	T		T		T	T	ARIDIC
FREQ.	60	40	80	0	100	40	0	100	80	40	100	0	100	100	
COND.	T		T		T			T	T		T		T	T	ARIDIC

COMPUTED BY FORTRAN PROGRAN VW18, NOV. 81 DATE 03/25/82

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

MOISTURE CONDITION CALENDARS
STATION:RHIZWA

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

YEAR 1976 (USTIC)

DAYS ---------->11	--------->21	------>30	MONTHS
2222211111	1111111111	1111111111	JAN
1111111111	1111111111	1111111111	FEB
1111111111	1111122222	2222222222	MAR
2222222222	2222222222	2222222222	APR
2222222222	2222222222	2222222222	MAY
2222222222	2222222222	2222211111	JUN
1111111111	1111111111	1111111111	JUL
1111111111	1111122222	2222222222	AUG
2222222222	2222221111	1111111111	SEP
1111111111	1111111111	1111111111	OCT
1111111111	1111122222	2222222222	NOV
2222222222	2222222222	2222222222	DEC

YEAR 1977 (USTIC)

DAYS ---------->11	--------->21	------>30
2222221111	1111111111	1111111111
1111111111	1111111111	1111111111
1111111111	1111122222	2222222222
2222222222	2222222222	2222222222
2222222222	2222233333	3333333333
3333333333	3333333333	3333333333
3333333333	3333333333	3333333333
3333332222	2222233333	3333333333
3333333222	2222222222	2222222222
2222222222	2222233333	3333333333
3333333333	3333333333	3333333333
3333333333	3333333333	3333322222

YEAR 1978 (ARIDIC)

2222222222	2222222222	2222222221	JAN
1111111111	1111111111	1111111111	FEB
1111111111	1111111111	1111111111	MAR
1111111111	1111122222	2222222222	APR
2222211111	1111111111	1111111111	MAY
1111111111	1111111111	1111111111	JUN
1111111111	1111111111	1111111111	JUL
1111111111	1111111111	1111111111	AUG
1111111111	1111111111	1111111111	SEP
1111111111	1111111111	1111111111	OCT
1111111111	1111111111	1111111111	NOV
1111111111	1111111111	1111111111	DEC

YEAR 1979 (ARIDIC)

1111111111	1111111111	1111111111
1111111111	1111111111	1111111111
1111111111	1111111111	1111111111
1111111111	1111111111	1111111111
1111111111	1111122222	2222222222
2222222222	2211111111	1111111111
1111111111	1111111111	1111111111
1111111111	1111122222	2222222222
2222222222	2222222222	2222222222
2111111111	1111111111	1111111111
1111111111	1111111111	1111111111
1111111111	1111111111	1111111111

YEAR 1980 (ARIDIC)

JAN	1111111111	1111111111	1111111111
FEB	1111111111	1111111111	1111111111
MAR	1111111111	1111111111	1111111111
APR	1111111111	1111122222	2222222222
MAY	2222222222	2222222222	2222222222
JUN	2222222222	2222222222	2222222211
JUL	1111111111	1111111111	1111111111
AUG	1111111111	1111122222	2222222222
SEP	2222222222	2222222222	2222222221
OCT	1111111111	1111111111	1111111111
NOV	1111111111	1111111111	1111111111
DEC	1111111111	1111111111	1111111111

THE CLASSIFICATION FOR 5 YEARS BETWEEN 1976 AND 1980 IS:ARIDIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:RIHAB

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN YEAR IS ONE DRY	M/D	MOI	WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX. CONSECUTIVE DAYS THAT MCS IS MOIST IN ONE YEAR	MOIST IN SOME PARTS WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1970	23.2	25.2	ISOHYPERTH.	251	109	0	251	109	0	45	45	30	0	ARIDIC
1971	23.2	25.2	ISOHYPERTH.	135	45	180	135	45	180	225	225	0	0	USTIC
1972	23.2	25.2	ISOHYPERTH.	115	94	151	115	94	151	176	176	15	3	USTIC
1973	23.2	25.2	ISOHYPERTH.	180	180	0	180	180	0	55	55	35	0	UNDEFIN.
1974	23.2	25.2	ISOHYPERTH.	241	68	51	241	68	51	97	97	15	0	USTIC
1975	23.2	25.2	ISOHYPERTH.	263	97	0	263	97	0	28	28	17	0	ARIDIC
1976	23.2	25.2	ISOHYPERTH.	309	51	0	309	51	0	19	19	28	0	ARIDIC
MEAN	23.2	25.2		211	84	64	211	84	64	97	97	19	0	ARIDIC
STAND.DEV.	0.0	0.0		66	47	78	66	47	78	75	75	11	0	
COEFF.VAR.				31	56	120	31	56	120	76	76	55	0	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81 DATE 03/25/82

STATION :RIHAB

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1970	T				T			T	T				T	T	ARIDIC
1971		T			T	T		T					T	T	USTIC
1972		T			T	T		T					T	T	USTIC
1973					T			T	T				T	T	UNDEFIN.
1974	T	T			T			T	T				T	T	USTIC
1975	T				T			T	T				T	T	ARIDIC
1976	T				T			T	T	T			T	T	ARIDIC
FREQ.	57	43	0	0	100	29	0	100	71	14	0	0	100	100	
COND.	T				T			T	T				T	T	ARIDIC

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81 DATE 03/25/82

MOISTURE CONDITION CALENDARS
STATION:RIHAB

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

```
---------->11-------->21------>30 DAYS  ---------->11-------->21------>30
           YEAR 1970            MONTHS             YEAR 1971
           (ARIDIC  )                              (USTIC   )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  APR  1111111111 1111111111 1111111111
2222222111 1111122222 2222222222  MAY  1111111111 1111133333 3333333333
2222222211 1111111111 1111111111  JUN  3333333333 3333333333 3333333333
1111111111 1111122222 2222222222  JUL  3333333333 3333333333 3333333333
2222111111 1111122222 2222222222  AUG  3333333333 3333333333 3333333333
2222222222 2222222222 2222222222  SEP  3322222222 2222233333 3333333333
1111111111 1111111111 1111111111  OCT  3333333333 3332222222 2222222222
1111111111 1111111111 1111111111  NOV  2222222222 2222233333 3333333333
1111111111 1111111111 1111111111  DEC  3333333333 3333333333 3333333333

           YEAR 1972                               YEAR 1973
           (USTIC   )                              (UNDEFIN.)
3332222222 2111111111 1111111111  JAN  2222222222 2222222222 2222222222
1111111111 1111111111 1111111111  FEB  2222222222 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  APR  1111111111 1111122222 2222222222
2222222222 2222222222 2222222222  MAY  2221111111 1111122222 2222222222
2222222222 2222222222 2222111111  JUN  2222222222 2211122222 2222222222
1111111111 1111133333 3333333333  JUL  2222222222 2222222222 2222222222
3333333333 3333333333 3333333333  AUG  2222222222 1111122222 2222222222
3333333333 3333333333 3333333333  SEP  2222222222 2222222222 2222211111
3333333333 3333333333 3333333333  OCT  1111111111 1111111111 1111111111
3333333333 3333333333 3333333333  NOV  1111111111 1111111111 1111111111
3333333333 3332222222 2222222222  DEC  1111111111 1111111111 1111111111

           YEAR 1974                               YEAR 1975
           (USTIC   )                              (ARIDIC  )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  MAR  1111111111 1111111111 1111111111
2222222111 1111111111 1111111111  APR  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  MAY  2222221111 1111111111 1111111111
1111111111 1111111111 1111111111  JUN  1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  JUL  1111111111 1111122222 2222222222
2222222222 2222233333 3333333333  AUG  2222222221 1111122222 2222222222
3333333333 3333333333 3333333333  SEP  2222222221 1111122222 2222222222
3333332222 2222222222 2211111111  OCT  2222222222 2221111111 1111111111
1111111111 1111111111 1111111111  NOV  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC  1111111111 1111111111 1111111111
```

COMPUTED BY PROGRAM VW 18,NOV 1981 DATE03/25/82

MOISTURE CONDITION CALENDARS ACCORDING TO
MATHEMATICAL MODEL OF F.NEWHALL(1972)

STATION:RIHAB

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

YEAR 1976
(ARIDIC)

```
                 DAYS
        --------->11-------->21------->30
JAN     1111111111 1111111111 1111111111
FEB     1111111111 1111111111 1111111111
MAR     1111111111 1111111111 1111111111
APR     1111111111 1111111111 1111111111
MAY     1111111111 1111111111 1111111111
JUN     1111111111 1111111111 1111111111
JUL     1111111111 1111122222 2222222222
AUG     2222111111 1111122222 2222222222
SEP     1111111111 1111122222 2222222222
OCT     2211111111 1111111111 1111111111
NOV     1111111111 1111111111 1111111111
DEC     1111111111 1111111111 1111111111
```

THE CLASSIFICATION FOR 7 YEARS BETWEEN 1970 AND 1976 IS:ARIDIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:SAMAH-AL-UYA

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1976	16.4	18.4	ISOTHERMIC	316	44	0	316	44	0	24	24	81	0	ARIDIC
1977	16.4	18.4	ISOTHERMIC	193	92	75	193	92	75	135	135	45	0	USTIC
1978	16.4	18.4	ISOTHERMIC	247	94	19	247	94	19	71	71	63	19	ARIDIC
1979	16.4	18.4	ISOTHERMIC	246	114	0	246	114	0	56	56	45	0	ARIDIC
1980	16.4	18.4	ISOTHERMIC	257	103	0	257	103	0	73	73	45	0	ARIDIC
MEAN	14.9	16.8		251	89	18	251	89	18	71	71	55	3	ARIDIC
STAND.DEV.	0.0	0.0		43	26	32	43	26	32	40	40	16	8	
COEFF.VAR.				17	30	172	17	30	172	56	56	28	223	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81 DATE 03/25/82

STATION :SAMAH-AL-UYA

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1976	T		T		T			T	T	T	T		T	T	ARIDIC
1977	T	T	T		T			T	T		T		T	T	USTIC
1978	T		T		T			T	T		T		T	T	ARIDIC
1979	T		T		T			T	T		T		T	T	ARIDIC
1980	T		T		T			T	T		T		T	T	ARIDIC
FREQ.	100	20	100	0	100	0	0	100	100	20	100	0	100	100	
COND.	T		T		T			T	T		T		T	T	ARIDIC

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81 DATE 03/25/82

MOISTURE CONDITION CALENDARS
STATION:SAMAH-AL-UYA

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

```
DAYS                                          DAYS
---------->11-------->21------>30             --------->11-------->21------>30
           YEAR 1976                MONTHS                YEAR 1977
           (ARIDIC  )                                     (USTIC   )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  APR  1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  MAY  1111111111 1111122222 2222222222
2222211111 1111111111 1111111111  JUN  2222222222 2222222111 1111111111
1111111111 1111122222 2222222222  JUL  1111111111 1111111111 1111111111
2222222221 1111111111 1111111111  AUG  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  SEP  2222222222 2222222222 2222222222
1111111111 1111111111 1111111111  OCT  2222222222 2222233333 3333333333
1111111111 1111111111 1111111111  NOV  3333333333 3333333333 3333333333
1111111111 1111111111 1111111111  DEC  3333333333 3333333333 3333333333

           YEAR 1978                                      YEAR 1979
           (ARIDIC  )                                     (ARIDIC  )
3333333333 3333333332 2222222222  JAN  1111111111 1111111111 1111111111
2222222222 2222222222 2222222222  FEB  1111111111 1111111111 1111111111
2222222222 2111111111 1111111111  MAR  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  APR  2222222222 2222211111 1111111111
1111111111 1111111111 1111111111  MAY  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  JUN  2222222222 2221111111 1111111111
1111111111 1111122222 2222222222  JUL  1111111111 1111111111 1111111111
2222222222 2222222222 2222222111  AUG  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  SEP  2222222222 2222222222 2222222222
1111111111 1111111111 1111111111  OCT  2222222222 2111111111 1111111111
1111111111 1111111111 1111111111  NOV  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC  1111111111 1111111111 1111111111

                         YEAR 1980
                         (ARIDIC  )
                JAN  1111111111 1111111111 1111111111
                FEB  1111111111 1111111111 1111111111
                MAR  1111111111 1111122222 2222222222
                APR  2222222222 2222222222 2222222222
                MAY  2222222222 2222222222 2222222211
                JUN  1111111111 1111111111 1111111111
                JUL  1111111111 1111111111 1111111111
                AUG  1111111111 1111122222 2222222222
                SEP  2222222222 2222211111 1111111111
                OCT  1111111111 1111111111 1111111111
                NOV  1111111111 1111111111 1111111111
                DEC  1111111111 1111111111 1111111111
```

THE CLASSIFICATION FOR 5 YEARS BETWEEN 1976 AND 1980 IS:ARIDIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION: SANABEN

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX. CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1976	16.6	18.6	ISOTHERMIC	310	50	0	310	50	0	50	50	120	0	ARIDIC
1977	16.6	18.6	ISOTHERMIC	211	87	62	211	87	62	75	75	45	0	ARIDIC
1978	16.6	18.6	ISOTHERMIC	276	73	11	276	73	11	43	43	64	11	ARIDIC
1979	16.6	18.6	ISOTHERMIC	360	0	0	360	0	0	0	0	120	0	ARIDIC
1980	16.6	18.6	ISOTHERMIC	301	59	0	301	59	0	35	35	51	0	ARIDIC
MEAN	16.6	18.6		291	53	14	291	53	14	40	40	80	2	ARIDIC
STAND.DEV.	0.0	0.0		54	33	26	54	33	26	27	27	37	4	
COEFF.VAR.				18	61	184	18	61	184	66	66	46	223	

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81 DATE 03/25/82

STATION : SANABAN

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
	OCCURENCE OF CONDITION														
1976	T		T		T			T	T	T	T		T	T	ARIDIC
1977	T		T		T			T	T		T		T	T	ARIDIC
1978	T		T		T			T	T	T	T		T	T	ARIDIC
1979	T		T		T			T	T	T	T		T	T	ARIDIC
1980	T		T		T			T	T	T	T		T	T	ARIDIC
FREQ.	100	0	100	0	100	0	0	100	100	80	100	0	100	100	
COND.	T		T		T			T	T	T	T		T	T	ARIDIC

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81 DATE 03/25/82

MOISTURE CONDITION CALENDARS
STATION:SANABAN

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

```
DAYS                                          DAYS
--------->11-------->21------>30              --------->11-------->21------>30
          YEAR 1976                MONTHS                YEAR 1977
          (ARIDIC  )                                     (ARIDIC  )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  APR  1111111111 1111111111 1111111111
2222222222 2222222222 2222222222  MAY  1111111111 1111122222 2222222222
2222211111 1111111111 1111111111  JUN  2222222222 2222222111 1111111111
1111111111 1111111111 1111111111  JUL  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  AUG  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  SEP  2222222222 2222222222 2222222111
1111111111 1111111111 1111111111  OCT  1111111111 1111122222 2222222233
1111111111 1111111111 1111111111  NOV  3333333333 3333333333 3333333333
1111111111 1111111111 1111111111  DEC  3333333333 3333333333 3333333333

          YEAR 1978                                      YEAR 1979
          (ARIDIC  )                                     (ARIDIC  )
3333333333 3222222222 2222222222  JAN  1111111111 1111111111 1111111111
2222222222 2221111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  APR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAY  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUN  1111111111 1111111111 1111111111
1111111111 1111122222 2222222222  JUL  1111111111 1111111111 1111111111
2222222222 2222222222 2222221111  AUG  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  SEP  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  OCT  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  NOV  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC  1111111111 1111111111 1111111111

                         YEAR 1980
                         (ARIDIC  )
                JAN  1111111111 1111111111 1111111111
                FEB  1111111111 1111111111 1111111111
                MAR  1111111111 1111122222 2222222222
                APR  2222222222 2222222222 1111111111
                MAY  1111111111 1111111111 1111111111
                JUN  1111111111 1111111111 1111111111
                JUL  1111111111 1111111111 1111111111
                AUG  1111111111 1111122222 2222222222
                SEP  2222222221 1111111111 1111111111
                OCT  1111111111 1111111111 1111111111
                NOV  1111111111 1111111111 1111111111
                DEC  1111111111 1111111111 1111111111
```

THE CLASSIFICATION FOR 5 YEARS BETWEEN 1976 AND 1980 IS:ARIDIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:SUMARA

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1970	21.2	23.2	ISOTHERMIC	0	71	289	0	71	289	360	360	0	45	UDIC
1971	21.2	23.2	ISOTHERMIC	20	111	229	20	111	229	340	340	0	4	USTIC
1972	21.2	23.2	ISOTHERMIC	0	72	288	0	72	288	360	360	0	27	UDIC
1973	21.2	23.2	ISOTHERMIC	52	131	177	52	131	177	308	308	15	70	USTIC
1974	21.2	23.2	ISOTHERMIC	244	61	55	244	61	55	106	106	15	0	USTIC
1975	21.2	23.2	ISOTHERMIC	126	98	136	126	98	136	165	165	15	0	USTIC
1976	21.2	23.2	ISOTHERMIC	0	137	223	0	137	223	360	360	0	15	USTIC
MEAN	21.2	23.2		63	97	199	63	97	199	285	285	6	23	USTIC
STAND.DEV.	0.0	0.0		91	30	84	91	30	84	105	105	8	26	
COEFF.VAR.				145	31	42	145	31	42	36	36	124	114	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81

DATE 03/25/82

STATION :SUMARA

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1970		T		T		T					T		T	T	UDIC
1971		T			T	T		T			T		T	T	USTIC
1972		T				T					T		T	T	UDIC
1973		T		T	T	T		T			T		T	T	USTIC
1974	T	T			T			T	T		T		T	T	USTIC
1975		T			T	T		T	T		T		T	T	USTIC
1976		T			T	T		T			T		T	T	USTIC
FREQ.	14	100	0	29	71	86	0	71	29	0	100	0	100	100	
COND.		T			T	T		T			T		T	T	USTIC

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81

DATE 03/25/82

MOISTURE CONDITION CALENDARS
STATION:SUMARA

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

```
DAYS                                          DAYS
--------->11-------->21------>30              --------->11-------->21------>30
          YEAR 1970                MONTHS                YEAR 1971
          (UDIC    )                                      (USTIC    )
3333222222 2222222222 2222222222  JAN  3333222222 2222222222 2222222222
2222222222 2222222222 2222222222  FEB  2222222222 2222222222 2222222222
2222222222 2222233333 3333333333  MAR  2222222222 2222222222 2222211111
3333333333 3333333333 3333333333  APR  1111111111 1111122222 2222222222
3333333333 3333333333 3333333333  MAY  2222222222 2222233333 3333333333
3333333333 3333333333 3333333333  JUN  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  JUL  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  AUG  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  SEP  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  OCT  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  NOV  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  DEC  3333333333 3333333333 3333333333

          YEAR 1972                                      YEAR 1973
          (UDIC    )                                      (USTIC    )
3333333333 3333333333 3333333222  JAN  3333333333 3333333333 3333333333
2222222222 2222222222 2222222222  FEB  3333333333 3333333333 3333333333
2222222222 2222222222 2222222222  MAR  3333333333 2222222222 2222222222
2222222223 3333333333 3333333333  APR  2222222222 2222222222 2222222222
3333333333 3333333333 3333333333  MAY  2222222222 2222222222 2221111111
3333333333 3333333333 3333333333  JUN  1111111111 1111111111 1111111111
3333333333 3333333333 3333333333  JUL  1111111111 1111122222 2222222222
3333333333 3333333333 3333333333  AUG  2222222222 2222233333 3333333333
3333333333 3333333333 3333333333  SEP  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  OCT  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  NOV  3333333333 3333333333 3333333333
3333333333 3333333333 3333333333  DEC  3322222222 2222222222 2222222222

          YEAR 1974                                      YEAR 1975
          (USTIC    )                                    (USTIC    )
2222222222 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  APR  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  MAY  2222222222 2222222222 2222222222
1111111111 1111111111 1111111111  JUN  2222222222 2222222222 2222111111
1111111111 1111122222 2222222222  JUL  1111111111 1111122222 2222222222
2222222222 2222233333 3333333333  AUG  2222222222 2223333333 3333333333
3333333333 3333333333 3333333333  SEP  3333333333 3333333333 3333333333
3333333333 2222222222 2222222222  OCT  3333333333 3333333333 3333333333
2111111111 1111111111 1111111111  NOV  3333333333 3333333333 3333333333
1111111111 1111111111 1111111111  DEC  3333333333 3333333333 3333333332
```

COMPUTED BY PROGRAM VW 18,NOV 1981 DATE03/25/82

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

MOISTURE CONDITION CALENDARS ACCORDING TO
MATHEMATICAL MODEL OF F.NEWHALL(1972)

STATION:SUMARA

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

YEAR 1976
(USTIC)

```
DAYS
---------->11-------->21------>30
           JAN  2222222222 2222222222 2222222222
           FEB  2222222222 2222222222 2222222222
           MAR  2222222222 2222222222 2222222222
           APR  2222222222 2222233333 3333333333
           MAY  3333333333 3333333333 3333333333
           JUN  3333333333 3333333333 3333333333
           JUL  3333333333 3333333333 3333333333
           AUG  3333333333 3333333333 3333333333
           SEP  3333333333 3333333333 3333333333
           OCT  3333333333 3333333333 3333333333
           NOV  3333333333 3333333333 3333333322
           DEC  2222222222 2222222222 2222222222
```

THE CLASSIFICATION FOR 7 YEARS BETWEEN 1970 AND 1976 IS:USTIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

MOISTURE CONDITION CALENDARS ACCORDING TO
MATHEMATICAL MODEL OF F.NEWHALL(1972)

STATION:SUMARA

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

YEAR 1976
(USTIC)

```
DAYS
--------->11-------->21------>30
          JAN  2222222222 2222222222 2222222222
          FEB  2222222222 2222222222 2222222222
          MAR  2222222222 2222222222 2222222222
          APR  2222222222 2222233333 3333333333
          MAY  3333333333 3333333333 3333333333
          JUN  3333333333 3333333333 3333333333
          JUL  3333333333 3333333333 3333333333
          AUG  3333333333 3333333333 3333333333
          SEP  3333333333 3333333333 3333333333
          OCT  3333333333 3333333333 3333333333
          NOV  3333333333 3333333333 3333333322
          DEC  2222222222 2222222222 2222222222
```

THE CLASSIFICATION FOR 7 YEARS BETWEEN 1970 AND 1976 IS:USTIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:UDAIN

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1970	23.2	25.2	ISOHYPERTH.	246	114	0	246	114	0	42	42	48	0	ARIDIC
1971	23.2	25.2	ISOHYPERTH.	269	91	0	269	91	0	26	26	41	0	ARIDIC
1972	23.2	25.2	ISOHYPERTH.	286	74	0	286	74	0	27	27	65	0	ARIDIC
1973	23.2	25.2	ISOHYPERTH.	229	74	57	229	74	57	74	74	15	0	ARIDIC
1974	23.2	25.2	ISOHYPERTH.	313	47	0	313	47	0	24	24	112	0	ARIDIC
1977	23.2	25.2	ISOHYPERTH.	105	30	225	105	30	225	255	255	0	0	USTIC
MEAN	23.2	25.2		207	78	74	207	78	74	115	115	40	10	ARIDIC
STAND.DEV.	0.0	0.0		112	33	108	112	33	108	135	135	40	26	
COEFF.VAR.				54	42	147	54	42	147	117	117	100	264	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81 DATE 03/25/82

STATION :UDAIN

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1970	T		T		T			T	T				T	T	ARIDIC
1971	T				T			T	T				T	T	ARIDIC
1972	T		T		T			T	T	T			T	T	ARIDIC
1973	T				T			T	T				T	T	ARIDIC
1974	T		T		T			T	T	T			T	T	ARIDIC
1977		T			T	T		T					T	T	USTIC
FREQ.	83	16	50	0	100	17	0	100	83	33	0	0	100	100	
COND.	T		T		T			T	T				T	T	ARIDIC

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81 DATE 03/25/82

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

MOISTURE CONDITION CALENDARS
STATION:UDAIN

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

YEAR 1970 (ARIDIC)			MONTHS	YEAR 1971 (ARIDIC)		
---------->11	--------->21	------>30 DAYS		---------->11	--------->21	------>30
1111111111	1111111111	1111111111	JAN	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	FEB	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	MAR	1111111111	1111111111	1111111111
1111111111	1111122222	2222222222	APR	1111111111	1111111111	1111111111
2222222222	2111122222	2222221111	MAY	1111111111	1111122222	2222222222
1111111111	1111111111	1111111111	JUN	2222222111	1111122222	2222222222
1111111111	1111122222	2222222222	JUL	2222111111	1111111111	1111111111
2222222222	2222222222	2222222111	AUG	1111111111	1111122222	2222222222
1111111111	1111111111	1111111111	SEP	2222222222	2111122222	2222222222
1111111111	1111122222	2222222222	OCT	2222222221	1111111111	1111111111
2222222222	2222222222	1111111111	NOV	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	DEC	1111111111	1111111111	1111111111

YEAR 1972 (ARIDIC)				YEAR 1973 (ARIDIC)		
1111111111	1111111111	1111111111	JAN	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	FEB	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	MAR	1111111111	1111111111	1111111111
1111111111	1111122222	2222222222	APR	1111111111	1111111111	1111111111
2222222222	2211111111	1111111111	MAY	1111111111	1111122222	2222222222
1111111111	1111122222	2222222222	JUN	2222221111	1111122222	2222211111
2111111111	1111122222	2222222222	JUL	1111111111	1111122222	2222222222
2222221111	1111122222	2222211111	AUG	2222222222	2111133333	3333333333
1111111111	1111111111	1111111111	SEP	3333333333	3333333333	3333333333
1111111111	1111111111	1111111111	OCT	3333333333	3322222222	2222222221
1111111111	1111111111	1111111111	NOV	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	DEC	1111111111	1111111111	1111111111

YEAR 1974 (ARIDIC)				YEAR 1977 (USTIC)		
1111111111	1111111111	1111111111	JAN	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	FEB	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	MAR	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	APR	1111111111	1111122222	2222222222
1111111111	1111122222	2222222222	MAY	2222222222	2222233333	3333333333
2222222221	1111122222	2222222222	JUN	3333333333	3333333333	3333333333
2222222211	1111111111	1111111111	JUL	3333333333	3333333333	3333333333
1111111111	1111111111	1111111111	AUG	3333333333	3333333333	3333333333
1111111111	1111111111	1111111111	SEP	3333333333	3333333333	3333333333
1111111111	1111111111	1111111111	OCT	3333333333	3333333333	3333333333
1111111111	1111111111	1111111111	NOV	3333333333	3333333333	3333333333
1111111111	1111111111	1111111111	DEC	3333333333	3333333333	3333333333

THE CLASSIFICATION FOR 6 YEARS BETWEEN 1970 AND 1977 IS:APIDIC
COMPUTED BY PROGRAM VW 18,NOV 81
DATE:03/25/82

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:YARIM

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	CUMULATIVE DAYS MCS IN ONE YEAR IS M/D	CUMULATIVE DAYS MCS IN ONE YEAR IS MOI	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 DRY	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 M/D	CUMULATIVE DAYS MCS WHEN SOIL TEMP >5 MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS WHEN SOIL TEMP > 8	MAX.CONSECUTIVE DAYS THAT MCS IS DRY AFTER SUMMER SOLST.	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1970	17.3	19.3	ISOTHERMIC	235	125	0	235	125	0	104	104	15	0	USTIC
1971	17.3	19.3	ISOTHERMIC	75	60	225	75	60	225	285	285	0	0	USTIC
1972	17.3	19.3	ISOTHERMIC	33	166	161	33	166	161	327	327	0	15	USTIC
1973	17.3	19.3	ISOTHERMIC	199	105	56	199	105	56	137	137	6	0	USTIC
1974	17.3	19.3	ISOTHERMIC	75	186	99	75	186	99	285	285	0	0	USTIC
1975	17.3	19.3	ISOTHERMIC	133	92	135	133	92	135	159	159	21	0	USTIC
1976	17.3	19.3	ISOTHERMIC	10	192	158	10	192	158	350	350	0	15	USTIC
1977	17.3	19.3	ISOTHERMIC	146	79	135	146	79	135	165	165	11	0	USTIC
MEAN	17.3	19.3		100	111	147	100	111	147	241	241	5	16	USTIC
STAND.DEV.	0.0	0.0		82	62	102	82	62	102	99	99	7	39	
COEFF.VAR.				82	56	69	82	56	69	41	41	135	235	

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STATION :YARIM

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1970	T	T			T			T	T		T		T	T	USTIC
1971		T			T	T		T			T		T	T	USTIC
1972		T			T	T		T			T		T	T	USTIC
1973	T	T			T			T	T		T		T	T	USTIC
1974		T			T	T		T	T		T		T	T	USTIC
1975		T			T	T		T	T		T		T	T	USTIC
1976		T			T	T		T			T		T	T	USTIC
1977		T			T	T		T	T		T		T	T	USTIC
FREQ.	25	100	0	0	100	75	0	100	63	0	100	0	100	100	
COND.		T			T	T		T	T		T		T	T	USTIC

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MOISTURE CONDITION CALENDARS
STATION:YARIM

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

DAYS
---------->11-------->21------>30

YEAR 1970
(USTIC)

			MONTHS
1111111111	1111111111	1111111111	JAN
1111111111	1111111111	1111111111	FEB
1111111111	1111111111	1111111111	MAR
1111111111	1111122222	2222222222	APR
2222221111	1111111111	1111111111	MAY
1111111111	1111111111	1111111111	JUN
1111111111	1111122222	2222222222	JUL
2222222222	2222222222	2222222222	AUG
2222222222	2222222222	2222222222	SEP
2222222222	2222222222	2222222221	OCT
1111111111	1111111111	1111111111	NOV
1111111111	1111111111	1111111111	DEC

DAYS
---------->11-------->21------>30

YEAR 1971
(USTIC)

1111111111	1111111111	1111111111
1111111111	1111111111	1111111111
1111111111	1111122222	2222222222
2222222222	2222222222	2222222222
2222222222	2222233333	3333333333
3333333333	3333333333	3333333333
3333333333	3333333333	3333333333
3333333333	3333333333	3333333333
3333333333	3333333333	3333333333
3333333333	3333333333	3333333333
3333333333	3333333333	3333333333
3333333333	3333333333	3333333333

YEAR 1972
(USTIC)

3333333333	3333222222	2222222222	JAN
2222222222	2222222222	2222222222	FEB
2222222222	2222222222	2222222222	MAR
2222222222	2222233333	3333333333	APR
3333333333	3333333333	3333333333	MAY
3333333333	3333333333	3333333333	JUN
3333333333	3333333333	3333333333	JUL
3333333333	3333333333	3333333333	AUG
3333333333	3322222222	2222222222	SEP
2222222222	2222222222	2222222222	OCT
2222222222	2222222222	2222222111	NOV
1111111111	1111111111	1111111111	DEC

YEAR 1973
(USTIC)

1111111111	1111111111	1111111111
1111111111	1111111111	1111111111
1111111111	1111111111	1111111111
1111111111	1111111111	1111111111
1111111111	1111111111	1111111111
1111111111	1111122222	2222222222
2222222221	1111122222	2222222222
2222222222	2222222222	2222222222
2222222222	2222233333	3333333333
3333333333	3333333333	3333333333
3333333333	3222222222	2222222222
2211111111	1111111111	1111111111

YEAR 1974
(USTIC)

1111111111	1111111111	1111111111	JAN
1111111111	1111111111	1111111111	FEB
1111111111	1111122222	2222222222	MAR
2222222222	2222222222	2222222222	APR
2222222222	2222222222	2222222222	MAY
2222222222	2222222222	2222222222	JUN
2222222222	2222222222	2222222222	JUL
2222222222	2222233333	3333333333	AUG
3333333333	3333333333	3333333333	SEP
3333333333	3333333333	3333333333	OCT
3333333333	3333333333	3333222222	NOV
2222222222	2222222222	2222222222	DEC

YEAR 1975
(USTIC)

2222222222	2222222222	2222111111
1111111111	1111111111	1111111111
1111111111	1111111111	1111111111
1111111111	1111122222	2222222222
2222222222	2222111111	1111111111
1111111111	1111122222	2222222222
2222222222	2222222222	2222111111
1111111111	1111133333	3333333333
3333333333	3333333333	3333333333
3333333333	3333333333	3333333333
3333333333	3333333333	3333333333
3333333333	3333333333	3333333333

COMPUTED BY PROGRAM VW 18,NOV 1981 DATE03/25/82

MOISTURE CONDITION CALENDARS ACCORDING TO
MATHEMATICAL MODEL OF F.NEWHALL(1972)

STATION:YARIM

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

DAYS ---------->11--------->21------->30			MONTHS	DAYS ---------->11--------->21------->30		
YEAR 1976 (USTIC)				YEAR 1977 (USTIC)		
3332222222	2222222222	2222222222	JAN	1111111111	1111111111	1111111111
2222222222	2222222222	2222222222	FEB	1111111111	1111111111	1111111111
2222222222	2222222222	2222222222	MAR	1111111111	1111111111	1111111111
2222222222	2222233333	3333333333	APR	1111111111	1111111111	1111111111
3333333333	3333333333	3333333333	MAY	1111111111	1111122222	2222222222
3333333333	3333333333	3333333333	JUN	2222222222	2222222222	2222222222
3333333333	3333333333	3333333333	JUL	2222111111	1111122222	2222222222
3333333333	3333233333	3333333333	AUG	2222222222	2222233333	3333333333
3333333333	3333333333	3222222222	SEP	3333333333	3333333333	3333333333
2222222222	2222222222	2222222222	OCT	3333333333	3333333333	3333333333
2222222222	2222222222	2222222222	NOV	3333333333	3333333333	3333333333
2222222222	2222222222	1111111111	DEC	3333333333	3333333333	3333333333

THE CLASSIFICATION FOR 8 YEARS BETWEEN 1970 AND 1977 IS:USTIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:ZABID

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1969	31.5	33.5	ISOHYPERTH.	360	0	0	360	0	0	0	0	120	0	ARIDIC
1970	31.5	33.5	ISOHYPERTH.	351	9	0	351	9	0	9	9	75	0	ARIDIC
1971	31.5	33.5	ISOHYPERTH.	360	0	0	360	0	0	0	0	120	0	ARIDIC
1972	31.5	33.5	ISOHYPERTH.	331	29	0	331	29	0	16	16	45	0	ARIDIC
1973	31.5	33.5	ISOHYPERTH.	353	7	0	353	7	0	7	7	75	0	ARIDIC
1975	31.5	33.5	ISOHYPERTH.	340	20	0	340	20	0	11	11	45	0	ARIDIC
MEAN	31.5	33.5		349	10	0	349	10	0	7	7	80	0	ARIDIC
STAND.DEV.	0.0	0.0		11	11	0	11	11	0	6	6	33	0	
COEFF.VAR.				3	106	0	3	106	0	87	87	42	0	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81

DATE 03/25/82

STATION :ZABID

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1969	T		T		T			T	T	T			T	T	ARIDIC
1970	T		T		T			T	T	T			T	T	ARIDIC
1971	T		T		T			T	T	T			T	T	ARIDIC
1972	T		T		T			T	T	T			T	T	ARIDIC
1973	T		T		T			T	T	T			T	T	ARIDIC
1975	T		T		T			T	T	T			T	T	ARIDIC
FREQ.	100	0	100	0	100	0	0	100	100	100	0	0	100	100	
COND.	T		T		T			T	T	T			T	T	ARIDIC

COMPUTED BY FORTRAN PROGRAM VW18, NOV. 81

DATE 03/25/82

MOISTURE CONDITION CALENDARS
STATION:ZABID

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

```
DAYS                                                DAYS
--------->11-------->21------>30                    --------->11-------->21------>30
          YEAR 1969                   MONTHS                  YEAR 1970
          (ARIDIC  )                                          (ARIDIC  )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  APR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAY  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUL  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  AUG  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  SEP  1111111111 1111122222 2222111111
1111111111 1111111111 1111111111  OCT  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  NOV  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC  1111111111 1111111111 1111111111

          YEAR 1971                                           YEAR 1972
          (ARIDIC  )                                          (ARIDIC  )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  APR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAY  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUL  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  AUG  1111111111 1111122222 2222222211
1111111111 1111111111 1111111111  SEP  1111111111 1111122222 2222222222
1111111111 1111111111 1111111111  OCT  2111111111 1111111111 1111111111
1111111111 1111111111 1111111111  NOV  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC  1111111111 1111111111 1111111111

          YEAR 1973                                           YEAR 1975
          (ARIDIC  )                                          (ARIDIC  )
1111111111 1111111111 1111111111  JAN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  FEB  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  APR  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  MAY  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUN  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  JUL  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  AUG  1111111111 1111122222 2222111111
1111111111 1111122222 2211111111  SEP  1111111111 1111122222 2222221111
1111111111 1111111111 1111111111  OCT  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  NOV  1111111111 1111111111 1111111111
1111111111 1111111111 1111111111  DEC  1111111111 1111111111 1111111111
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THE CLASSIFICATION FOR 6 YEARS BETWEEN 1969 AND 1975 IS:ARIDIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

DETERMINATION OF SOIL MOISTURE REGIME ACCORDING TO FRANKLIN NEWHALL SYSTEM OF COMPUTATION
(CORRECTION FOR TEMPERATURE IS 2.5; SEASONAL AMPLITUDE MODIFIED BY FACTOR 0.66)

STATION:ZABID CAMP

YEAR	MEAN SOIL TEMPERATURE ANNUAL	MEAN SOIL TEMPERATURE SUMMER	TEMPERATURE REGIME	CUMULATIVE DAYS MCS IN ONE YEAR IS DRY	M/D	MOI	WHEN SOIL TEMP >5 DRY	M/D	MOI	MAX.CONSECUTIVE DAYS THAT MCS IS MOIST IN SOME PARTS IN ONE YEAR	WHEN SOIL TEMP > 8	DRY AFTER SUMMER SOLST.	MOIST AFTER WINTER SOLST.	MOISTURE REGIME
1969	31.5	33.5	ISOHYPERTH.	348	12	0	348	12	0	12	12	75	0	ARIDIC
1970	31.5	33.5	ISOHYPERTH.	300	10	50	300	10	50	60	60	75	0	ARIDIC
1971	31.5	33.5	ISOHYPERTH.	345	15	0	345	15	0	15	15	75	0	ARIDIC
1972	31.5	33.5	ISOHYPERTH.	331	29	0	331	29	0	16	16	45	0	ARIDIC
1973	31.5	33.5	ISOHYPERTH.	331	29	0	331	29	0	14	14	45	0	ARIDIC
1974	31.5	33.5	ISOHYPERTH.	267	51	42	267	51	42	58	58	19	0	ARIDIC
1975	31.5	33.5	ISOHYPERTH.	299	23	38	299	23	38	48	48	45	0	ARIDIC
1976	31.5	33.5	ISOHYPERTH.	338	22	0	338	22	0	14	14	91	0	ARIDIC
1977	31.5	33.5	ISOHYPERTH.	311	49	0	311	49	0	27	27	45	0	ARIDIC
1978	31.5	33.5	ISOHYPERTH.	342	18	0	342	18	0	10	10	52	0	ARIDIC
MEAN	31.5	33.5		321	25	13	321	25	13	27	27	56	0	ARIDIC
STAND.DEV.	0.0	0.0		26	14	21	26	14	21	20	20	21	0	
COEFF.VAR.				8	55	162	8	55	162	73	73	37	0	

COMPUTED BY FORTRAN PROGRAM VW18,NOV. 81 DATE 03/25/82

STATION :ZABID CAMP

YEAR	OCCURENCE OF CONDITION 1	2	3	4	5	6	7	8	9	10	11	12	13	14	MOISTURE REGIME
1969	T		T		T			T	T	T			T	T	ARIDIC
1970	T		T		T			T	T	T			T	T	ARIDIC
1971	T		T		T			T	T	T			T	T	ARIDIC
1972	T		T		T			T	T	T			T	T	ARIDIC
1973	T		T		T			T	T	T			T	T	ARIDIC
1974	T				T			T	T				T	T	ARIDIC
1975	T		T		T			T	T	T			T	T	ARIDIC
1976	T		T		T			T	T	T			T	T	ARIDIC
1977	T		T		T			T	T	T			T	T	ARIDIC
1978	T		T		T			T	T	T			T	T	ARIDIC
FREQ.	100	0	90	0	100	0	0	100	100	90	0	0	100	100	
COND.	T		T		T			T	T	T			T	T	ARIDIC

COMPUTED BY FORTRAN PROGRAN VW18, NOV. 81 DATE 03/25/82

MOISTURE CONDITION CALENDARS
STATION:ZABID CAMP

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

DAYS ---------->11--------->21------->30			MONTHS	DAYS ---------->11--------->21------->30		
YEAR 1969 (ARIDIC)				YEAR 1970 (ARIDIC)		
1111111111	1111111111	1111111111	JAN	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	FEB	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	MAR	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	APR	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	MAY	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	JUN	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	JUL	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	AUG	1111111111	1111111111	1111111111
1111111111	1111122222	2222222111	SEP	1111111111	1111133333	3333333333
1111111111	1111111111	1111111111	OCT	3333333333	3333233333	3333333333
1111111111	1111111111	1111111111	NOV	3333332222	2222211111	1111111111
1111111111	1111111111	1111111111	DEC	1111111111	1111111111	1111111111
YEAR 1971 (ARIDIC)				YEAR 1972 (ARIDIC)		
1111111111	1111111111	1111111111	JAN	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	FEB	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	MAR	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	APR	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	MAY	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	JUN	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	JUL	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	AUG	1111111111	1111122222	2222222211
1111111111	1111122222	2222222222	SEP	1111111111	1111122222	2222222222
1111111111	1111111111	1111111111	OCT	2111111111	1111111111	1111111111
1111111111	1111111111	1111111111	NOV	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	DEC	1111111111	1111111111	1111111111
YEAR 1973 (ARIDIC)				YEAR 1974 (ARIDIC)		
1111111111	1111111111	1111111111	JAN	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	FEB	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	MAR	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	APR	1111111111	1111111111	1111111111
1111111111	1111122222	1111111111	MAY	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	JUN	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	JUL	1111111111	1111122222	2222221111
1111111111	1111122222	2222211111	AUG	1111111111	1111122222	2222222222
1111111111	1111122222	2222222221	SEP	2222222221	1111133333	3333333333
1111111111	1111111111	1111111111	OCT	3333333333	3333333333	3333333222
1111111111	1111111111	1111111111	NOV	2222222222	2221111111	1111111111
1111111111	1111111111	1111111111	DEC	1111111111	1111111111	1111111111

COMPUTED BY PROGRAM VW 18,NOV 1981 DATE03/25/82

SOIL SURVEY OF THE YEMEN ARAB REPUBLIC

MOISTURE CONDITION CALENDARS ACCORDING TO
MATHEMATICAL MODEL OF F.NEWHALL(1972)

STATION:ZABID CAMP

(1)=COMPL.DRY (2)=PARTLY DRY (3)=COMPL.MOIST

DAYS ---------->11--------->21------->30			MONTHS	DAYS ---------->11--------->21------->30		
YEAR 1975 (ARIDIC)				YEAR 1976 (ARIDIC)		
1111111111	1111111111	1111111111	JAN	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	FEB	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	MAR	1111111111	1111111111	1111111111
1111111111	1111122222	2222222211	APR	1111111111	1111122222	2221111111
1111111111	1111111111	1111111111	MAY	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	JUN	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	JUL	1111111111	1111122222	2222222221
1111111111	1111133333	3333333333	AUG	1111111111	1111111111	1111111111
3333333333	3333233333	3333222222	SEP	1111111111	1111111111	1111111111
2221111111	1111111111	1111111111	OCT	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	NOV	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	DEC	1111111111	1111111111	1111111111
YEAR 1977 (ARIDIC)				YEAR 1978 (ARIDIC)		
1111111111	1111111111	1111111111	JAN	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	FEB	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	MAR	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	APR	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	MAY	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	JUN	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	JUL	1111111111	1111122222	2221111111
1111111111	1111122222	2222222211	AUG	1111111111	1111111111	1111111111
1111111111	1111122222	2222111111	SEP	1111111111	1111122222	2222211111
1111111111	1111122222	2222222222	OCT	1111111111	1111111111	1111111111
2222222222	2211111111	1111111111	NOV	1111111111	1111111111	1111111111
1111111111	1111111111	1111111111	DEC	1111111111	1111111111	1111111111

THE CLASSIFICATION FOR 10 YEARS BETWEEN 1969 AND 1978 IS:ARIDIC
COMPUTED BY PROGRAM VW 18,NOV 81 DATE:03/25/82

CLIMATE TABLE SET G: TEMPERATURE CONFIGURATION TABLES FOR FOUR STATIONS EAST OF THE MOUNTAINS

The G set of tables includes four stations from the eastern region of the survey area. Average monthly temperature data for these stations were available from the climate annex of the Agrar- und Hydrotechnik Report, 1980. These stations were used to make estimates of the soil temperature regime and to check whether the temperature regimes are iso-. The stations for which complete data were available are not in the Yemen Arab Republic, but in nearby countries. These data were used because of the probable close similarity between these stations and areas in Yemen where no data are available. In the cited report, data for Ma'rib are given which are partially observed and partially generated from the more complete data of the other three stations listed below. This data was also used. All four stations are not iso-, and the winter-summer temperature difference is much greater than 5°C. From this evidence, it was concluded the area to the east of the mountain range is hyperthermic and non-iso.

STATIONS:

Ma'rib
Nejran, Saudi Arabia
Nuqub, South Yemen
Bayhan, South Yemen

DETERMINATION OF CLIMATIC REGIME ACCORDING TO
SOIL TAXONOMY(USDA,1974)
USING FRANKLIN NEWHALL SYSTEM OF COMPUTATION

STATION : MARIB LATITUDE : 14 30 N

INPUT DATA:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRECIPITATION:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TEMPERATURE :	19.1	21.0	24.9	26.8	31.5	33.4	35.1	33.8	31.6	24.4	21.3	19.0

OUTPUT : CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE

36.1	47.8	106.0	139.0	184.4	187.8	197.5	191.5	174.1	96.9	54.4	35.0

ANNUAL RAINFALL : 0.0 MM ANNUAL EVAPOTRANSPIRATION : 1450.7 MM

SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66

MEAN SOIL TEMPERATURES (DEGREES CENTIGRADES)				SEASONS WHEN SOIL TEMPERATURE IS HIGHER THAN				REGIME
				FIVE DEGREES		EIGHT DEGREES		
ANNUAL	SUMMER	WINTER	DIF-FEREN CE	BEGIN	LENGTH (DAYS)	BEGIN	LENGTH (DAYS)	
29.3	34.2	24.6	9.5		360		360	HYPERTH.

COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976 DATE :05/20/82

DETERMINATION OF CLIMATIC REGIME ACCORDING TO
SOIL TAXONOMY(USDA,1974)
USING FRANKLIN NEWHALL SYSTEM OF COMPUTATION

STATION : NEJRAN LATITUDE : 14 30 N

INPUT DATA:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRECIPITATION:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TEMPERATURE :	16.1	17.9	21.6	24.4	27.4	29.0	30.7	30.0	26.2	21.2	18.1	15.9

OUTPUT : CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE

32.9	40.4	78.1	110.6	150.7	164.7	178.4	173.4	134.1	73.4	44.9	31.4

ANNUAL RAINFALL : 0.0 MM ANNUAL EVAPOTRANSPIRATION : 1213.1 MM

SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66

MEAN SOIL TEMPERATURES (DEGREES CENTIGRADES)				SEASONS WHEN SOIL TEMPERATURE IS HIGHER THAN				REGIME
				FIVE DEGREES		EIGHT DEGREES		
ANNUAL	SUMMER	WINTER	DIF-FEREN CE	BEGIN	LENGTH (DAYS)	BEGIN	LENGTH (DAYS)	
25.7	30.1	21.4	8.8		360		360	HYPERTH.

COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976 DATE :05/20/82

DETERMINATION OF CLIMATIC REGIME ACCORDING TO
SOIL TAXONOMY(USDA,1974)
USING FRANKLIN NEWHALL SYSTEM OF COMPUTATION

STATION : BAYH[illegible] LATITUDE : 14 30 N

INPUT DATA:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRECIPITATION:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TEMPERATURE :	17.5	20.4	23.8	25.4	27.0	28.3	28.3	29.9	26.8	22.6	19.5	16.3

OUTPUT : CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE

39.5	56.7	101.5	123.2	150.7	156.7	159.6	170.0	137.7	86.2	53.4	31.6

ANNUAL RAINFALL : 0.0 MM ANNUAL EVAPOTRANSPIRATION : 1266.9 MM

SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66

MEAN SOIL TEMPERATURES (DEGREES CENTIGRADES)				SEASONS WHEN SOIL TEMPERATURE IS HIGHER THAN			
				FIVE DEGREES		EIGHT DEGREES	REGIME
ANNUAL	SUMMER	WINTER	DIFFERENCE	BEGIN	LENGTH (DAYS)	BEGIN	LENGTH (DAYS)	
26.3	29.5	22.4	7.1		360		360	HYPERTH.

COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976 DATE :05/20/82

DETERMINATION OF CLIMATIC REGIME ACCORDING TO
SOIL TAXONOMY(USDA,1974)
USING FRANKLIN NEWHALL SYSTEM OF COMPUTATION

STATION : NUQUB LATITUDE : 14 30 N

INPUT DATA:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PRECIPITATION:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TEMPERATURE :	19.0	21.1	23.0	26.2	28.2	30.1	30.7	30.8	28.3	24.0	20.8	17.6

OUTPUT : CALCULATED EVAPOTRANSPIRATION ACCORDING TO THORNTHWAITE

45.1	58.0	87.2	134.0	159.6	171.8	176.4	176.8	150.8	99.4	59.5	34.7

ANNUAL RAINFALL : 0.0 MM ANNUAL EVAPOTRANSPIRATION : 1355.3 MM

SOIL TEMPERATURE REGIME AT 50 CM DEPTH ESTIMATED FROM AIR TEMP.DATA
BY ADDING 2.5C TO ANNUAL MEAN AND REDUCING AMPLITUDE BY A FACTOR 0.66

MEAN SOIL TEMPERATURES (DEGREES CENTIGRADES)				SEASONS WHEN SOIL TEMPERATURE IS HIGHER THAN			
				FIVE DEGREES		EIGHT DEGREES	REGIME
ANNUAL	SUMMER	WINTER	DIFFERENCE	BEGIN	LENGTH (DAYS)	BEGIN	LENGTH (DAYS)	
27.5	31.1	23.7	7.5		360		360	HYPERTH.

COMPUTED BY FORTRAN PROGRAM VW08 ,MARCH 1976 DATE :05/20/82

FREQUENCIES REQUESTED BY SOIL TAXONOMY FOR SOIL CONDITIONS DIAGNOSTIC OF SOIL MOISTURE REGIMES

Condition No. 1

Condition that the number of cumulative days that the moisture control section (MCS) is completely dry when the soil temperature is higher than 5°C is greater than half of the time that the soil temperature is above 5°C. This condition is used for the definition of the aridic moisture regime. The frequency requirement is, according to Newhall's tables, more than 50%.

Condition No. 2

Condition that the number of consecutive days that the moisture control section is moist in some or all parts when the soil temperature is higher than 8°C is greater than ninety days. This condition, when occurring in more than 50% of the observed years, eliminates the aridic moisture regime.

Condition No. 3

Condition that the number of consecutive days that the moisture control section is dry in all parts during the four months following the summer solstice is higher than forty-five days. The frequency requirement is more than 60%. This condition should be met for the xeric moisture regime.

Condition No. 4

Condition that the number of consecutive days that the moisture control section is moist in all parts during the four months following the winter solstice is higher than fourty-five days. The frequency of occurrence should be more than 60% to qualify for the xeric moisture regime.

Condition No. 5

Condition that the number of cumulative days that the moisture control section is dry in some or all parts in one year is higher than ninety days. The frequency requirement is more than 50% and is diagnostic for the ustic moisture regime.

Condition No. 6

Condition that the number of cumulative days that the moisture control section is moist in some or all parts for more than 180 days in one year. The frequency requirement is 50% and this condition is used to identify ustic soil moisture regimes.

Condition No. 7

Condition that all monthly precipitations exceed the monthly potential evapotranspiration. This condition is required for recognizing the perudic soil moisture regime which is a subdivision of the udic moisture regime. No specific frequency requirement is mentioned in Soil Taxonomy but 50% is taken as the lower limit for the requirement.

Condition No. 8

Condition that the number of cumulative days that the moisture control section is dry in some or all parts when the soil temperature is more than 5°C is equal or higher than ninety days. This condition should occur in more than 50% of the observed years and is then diagnostic of the ustic moisture regime.

Condition No. 9

Condition that the number of cumulative days that the moisture control section is dry in some or all parts during the time that the soil temperature is above 5°C is greater than 60% of the days that the soil temperature is above 5°C. It is used for distinguishing subgroups in Alfisols, Inceptisols and Mollisols. The frequency of occurrence should be equal to or less than 50% for the typic subgroups.

Condition No. 10

Condition that the number of cumulative days that the moisture control section is dry in all parts during the time that the soil temperatures are above 5°C is greater than 75% of the time that the soil temperature is higher than 5°C. The required frequency of occurrence should be higher than 50% to distinguish typic subgroups in Aridisols.

Condition No. 11

Condition requiring that the mean annual soil temperature be less than 22°C. No indication of a frequency requirement was found in Soil Taxonomy and 50 is taken as the minimum critical percentage. This condition is required for the xeric moisture regime.

Condition No. 12

Condition that the difference between winter and summer soil temperatures is equal to or higher than 5°C. This difference is diagnostic for non-iso soil temperature regimes. It is also a required condition for the xeric moisture regime. The frequency of occurrence required is set at 50% minimum.

Condition No. 13

Condition that the number of days that the soil temperature is higher than 5^0 is greater than zero. This condition is needed for qualification in the aridic moisture regime. The frequency of occurrence is taken at 50% minimum.

Condition No. 14

Condition that the temperature regime is neither pergelic nor cryic. This condition is required for qualification in the ustic moisture regime. The frequency of occurrence is taken at 50% minimum.

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