Agriculture in al-hassa oasis, Saudi Arabia: a review of development

Mohammed A. Al-Jabr

AGRICULTURE IN AL-HASSA OASIS, SAUDI ARABIA: A REVIEW OF DEVELOPMENT

Mohammed A. Al-Jabr , B.A.

Thesis submitted to the Faculty of Social Sciences for the Degree of Master of Arts, University of Durham.

August, 1984

IN THE NAME OF GOD, THE MERCIFUL, THE COMPASSIONATE

ABSTRACT

Al-Hassa oasis is the oldest and largest agricultural area in Saudi Arabia, its establishment and expansion being due to the enormous reserves of groundwater.

Irrigated farming methods which developed over centuries continued relatively unchanged until recently. Traditional subsistence farming faced increasing pressure in the early 1950's from three forces. Shifting sands continued encroaching on farmland and villages, the lack of efficient ground water irrigation distribution, and drainage resulted in increasing soil salinity and waterlogging, and economic and social changes, regional and national, brought about by the oil boom. The latter changes radically altered the relative status of agriculture.

These factors are studied in the context of their physical setting, including climate, topography, geology, soils and hydrology, which affect not only traditional farming, but also any modern developments in agriculture in the oasis.

In the late 1960's the sand stabilization and irrigation and drainage projects were begun, and their objectives and effects on al-Hassa ocasis are discussed.

These projects together with national governmental financial incentives have created eventually a significant but not complete response from farmers. The difficulties of changing established rural systems appear greater than those of developing new land by new entrepreneurs. Similarly the success in improving the use of land and water resource has been less than hoped but nevertheless very significant.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisor, Professor H. Bowen-Jones, for his untiring patience, guidance and encouragement. Without the benefit of his learned support and advice this work might never have emerged.

My thanks also go to the staff and my colleagues at the Department of Geography, the staff of the main University Library and its Oriental Section, the staff of the Geography Department Library, and to everyone else at the University of Durham. In addition, I thank Mrs. Bell for typing from my manuscript.

In Saudi Arabia I wish to thank my University for their support and encouragement; also the H.I.D.A., H.A.R.C, the S.A.A.B., the King Faisal University at Hofuf, and the farmers of al-Hassa oasis for the information and encouragement they have given.

Finally, I am grateful to my family, and my friends for their continued encouragement and support during my studies.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Following Page

Fig. No.

CHAPTER ONE

INTRODUCTION

1.1 OBJECTIVE

An overview of the development of agriculture in al-Hassa oasis in the context of :

(a) traditional, primarily non-commercial farming as practised with little structural or technical change for thousands of years up to about 1950.

(b) the al-Hassa development project which changed fundamentally the system of water distribution and drainage above farm level and introduced some other innovations.

(c) changing local, regional and national social, economic and political factors. These changes became particularly important, first with the creation of a unified kingdom of Saudi Arabia during the 1920's, and secondly with the oil era which commenced in the 1940's.

(d) lastly the more or less permanent physical factors of climate, topography, geology, soils and hydrology. An attempt is made to identify the effects on present and future agriculture in al-Hassa, not only of changes but also of the underlying physical factors and the legacy of traditional methods of land use. These last two factors present very considerable constraints on recent and present developments within agriculture.

In this introduction there is therefore presented a short summary of the history of the oasis to provide a perspective in time for the situation as it appears in the second half of the twentieth century. This is followed by a brief descriptive statement of the main characteristics of the oasis in the early 1980's. Fig.1.1.

1.2 HISTORICAL BACKGROUND

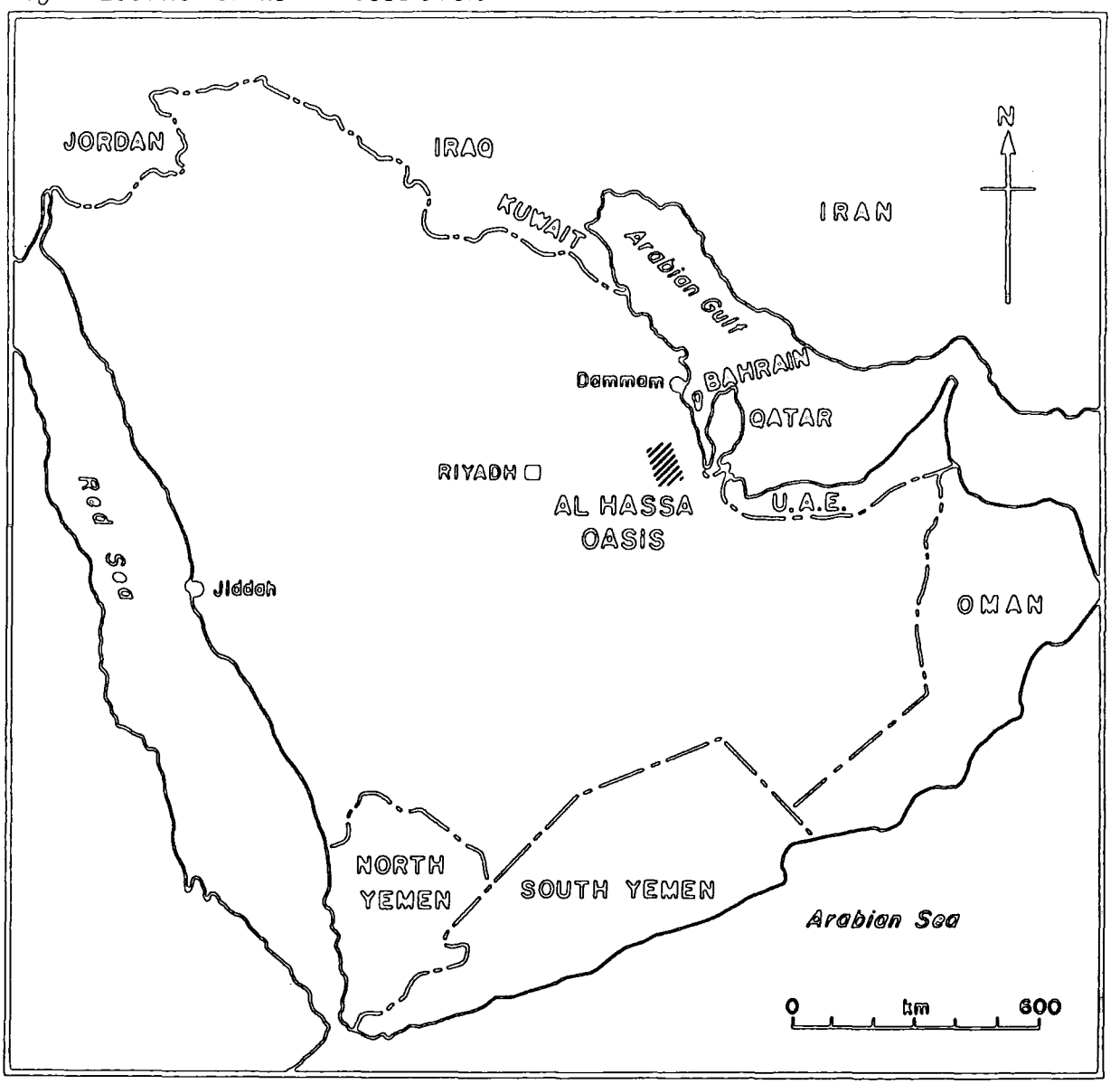
A. The meaning of al-Hassa

Vidal (1953), following Hava's dictionary, stated that the meaning of the word al-Hassa is "swampy ground covered with sand." The word al-Hassa, as Yakut (1955) defined it, is the plural of hisy, and means sandy soil which, having a substratum of compact sone, keeps rain water for a long time, this water being easily reached with little digging; the excavation proper is called hisy. Nallion and Wüstenfeld give the same definition (see Vidal 1955).

In the past the name al-Hassa applied to the whole region from Southern Iraq to Northern Oman, and from Al-Yamamah in the West to the Arabian Gulf in the East, which region had formerly been called Al-Bahrain. However, since 1953 when the region's capital was moved from Hofuf to Dammam, the region as a whole has been called the Eastern Province, leaving the name al-Hassa to apply to Hofuf and the group of oases to the north and east of the town, and including the immediately surrounding area.

The definition given above is confirmed by the physical evidence which will be described in the following

Fig 1·1 Location of the Al Hassa Oasis



chapters dealing with the topography, geology and hydrology of the oasis.

B. Ancient History

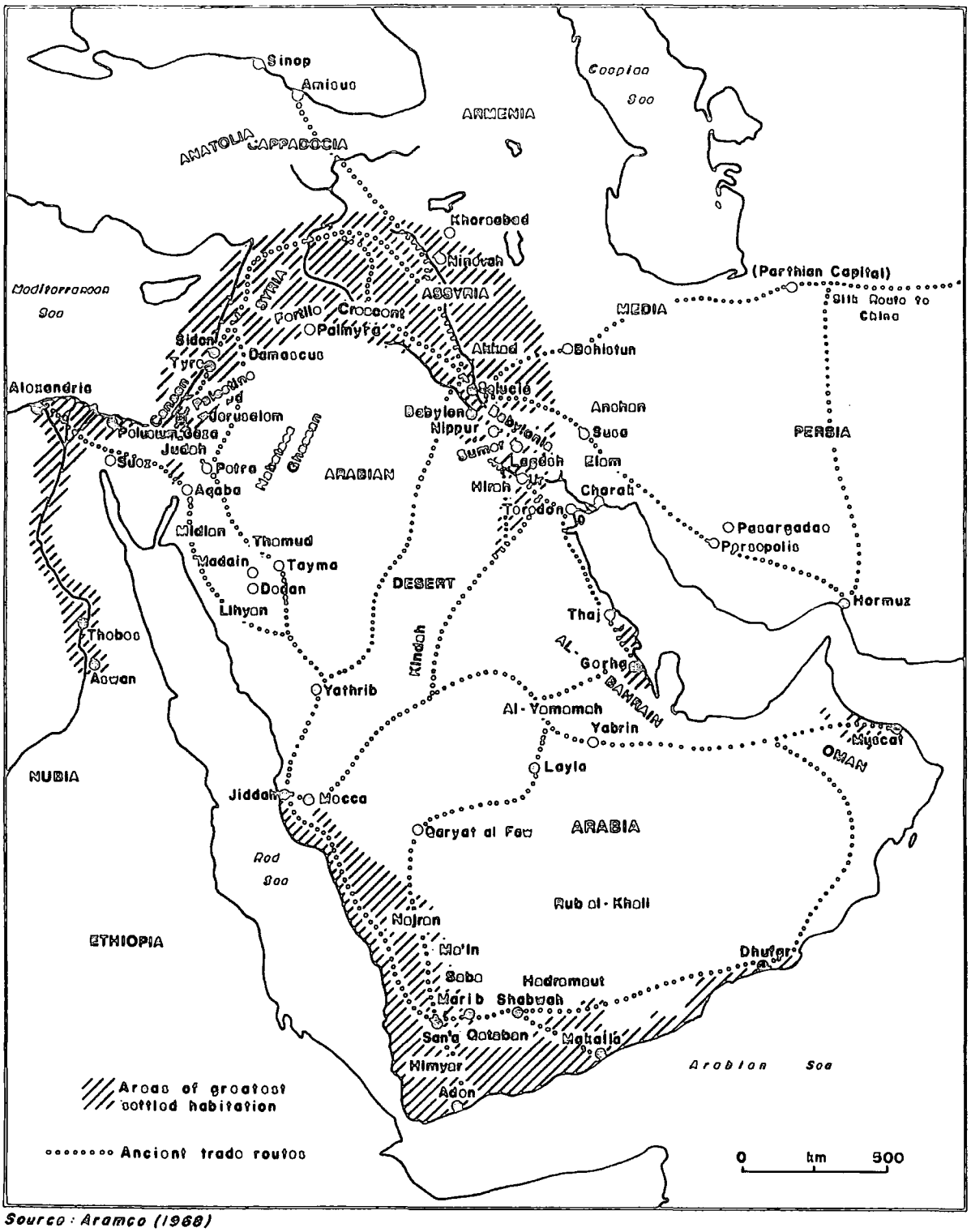
The oasis of al-Hassa is probably one of the oldest and largest existing agricultural centres in the world, settled some 5,000 years ago (Bowen-Jones 1980). Its settlement is partly a result of the availability of water, as well as its position on the major trade routes between inland Arabia and the Gulf. Figure 1.2 shows the ancient trade routes, one of which passed through Al-Bahrain (now al-Hassa) to Gerrha. The first mention of the area is in the "Geography of the Roman Empire" by Strabo (born in 63 BC) who referred to al-Hassa as an agricultural production centre (Humaidan 1980). He also mentions the sea port of Gerrha, probably the present Al-Uqair, of which he says:

> "The merchants of Gerrha generally carry the Arabian merchandise and aromatics by land; but Aristobules says; on the contrary, that they frequently travel into Babylonia on rafts and thence sail up the Euphrates with their cargoes, but afterwards carry them by land to all parts of the country."

Gerrha was apparently an important centre of trade with Babylonia in products not only from south western Arabia but also from Oman and India. Speaking of Gerrha's wealth, Strabo says:

> "By the trade both the Sabaeans and Gerrhaei have become the richest of all tribes, and possess a great quantity of wrought articles in gold and silver as couches, tripods, basins, drinking vessels, to which we must add the costly magnificence of their houses, for the doors, walls and roofs are variegated with inlaid ivory, , silver and previous stones."

Fig. 1-2 Ancient Arabia



Source : Aramco (1968)

Pliny (23-79 AD) described Gerrha as the main port of the region of Attene, which was located fifty Roman miles inland which must have been on or near the site of present day al-Hassa oasis. (Aramco 1968).

Ptolemy (the middle of the second century AD) mentions a number of tribes and their locations in the Eastern Province, including the Iolysite in the interior near the present town of Hofuf. Forster (1844) explains that this name means Ul Ahsanys or the inhabitants of Ul-Ahsah.

It has been suggested that "In Pliny's time it al-Hassa oasis must have been, as now, a well populated area. Caravans naturally would have halted there on the long journey from Gerrha to the Hadhramout or the Mediterranean." (Cornwall 1946). Certainly al-Hassa oasis would have been the only major inhabited area before the caravans crossed the desert regions to Central Arabia.

C. Al-Hassa In The Arab Geographies

Al-Hassa, as it is called today, was not known by that name in the writings of Arab geographers. However, it was known as Al-Bahrain which extended from Southern Iraq as far as Northern Oman and from Al-Yamamah in the West to the Arabian Gulf in the East, with the town of Hajar as its capital (Yakut 1955). Accordingly, the sources only mention Hajar; for example Ibn Khordadhbeh (3rd/9th century) reports that Hajar was one of the important settlements in Al-Bahrain region (Ibn Khordadhbeh 1967). Ibn Al-Fakih (3rd/9th century) states that the

name of the region was Al-Bahrain and its capital was Hajar (Al-Fakih 1967).

However, the first ever mention of al-Hassa appeared in the 4th/10th century : Ibn Haukal mentions al-Hassa as one of the settlements of the region (Ibn Haukal 1938) Al-Moqaddasi (1967) (4th/10th century) reported that the region under study was called Hajar and its capital was al-Hassa.

Yakut (1955), the 7th AH/13th AD century writer, gives more details when he points out that the town of al-Hassa was built by Abu Tahir al-Qarmati in 317/929 to be a capital for his family i.e. the Carmathians.

Historically speaking, at the dawn of Islam al-Hassa became a part of the Islamic State, beginning from the 7th year of the Hijra/628 AD, when the first delegation set out for Madinah, met the Prophet, *Peace be upon Him*, and adopted Islam (Al-Abdul-Qadir 1960). Accordingly, al-Hassa paid the kharaj (religious tax) to the central government which amounted to 80,000 dirham annually during the Prophet's, *Peace be upon Him*, life time, (Yakut 1955) while it increased to 500,000 dirham during the time of the second Caliph Omar bin al-Khattab, *May God be pleased with Him*. This amount of money was high enough to make both the Prophet and Omar surprised, for they had never received such an amount from anywhere before (Abu Yusuf 1884 and Yakut 1955). The kharaj paid by this region, including Al-Yamamah, was 510,000 dinar in 237/851. (Bin Jafar 1967). It should be noted that kharaj (as

also the zakat) was assessed by a local committee and not by an external tax assessor. The high level of payments made by al-Hassa represents therefore a measure of true rather than nominal wealth. Thus it can be seen that the region of al-Hassa was flourishing both as an agricultural region and as a trading centre.

However, al-Hassa reached the zenith of its rise and development during the time of the Carmathians who, under the leadership of Abu Tahir al-Qarmati, fortified the town of al-Hassa, built up a strong army, dominated a vast area and controlled the Iraqi pilgrim route to Makkah (Al-Elawy1976 and al-Zaylai 1978). He even went further and invaded Makkah in 317/929, killed many pilgrims, and forced the Abbasid State to pay him a ransom (Al-Zaylai 1978).

Nevertheless, the glory of the Carmathians of al-Hassa did not last long. The family of al-Uyunis, with the support of the Abbasids, got rid of the former in 466/1073 and established for themselves a new state in al-Hassa (Al-Abdul-Qadir 1960). Al-Uyunis had ruled the region of al-Hassa until 651/1253 when a new family called Banu Amir took over power from the former (Al-Abdul-Qadir 1960). The situation in al-Hassa suffered from instability and civil strike until the region came under the rule of the Ottomans in 963/1555 (Al-Abdul-Qadir 1960).

D. The Ottoman period

Although, al-Hassa was considered by the Ottoman Empire as a frontier line against the Portuguese advance to the Arabian Gulf, yet it was also a vital region for the Ottomans since al-Hassa had been famous for its agricultural products, besides its commercial importance and mutual trade with central Arabia and near by (Lorimer 1908 and Al-Elawy 1976).

However, the Ottomans did not succeed in controlling al-Hassa as Banu Khalid, the strongest tribe in the region, took over power in 1077/1670 and they used al-Mubarraz as the capital of their emirate. They fortified their capital well and had controlled the region for more than one century until they were removed by the first Saudi dynasty in 1204/1790 (Al-Abdul-Qadir 1960). The Saudis did not last long as their capital al-Dariyyah was destroyed by the troops of Mohammed Ali, the Egyptian ruler, in 1233/1818. The Egyptian troops then found their way easy to take over al-Hass, and lasted there for six years (1818-1824) (Vidal 1955). It seems that the Saudis restored their power at the hands of the second dynasty and, beginning from 1824, the area was in dispute between Banu Khalid and the Saudis, as well as between the latter and the Egyptians, until finally al-Hassa fell under the rule of the Ottomans in 1871 (Vidal 1955).

During the Ottoman sovereignty, the administration of al-Hassa region seems to have been inefficient both in terms of security and in terms of collection of taxes.

There were frequent attacks by the bedouins on the settlements and on caravans and other travellers (Al-Abdul-Qadir 1960). Lorimer gives an example of injustice in the assessment of taxation :

> "It should be noted that Turks profess to take the value of one-tenth of the crop; but they really obtain more by overestimating the pecuniary value of the Government share. Thus in 1907, when the export of dates from the Hasa oasis ceased on account of the insecurity of the roads, etc. the price of dates fell locally to 3 dollars per mann (240 kg), but the tax for the year was nevertheless calculated at 7 dollars per mann."* (Lorimer 1908).

In 1903 the total annual tax revenue from the region amounted to £54,000 English, from all sources including agricultural products (£24,411 English) and pearls, livestock, customs and local craftwork. Of the total revenue, £48,600 English was required to cover military expenditure, leaving insufficient funds to cover the civil administration (Lorimer 1908). This situation contributed to the instability of the Ottomans' rule, and prompted some prominent residents of the region to petition King Abdul-Aziz Al-Saud to retake control of the region which he did in 1331/1913 when he expelled the Ottomans (Al-Abdul-Qadir 1960). Thus the region of al-Hassa became a part of the Kingdom of Saudi Arabia. Al-Hassa, the subject of this study, now officially includes Hofuf, Mubarraz and the surrounding settlements as mentioned above.

---

* Dollar in this context means the Maria Teresa thaler.

E. Al-Hassa in the Kingdom of Saudi Arabia

King Abdul-Aziz bin Saud recaptured Riyadh in 1902 and within a few years had extended his authority throughout the Najd (Al-Farsy 1978). As mentioned above he took the region of al-Hassa in 1913, which was thus one of the earliest provinces of the unified country which was eventually established in 1926 following the capture of the Hijaz, and in 1932 named the Kingdom of Saudi Arabia. Before 1926 when revenues derived from the pilgrimage to the Holy Cities of the Hijaz became available, the chief source of income to the government in Riyadh was agricultural production and trade in which al-Hassa played a major part.

Up to the 1940's changes in the life of the country mainly were of a socio-political nature. Social stability was gradually achieved by reducing both the inter-tribal warfare among the bedouin and their tendency to raid cultivated land, settlements and caravans and travellers. The king succeeded in this both by supplanting tribal loyalties by a broader loyalty to Islam by sending religious teachers among them, and by giving them land and encouraging them to make permanent settlements (Knauerhase 1975 and Al-Mana 1982). This settlement process is known as Hijra. There were no significant economic developments until oil exports began to grow in the late 1940's.

Al-Hassa itself continued as a prosperous traditional oasis despite the changes of rule. A remarkable and highly complex system of irrigation had evolved through the

centuries resulting from ownership and inheritance customs, which involved a complicated network of criss-crossing channels. The system, which is described in Chapter No. 2 was not changed until the establishment of the al-Hassa Irrigation and Drainage Project (1967-1972, see Chapter No. 5).

Al-Hassa was not affected by the first Hijra settlement policies. Although the Ottoman owned land was taken by the Saudi government, it was not settled by the bedouins. Instead some was leased, some sold (such as at Samhah, west of Hofuf, which has become a new residential area), and some granted to local inhabitants. In addition, some of this land was retained by the government, of which some has been used for new development such as al-Hassa Irrigation and Drainage Authority, Hofuf Agricultural Research Centre and pilot farms; some of this land has also been used for recreation, with picnic areas such as Ain Najm and Shabani, which include such facilities as swimming pools and children's playgrounds.

Although the changes involved with the establishment of the unified Kingdom, as mentioned above, had an effect on al-Hassa, it was mainly one of increased stability and security. Fundamental changes did not occur until the development of the first oilfields to the north and east of the oasis which resulted in the social and economic impact described in Chapter No. 4 . Of equal importance were such developments as the Sand Stabilization and the al-Hassa Irrigation and Drainage Projects and the availability of

agricultural finance and expertise through such institutions as the King Faisal University, Hofuf Agricultural Research Centre and the Saudi Arabian Agricultural Bank (SAAB). (See Chapter No.5).

1.3 AL-HASSA TODAY

(a) The situation in al-Hassa oasis has changed significantly over the last thirty years. Agriculture has declined in importance and is no longer the main economic activity as a result of the growth of other sectors, particularly the oil industry which in turn has stimulated the growth of other industries.

(b) This trend away from agriculture to other industries has resulted in a migration of labour from the rural areas to the towns. This increasing urbanization is demonstrated in the way Hofuf and Mubarraz have both expanded to the extent that they now form one continuous built up area with a combined population in 1980 estimated by the author at between 250,000 and 300,000. In addition, all the villages in the oasis have expanded, some to the extent of becoming towns, such as Al-Uyun, Al-Taraf, Al-Jafar, Al-Omran and Al-Jash Shah.

(c) The development of the giant Ghawar oilfield only 20 km west of Hofuf has had a tremendous impact, direct and indirect, on the oasis. It provides considerable employment and income, and because of its importance Aramco has built a hospital and a technical training school. Aramco also constitutes a growing market for the farm

produce from the oasis which is now its main supplier of fruit and vegetables.

(d) There has also been development of local industries, including the following: cement plant (Hofuf is the biggest cement producer in Saudi Arabia), brick factories, clothing factory,two date processing and packing plants, dairy factories, soft drinks factory, and many smaller establishments. However, the trend towards setting up new factories has slowed, owing to the shortage of skilled labour and resulting high wages which make imports more competitive in price.

(e) As the site of a major University, the King Faisal University, al-Hassa has become a centre for scientific research. Other research establishments include the HARC. Also there are several training schools such as Aramco Institute (mentioned above), Institute of Civil Engineering, Institute of Industrial Technology, Veterinary Institute and Teacher Training College. In addition, there is a branch of Imam Mohammed bin Saud University, which specializes in the Humanities, Law and Religion.

(f) Al-Hassa is located at a junction of all routes to and from Riyadh, Central and Western Arabia to the west and the Arabian Gulf, Qatar,United Arab Emirates and Oman to the east,and Kuwait, Iraq and Jordan to the north. A new six-lane motorway has been built from Dammam to Hofuf which is being extended to Riyadh and beyond. In addition, there is a railway which links the Eastern Province with the capital, Riyadh, via Hofuf. This nodal position in the

country's communications network has helped al-Hassa to retain its importance as a trading centre.

(g) Despite these developments in industries and urbanization, the oasis with its fifty villages has remained one of the major national concentrations of agricultural potential and production. This has been achieved with the help of government investment in agricultural projects and subsidies. Also the improved communications within the oasis and to the rest of the country have brought new markets for agricultural products within easy reach.

1.4 METHODOLOGY

(a) Methodology is partly determined by the nature of data available and which could be collected during fieldwork.

(b) As noted in Section 1.2 and Section 2 very few, if any, records exist for the period before the surveys which commenced in the 1950's. One of the field work tasks, therefore, was to collect what remains of oral tradition as remembered by older people of the early twentieth century, this in addition to personal and family knowledge of the past and the period of change during the 1960's and 1970's. This evidence cannot be quantified, but can be evaluated only by testing against what still remains of traditional agriculture.

(c) For the period since the early 1960's more information is available in the form of surveys and reports

produced by consultants, the MAW and HIDA. All such information is, however, associated with the development projects and particular specialised areas of research. Al-Hassa itself cannot be isolated statistically from the more general statistical returns produced by MAW for the whole Eastern Province. There has been no national census since 1974 and no figures are available for employment or national status of residents. Use has been made of research studies carried out at postgraduate level during the last 10-15 years but these are all focussed on very specialised themes. The author has himself carried out field surveys and interviews and the data results are incorporated in the thesis.

(d) It is impossible for a single researcher to cover all the sectors relevant to agriculture as carried out on thousands of individual holdings, and the main emphasis throughout is on the evaluation of the broad trends so far as they can be estimated in the absence of any regular co-ordinated monitoring system.

1.5 THESIS STRUCTURE

Chapter Two is devoted to an examination of the characteristics of traditional farming in the oasis. This reconstruction and analysis is presented at an early stage because it allows us to see how, at a pre-scientific stage and without any scientific exploration and understanding of the region's natural resources, communities could and did create one of the largest oasis irrigation farming

systems. The consequences of these human activities for thousands of years remain profoundly important today. This is particularly important because modern planned development of al-Hassa implies the transformation of a long-established situation which is a much more complex operation than virgin land development as at Haradh or Wadi Al-Dawasir. Chapter Three examines, in the light of modern knowledge, what we now know of the physical resources that are at the disposal of farmers and the physical factors which influence the nature of agriculture in the oasis. In chapter Four are examined the social, economic and political factors which, particularly since the creation of the Kingdom and the coming of oil wealth, have affected agriculture in al-Hassa during recent decades. These have to be assessed at local, regional and national levels. Chapter Five examines the recent planned development of the oasis, initiated in 1960 through the al-Hassa Irrigation and Drainage Project. Chapter Six examines recent trends in al-Hassa agriculture and attempts, in conclusion, an evaluation of planned development.

CHAPTER ONE

REFERENCES

Abu Yusuf, Yaqub bin Ibrahim, (1302 AH/1884 AD), Kitab al-Kharaj, Bulaq, (in Arabic).

Al-Abdul-Qadir, M.A., (1379 AH/1960 AD), History of al-Hassa in the past and present, Riyadh, Saudi Arabia, (in Arabic).

Al-Elawy, I.S. (1976), The Influence of oil upon Settlement In Al-Hassa oasis, Saudi Arabia, (unpublished Ph.D. thesis), University of Durham I.K.

Al-Farsy, Fouad (1978), Saudi Arabia, A case study In Development, Stacey International,London.

Al-Mana, M., (1982),Arabia Unified, A portrait of Ibn Saud, Hutchinson Benham, London.

Al-Moqaddsi, (1967), Ahsan al-Taqsim fi Marifat al-Aqalim, Leyden (in Arabic).

Al-Zaylai, A., (1978), Makkah and its relation, (unpublished M.A. thesis) University of King Saud, Riyadh, Saudi Arabia, (in Arabic).

Aramco (1968) Aramco Handbook, Arabian American Oil Company, Dhahran, Saudi Arabia.

Bowen-Jones, H., (1980), Agriculture and the Use of Water Resources in the Eastern Province of Saudi Arabia, Issues In Development : In Gulf States, Ziward Daftari, M. (ed) M.D. Research and Services Ltd. London.

Cornwall, P.B. (1946), Ancient Arabia : Explorations In Hasa, 1940-41, The Geographical Journal, Vol.107, The Royal Geographical Society, London.

Forster, C. (1844), The Historical Geography of Arabia, London.

Humaidan, S.H., (1980), Policies and Management Guidelines for Optimum Utilization of al-Hassa Irrigation and Drainage Project, Saudi Arabia, (unpublished Ph.D. dissertation), Oklahoma State University, U.S.A.

Ibn Al-Fakih, B., (1967), Kitab al-Boldan, Leyden, (in Arabic).

Ibn Haukal, A.H.A., (1938), Kitab Sovat al-Aardh, Leyden, (in Arabic).

Ibn Khordadbeh, A.O.A., (1967), Kitab al-Masalik Wal-Mamalik, Leyden, (in Arabic).

Lorimer, J.G., (1908), Gazetteer of the Persian Gulf, Oman, and Central Arabia, Vol.II, Calcutta, India.

Qudamah bin Jafar, (1967), Nubadh Min Kitab al-Kharaj wa Sanat al-Kuttab, Leyden, (in Arabic).

Vidal, F.S., (1955), The oasis of al-Hassa, Dhahran, Saudi Arabia.

Yakut al-Hamawi, I.S.A., (1955), Mu'djam al-Buldan, Vol.I, Dar Sader Dar Beirut, Beirut, (in Arabic).

CHAPTER TWO

2.1 TRADITIONAL AGRICULTURE IN AL-HASSA OASIS

Agricultural activities in al-Hassa have been governed by socio-economic and techological factors affecting not only the oasis but also the surrounding region and, since the 1920's the whole kingdom of Saudi Arabia, as well as by the physical conditions prevailing. The socio-economic situation and the technologies available to farmers have changed fundamentally and quickly since the 1930's and these changes have accelerated during the last thirty years.

Before oil was discovered in 1935 in the region, agriculture was the most important income source for most of the people in the region, and for many centuries traditional agriculture was subsistence based. Although oil exploitation has had both directly and indirectly strong effects on the general aspects of people's lives and particularly on agricultural activities, still traditional agricultural methods to some extent have continued to be practised, especially on private farms.

The presence of accessible ground water usable for irrigation, as examined in Chapter Three, has always been the basis for agriculture in the oasis; this has been so for over 4,000 years.

In this chapter the characteristic features of the local traditional systems of irrigated agriculture are examined not so much for their historical interest but because of their effects on the present and on future situations.

2.2 TECHNOLOGY OF PRODUCTION

From the time of first settlement of the oasis to approximately 1950, agriculture in al-Hassa was characterised by the application of traditional technology to irrigated cultivation. There are no very early accounts of the farming systems but we can piece together a picture of their main characteristics.

First, where water was available from free flowing springs, the limitations imposed by traditional technology were mainly in the sectors of water distribution and of land cultivation. Where, on the other hand, groundwater was available at shallow depths but lower than the land surface then there were the additional technological limitations of water extraction methods.

In Chapter Three, the characteristics of Saih and Mugharraf irrigation techniques, the first being the gravity distribution of free flowing springs, the latter involving the lifting of water to the level required for subsequent gravity distribution, are examined in more detail. Whilst the system of extraction and distribution were ingenious and complex the constraints of reliance only on human and animal labour were considerable and encouraged the use of small land units.

Secondly, the topography of the oasis, as described in Chapter Three, did not permit a regular uniform pattern of irrigation and cultivation throughout the oasis. The difference between the Saih and Mugharraf system, is not only one of hydrology but also reflects the uneven

nature of the topography. This lack of uniformity which also affected soil development further encouraged small scale land use. Al-Hassa area contrasts with some of the river plains bordering the Gulf such as those found in Khuzestan in southwestern Iran and Basrah in southern Iraq where large areas of flat land with low relief are found. The irrigation practices in such areas can be of fairly simple gravity type whereas in al-Hassa oasis, where the topography even in the relatively smaller area is less uniform and where all water is of sub-surface origin, both gravity and Mugharraf irrigation were practised.

Thirdly, traditional distribution canal construction technology was particularly characterized by making use of natural water courses flowing from springs at different controlling points. The main building efforts were made in strengthening weak banks of the water courses, and in constructing aqueducts and small bridges for the water channels. The materials used in these activities were stones, mudbricks, soil and date palm timber. The pattern of channels therefore reflected a human use of natural physical features rather than an imposition of a totally artificial net of engineering works. This piecemeal minor modification of natural topographic features was carried out over many centuries by hundreds of individuals and families each seeking to maximise, independently, the productive potential of small plots of irrigable land for mainly subsistence purposes. Over the centuries many separate water sources were tapped and used, and whilst

some customary observances developed to avoid conflict over competition for water and land, no general cooperation or coordination either evolved or were imposed by any authority until 1967.

Wakuti (1969) listed 336 wells in the oasis area and 162 springs (including 35 large springs). Some of the wells are of depths of between 100-180 meters and a few with depths of 250 meters. All the springs were originally artesian, but the artesian pressure has fallen since the expansion in the use of pumps and the introduction of modern drilling rigs to the region, thus reducing the volume of free flow. As both hydrological and economic changes took place even before the 1950's, so the complexity of the irrigation system and landholding pattern increased, and traditional technical reaction to change introduced even more rigidity into the farming scene.

Fourthly, the traditional energy sources in the oasis depended on animal (donkey) and human energy for water extraction for irrigation purposes. An example of this is the mugharraf irrigation. Another source of energy used in irrigation is the utilization of gravity for distribution of water. In relation to cultivation and land layout, animal and human power availability also dominated farming processes in the oasis.

Traditional agricultural practices through the centuries therefore resulted in a non-planned assemblage of small cultivated land units which has affected greatly the introduction of new technology. Further, the small-scale

patchwork of irrigated landholdings, during the long pre-scientific period with simple technology, made adequate drainage impossible in the oasis. As in al-Qatif, the greatest long-term resource problem became the deterioration of soil caused by inadequate drainage. (see Chapter Three).

2.3 CROPS

The al-Hassa oasis is one of the most important agricultural regions in Saudi Arabia, leading all areas in date palms as well as producing large quantities of vegetables, fruits and alfalfa. It is also the only important rice producing area in Saudi Arabia.

In an area of traditional agriculture, crop production in the oasis was highly labour intensive where everything was done by hand and using animals to some extent,and where the high density of population provided a cheap labour force. This situation is still witnessed in the oasis in spite of the rise in labour costs which has recently taken place.

There are no records for earlier periods but the data on the main crops produced in al-Hassa oasis in the1960's and 1970's indicate approximately what would have been the normal traditional balance.

Tables 2.1 and 2.2 show the crops which were grown.

Table 2.1 Area under main crops, 1960

Crop	Area (ha.)
Date-tree with or without sub-cultures	4,750
Alfalfa	880
Rice	1,150
Other crops such as vegetables and fruits	1,900
Total	7,900

Source: Wakuti Consulting Engineers (1969), p.14.

It can be seen from Tables 2.1 and 2.2 that although the area under date cultivation has declined by 13.24%, it has increased as a proportion of the total cultivated area from 60% (in 1960) to 69.75% (in 1970). Meanwhile the area under alfalfa has increased by about 30%, and the area under rice has decreased sharply.

Although it appears from the tables that the area under fruit and vegetable cultivation has declined by 70%, this is actually not a true picture. Because, first, while there were no specialized fruit and vegetable farms before 1960; the author's personal experience indicates that farmers have since then shown a tendency to introduce and cultivate fruit and vegetables, encouraged by the growing demand for them in markets locally and in the whole region, improved marketing and transport (all of which are

Table 2.2 Land Use in al-Hassa Oasis in the early 1970's

Crop	Area		Production Tons	Yield Tons/Ha
	Donums [a]	% of Total		
Date Palms	41,210	69.75	46,751	11.35
Pomegranates	1,911	3.23	4,506	23.58
Other Fruits	894	1.51	2,067	23.12
Tomatoes	1,038	1.76	1,937	18.66
Dry Onions	510	0.86	518	10.16
Okra	144	0.24	100	6.94
Watermelons	127	0.21	333	26.22
Egg Plant	122	0.20	265	21.72
Radishes	121	0.20	119	9.83
Squash	115	0.19	147	12.78
Pumpkins	88	0.15	163	18.52
Green Onions	76	0.13	66	8.68
Lettuce	73	0.12	274	37.53
Cucumbers	72	0.12	151	20.97
Other Vegetables	144	0.24	222	15.42
Alfalfa [b]	11,336	19.19	93,593	82.56
Other Fodder Crops	125	0.21	-	-
Rice	498	0.84	72	1.45
Wheat	300	0.51	45	1.50
Barley	174	0.29	29	1.67
	59,078	100.00		

Source : Humaidan, S.H., (1980), p.31.

Note [a] 10 Donums = 1 hectare.

[b] Mostly grown under date palms.

confirmed by the author's personal experience); and high net returns (see Chapter Five). Secondly, the oasis is increasingly characterised by intercropping, which means that the whole area dominated by date palms also produces fruit and vegetables. Indeed the proportion of fruit trees to date palms often reaches one to one (personal observation. Se also El Prince et al. 1982).

A - Dates

Dates are the most important crop in al-Hassa oasis as they occupy 93% of the total cultivated land (El Prince et al, 1982). The dates produced in the oasis include some of the best varieties found in the Arabian Peninsula, particularly the khalas. Dates in the past were the main staple diet in the region and particularly for the bedouins, the low quality dates being used for animal feeding. In addition palm trees contributed in many other ways to the livelihood of the people of the oasis, used in house building, for heating and cooking, as well as in making mats, baskets, hand fans and ropes.

More than 20 varieties of date are produced in the oasis. The best and most commercially important of these are shown in Table 2.3.

Table 2.3 : Numerical Proportion of Date-Palm Varieties in al-Hassa Oasis

Variety	%	Quality
Khalas	15	Excellent
Sheishi	4	Good
Shebeibi	6	Good
Rizez	60	Low*
Other	15	Varied
Total	100	

Source : Al-Ghazal, A.A., (1981), p.8.

It can be seen from Table 2.3 that the top three varieties constitute only 25% while the lower quality Rizez variety alone occupies 60% of the palm trees.

Considering date production in the oasis, the earliest estimate of average date production in 1905 was made by Lorimer (1908) to be 51,000 tons. Later, Vidal (1955) in 1951 gave an estimation for the number of palm trees as 2 million but he gave no production figures. Some more recent estimates of the production of dates in the oasis are shown in Table 2.4. Further estimates of date production up to 1983 will be discussed in Chapter Five.

* Note: Other objective qualitive assessments would place the Rizez variety in the good quality category, a judgement with which the author agrees.

Table 2.4 Date Production in al-Hassa Oasis

Year	Production in Tons
1955	62,500
1960	32,000
1967	37,331
1970	47,000
1976	46,500

Source: Ied, S.Y., (1979), p.295

It can be observed from this table that the highest recorded production was in 1955 (62,500 tons) from which it dropped dramatically in 1960 to only half the 1955 production. The production later began to rise but it has never again reached the high production levels characteristic of at least the end of the period of traditional farming.

Abder Rahman and Abdelhadi (1982) have pointed out that some spatial differentiation in the choice of date varieties was common before the irrigation and drainage project was established. Khalas dates, the most valuable, appear to have relatively low salt tolerance and were mainly grown near to springs where water of low salinity was available and soil waterlogging least developed. The Rizez variety, most tolerant and less valuable, could be grown on the more extensive lower lands furthest from the water sources but which received water which had become

more charged with soluble salts and were most prone to waterlogging (see also Chapter 3).

B - Cereals

Many cereals are known to have been traditionally important in the oasis, the most important of them being rice. Other cereals were and are wheat, barley, maize and sorghum. Rice in particular has especial importance in the Hassawi diet. Cereal crop cultivation goes far back into the history of the area, but imported grain is reported to have increased during the twentieth century. As a result,local production remained small until the Second World War when the area under grains increased and cereal cultivation was found on about 3,500 farms because of the unavailability of imports (Ied 1979). The area devoted to cereals seems to have shrunk again, first as a result of interruption to the flow of imports being removed and, secondly, as the competition became stronger of cheap imported cereals, the flow of which responded to the growth in foreign currencey brought by oil exports. In addition, certain discouragements of cereal growing followed the establishment of the irrigation and drainage project in 1972.

As mentioned above, the earliest estimates of production were made in 1905 by Lorimer (1908) based on the Turkish tax on cereals. Rice production according to these estimates was about 3,800 tons, and wheat about 600 tons. However, these figures should be taken with

caution as the Turks were used to exaggerate their estimates of production so as to raise more taxes. Unfortunately there are no other data available and the only evidence of change has been obtained orally. The grain production in the oasis in 1971-1972 is shown in the following table.

Table 2.5 : Cereal Production in al-Hassa Oasis (1971-72)

Crop	Production in Tons
Rice	68
Wheat	30
Maize	72
Sorghum	28
Barley	17
Total	215

Source : Ied, S.Y. (1979) p.293.

It can be observed that by this date cereal production, compared with date production was extremely low.

C - Rice

Al-Hassa oasis was particularly famous in the region for producing and exporting rice, the Hassawi variety being characterized by its red colour. Rice is usually cultivated (in basins called Dwahi) in a rotation with some vegetables such as onion, okra, egg-plant,

beans and tomatoes, the basins edged generally by date palms. The crop is sown between late May and early June and harvested in about five months after sowing.

Table 2.6 shows that the production of rice decreased considerably between 1965 and 1972. The increase witnessed in 1975 (3,000 tons) can be related to the cash grants paid by the Ministry of Agriculture and Water to the farmers to encourage them to produce more crops.

Table 2.6 : Rice Production in al-Hassa Oasis

Year	1965	1968	1969	1972	1975
Production in tons	2,049	990	1,000	68	3,000

Source : Ied, S.Y. (1979) p.442.

However, for several reasons such as the crop's high demand for water and manual labour, and the competition of imported rice, the crop is no longer of any importance.

D - Alfalfa

The Hassawi strain of alfalfa is the only one to have been grown in the oasis for as long as folk memory extends, and as with other local strains grown in the region "has consistently been proved superior to a wide range of imported alfalfa varieties" (Cresswell 1978). The main forage crop, the area under this production has for many years been second only to that under date palms. Alfalfa is usually grown for about three to five years before

reseeding, in irrigated basins. Traditionally, animal manures were used to fertilise the crop but chemical fertilizers have recently been utilised. Alfalfa was not only produced for the farmers' own livestock but has also always been sold as a cash crop.

E - Fruit and Vegetables

Fruits and vegetables were grown in the past to meet local needs. They were generally not grown separately but usually planted among the palm trees. They had no commercial significance in the past as most landholders grew fruit and a small range of vegetables for their own use, but recently specialised production for sale has increased and together they are next to dates in importance as cash crops.

The most important fruits grown in al-Hassa today are grapes, figs, peaches, apricots, lemons, rough lemons, pomegranates, and water-melons. The most important vegetables are tomatoes, onions, okra, egg-plants, carrots, peppers, cucumbers, lettuces and pumpkins, but traditionally small amounts of many others, such as chard, parsley etc. were grown for household consumption. In the oasis as a whole the range of vegetables and tree crops has always been fairly extensive but the range appears to have been quite small on any particular holding.

D - Crop Cultivating Systems and Husbandry Requirements

A. Palm trees

The palm trees reproduction normally occurs in one of two ways, propagation by seedlings and vegetative propagation by offshoots. The latter method has always traditionally

been favoured in al-Hassa because, whilst there is only a limited natural growth of offshoots, propagation is true to type and best quality date palms can be selected. In this method the shoots appearing at the lower part of the trunk are cut and planted usually at six metres spacing (see Chap. 2.5). This method also works best when date palms are well maintained and numerous since the growth of offshoots becomes less vigorous when palms are neglected and as they grow older, and because it takes 4 to 6 years for offshoots to grow to a stage of suitability for planting (Bondok and El-Hana Wey, 1982).

Palm tree cultivation consists of several processes of which the most important are as follows.

Hoeing (using sakhkin-hoe) is executed for purposes of loosening the soil as well as cleaning it from weeds. Other tools such as the sickle (mihashsh) for cutting vegetation are used. Because of the high traditional density of the palms ploughing between the trees was not practised.

The application of fertilizers as a process accompanies hoeing and cleaning,and all are carried out after the date harvest when the farmer has ample time for crop husbandry. The farmer usually divided his date garden into two parts to be fertilized alternately every two years because annual application was expensive in time, labour and materials. Before the introduction of artificial fertilisers, local organic materials were used, animal manure mainly from cows and donkeys, and derived from the burning of the leaves and dry parts of the plant.

Palm trees have to be cleaned and trimmed in the following ways if production is to be maximised. The removal of dead fronds is necessary to protect the tree from infection by insect pests which otherwise severely damage the palm. The selective removal of the fronds is done to encourage fruiting. The removal of thorns which may injure the dates during their development also makes easier the hand pollination of the palms, so this process is usually executed before the pollination period. Hand pollination was and is extremely demanding of skilled labour.

It is known that palm trees can survive water deficiency for many consecutive years because of their extensive rooting systems. This is particularly true in al-Hassa where the natural water table is generally high (see Chapter Three). However, yields are adversely affected. It is noted also that the date palm is not severely affected by over-irrigation. The irrigation system traditionally followed in al-Hassa is basin irrigation where the area is divided into large elongated basins sub-divided into smaller ones which are irrigated from distribution channels (msanah). Where the palm trees are intercropped with other crops, furrow irrigation is practised. The palm trees traditionally were irrigated on average twice or more times a week but practice varied greatly according to the local depth of water table, soil conditions, irrigation water availability and palm variety. In general there was a tendency to over-irrigation, which hastened soil-water deterioration.

During the centuries of subsistence orientated agriculture, careful date palm husbandry demanded considerable manual labour inputs throughout the year.

B. Rice

Rice is sensitive to cold weather so it is cultivated only in the period between June and November; the rice plots are usually put under vegetables during the winter. The crop was usually sown in nursery plots and then transplanted to the main plots (dwahi) described earlier in this chapter. Weeding and fertilizing were carried out usually 3-4 weeks after transplantation. The fertilizing of the rice plots was similar in type to that of palm trees, but the process was repeated two months after transplantation. At the harvest stage the crop heads were cut by hand and collected together. The crop was then threshed by a group of donkeys treading the grain on a circular platform, the animals tied to a central pole. The rice was later hand winnowed in the wind. Rice because of its high demand for water was irrigated once every 2-3 days and at the heading stage was permanently inundated. Here too, a considerable amount of labour went into land preparation, crop husbandry, irrigation and weeding.

C. Other Crops

The cultivation of other crops usually shared some of the agricultural processes mentioned above, following or going hand in hand with the processes practised in the palm and rice cultivation. Since there were few, if any, special plots given over to these crops, which were normally

inter-mixed with other plants, the tendency again was to over water, or at least not to apply irrigation water specifically to meet the requirements of these secondary crops.

2.4 TRADITIONAL IRRIGATION SYSTEMS

Introduction

Two main irrigation methods have long been used in the cultivation of the crops considered in Chapter 2.3, namely saih and mugharraf. Both of these irrigation methods, examined below, resulted in the rise in the groundwater table, the increase in the soluble salts content of irrigation water, as well as the expansion of the area of salinised land.

The farmers' tendency towards over-irrigation which produced increasing soil and water salinity resulted from average irrigation periodicity of twice a week in winter and three to four times a week in summer. This periodicity was dominated by the perceived requirements of the dominant crops, date palms , alfalfa and rice,on sandy loam soils which when well maintained have a low water holding capacity (see Chapter 3.4), and given the high evaporation and transpiration rates (see Chapter 3.3).

By the early 1950's the agricultural areas in the oasis were estimated to total 16,000 ha. (Wakuti 1969). The combination of over-irrigation and the successive re-use of irrigation water which passed from plot to plot built up the soil salinity, and because of the absence of a good

drainage system, the area actually carrying crops was much smaller.

Wakuti surveys (1963) indicated that the total irrigated area in al-Hassa was then about 8,000 has. Furthermore, in 1965 the area actually under cultivation was estimated as 4,000 has. (Bowen-Jones 1979). This situation appears to have developed as a result of the combination of the impact of sand movement (see Chapter 3.2) and the deteriorating conditions of soil and drainage in the oasis.

The general dominant characteristic of agriculture in the oasis today is still its traditionalism. Primitive farming practices and agricultural tools are used. In addition, most of the farms in al-Hassa oasis are too small to be economically viable. It can be seen from Table 2.7 that 52.1% of the farms are below 5 donums in size and account for 14.1% of the total cultivated land, while 76% are below 10 donums, and comprise 31.2% of the total land under cultivation. Moreover, the proportion of land under date palms is highest in the smallest farms. It should be realised that until the 1950's agriculture was of a subsistence nature, based upon dates, for which small size of farms was traditionally not a disadvantage. It has only become one because it is an obstacle to modernization, and because in the changing economic situation the small size of farms makes it more difficult for farmers to obtain adequate financial returns (see Chapter 6) relative to those returns from non-agricultural activities.

Table 2.7 Farm Size Distribution in al-Hassa Oasis[a]

Farm Size Donums	Farms		Land in Farm		Cultivated Area		Area in Palms	
	Number	% of Total	Donums	% of Total	Donums	% of Total	Donums	% of Cultivated area
0-2	953	11.78	937	1.15	902	1.35	817	91
2-5	3,263	40.33	9,091	11.10	8,600	12.72	7,556	88
5-10	1,931	23.87	12,581	15.37	11,574	17.12	9,668	84
10-20	1,132	13.99	14,810	18.09	13,703	20.27	11,138	81
20-40	536	6.62	13,965	17.06	12,306	18.21	9,245	75.20
40-60	141	1.74	6,542	7.99	4,999	7,39	3,104	62
60-100	62	0.77	4,302	5.26	3,175	4.69	2,047	62.25
100-200	37	0.46	5,287	6.46	3,746	5.54	1,284	34
200-500	30	0.37	8,254	10.08	4,921	7.28	1,347	47
Over 500	6	0.08	6,097	7.44	2,624	5.43	457	9.5
Total	8,091	100.00	81,866	100.00	67,588	100.00	46,663	69.04

Source : Humaidan, S.A. (1980), p.36.

Note [a] Includes some farms outside al-Hassa Irrigation and Drainage project.

[b] 10 Donums = 1 hectare.

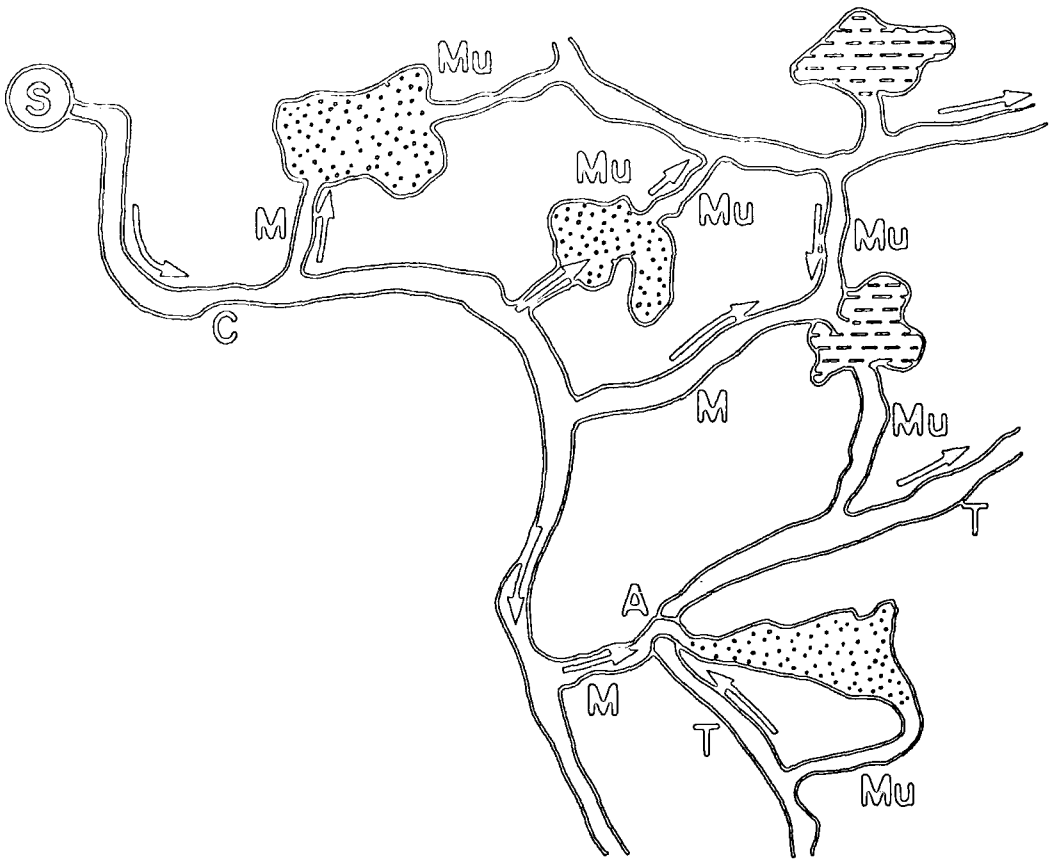
Land use in al-Hassa today can be safely said to be due to four factors; First, historically speaking, the long period that al-Hassa has been settled, at least 2,500 years (see Chapter 1). Secondly, the tremendous number of natural flow springs and the importance of their water in such a hot, arid zone resulted in a complex pattern of settlements and water distribution (see Figs. 2.1 and 4.4 - location of villages). Thirdly, the fact that according to the Islamic law of inheritance, when a landowner dies, all he owns is divided among his heirs. Consequently land holdings were split between them, unless they came to some other arrangements, such as holding the land jointly or selling the land (see Chapter 2.5.2). Finally, there remains the prestige attached to holders of date gardens, as Vidal (1955) mentioned, on account of the relaxation available in their shade and the relief from the harsh climate (see Chapter 3). Date gardens provide pleasant surroundings for social and business discussions. In addition, there is the influence of the story in the Holy Quran which only mentions dates as part of the diet of Mary The Virgin, Mother of the Prophet Lord Jesus, *Peace be Upon him* shortly before His Birth (Quran).

Generally, the farms in the oasis were irrigated by one of two methods usually determined by farm size and location. These were:

A. Saih Irrigation

B. Mugharraf Irrigation

Fig 2.1 Schematic Arrangement of Traditional Water Distribution System



S Spring

C Main distribution canal

M Masqa – secondary canal

Cultivated plot with water right

Cultivated plot with Hurr water

Mu Munajjah

T Thabr

A Aqueduct

A. Saih Irrigation

In this method the water's natural flow from a spring is diverted into channels following the general slope direction. By this gravity flow method, the water is used to irrigate successively farms nearest the spring and then at increasing distance from the source. The water leaving the spring was channelled through a main canal which was tapped by subsidiary irrigation canals (masqa), and diverted into the farm plot field channels - Fig.2.1. Surplus water was carried away by a channel called munajja to a larger canal called thabr. From the thabr the water itself could then be diverted for re-use twice or three times more on lowlying farms. In some cases this already used water was mixed with pure (hurr) water before being used for irrigation. Surplus water eventually found its way on and below the surface to depressions in and around the oasis - the sabkah, salt-flat area.

Over the years a very complex network of canals and channels was developed to distribute water from more than 160 springs and 330 wells to holdings, and the total length of distribution system was far longer than technically necessary for the area under cultivation. The occupation of land was not simultaneously completed and during centuries of waxing and waning prosperity each landholder's irrigation system had to be fitted into the previously existing pattern. As noted in Chapter 2.5 there was no overall planned regulation and the multiplicity of earth distribution channels itself led to considerable loss by evaporation and seepage. The

water loss was in itself unimportant because the availability of ground water exceeded the outflow from springs and extraction from animal and man operated wells. The seepage however caused increasing waterlogging. Canal and channel construction and maintenance became more and more demanding of manual labour, not only because of the great distances involved but also because intercrossings had to be constructed with many small aqueducts (nabah), carrying one farmer's water over another's and to keep separate the clean water (hurr) from the charged water in the thabr and tawiyih canals. Every landholder was responsible personally for opening and closing the "gate" (jussah) allowing water to enter from the masqa, on the understanding that other farmers also needed enough water from the masqa to irrigate their farms. The irrigation times and cycles which developed, varied according to the location of the farm in relation to the masqa and size of the farm. The farms adjacent to the masqa had a better chance of obtaining more pure (hurr) water for irrigation and this location gave the farmer more economic power. Thus farms which had ample water were usually unfortunately over-irrigated, which led sometimes to waterlogging, particularly where impermeable layers lay near the surface.

B. Mugharraf Irrigation

This method differs from saih only really in the way in which groundwater is extracted, although this has consequential effects on other aspects of the irrigation system. Where the land lay higher than the level to which

artesian water pressure rose or even higher than the saih distribution canals, the soils were often suitable for cultivation but the water would have to be raised mechanically. For small landholdings only slightly elevated, then manpower was sufficient to lift water from wells and canals. Donkey power was used where the farms were larger and required more irrigation water as well as where the ground surface was pronouncedly higher than the level of irrigation canal. The distribution systems were similar in type to, but on a smaller scale than the saih system because the quantity of water available was more limited.

The saih irrigation method, according to all the information available and personal experience, was more common and used whenever the water level in canals was high enough to supply irrigation water to the farm by gravity; it was used for all types of crops. The mugharraf method was practised where the water level was not high enough in the canals to supply the irrigation water to the farms and was less suitable than saih for perennial crops such as date palms with large perpetual requirements. This latter method had disappeared gradually since about 1950 as a result of the introduction of engine powered pumps to lift the water from canals to farms thus lessening the input of human and animal labour and allowing an extension of the cultivated area on the higher land.

In al-Hassa oasis the donkey provided the most important means of lifting water, and of pack and draught transport for agricultural and other purposes. Its manure

was used for fertilizer. It is not surprising that the al-Hassa donkey breed became regionally famous. However, tillage and other labour was carried out by manual labour and with hand tools, and the density of planting of palms and the complex and extensive network of irrigation channels and canals were responses to this high input of manual labour. These factors, as well as the small size and fragmented distribution of farm holdings and plots have proved obstacles to the use or introduction of new technologies to improve the agriculture of al-Hassa oasis, as examined in Chapter 5.

2.5 LAND HOLDINGS AND TENURE IN AL-HASSA OASIS

2.5.1 Land Holdings and Water Rights

The origin and early development of the systems of irrigation which for thousands of years made possible the establishment of farms in the oasis is not known. The al-Hassa area clearly was important, both strategically and commercially as indicated in Chapter 1.2. The region had economic and political relationships with other ancient civilizations of the Levant, in Mesopotamia, Persia, India and other parts of the Arabian Peninsula.

In spite of this there is no recorded historical or archaeological evidence to inform us about the beginning and the development of the irrigation system in al-Hassa oasis, unlike that found in Iraq, Egypt, Greece, and Persia. It is very curious that until very recently none of the residents of the oasis wrote or even noted any comments on the history of agriculture and irrigation. One example of the resulting now unanswerable questions is why were springs in the western part of the oasis most commonly used to irrigate farms in the eastern part of the oasis bypassing land nearer to them in the west, or only irrigated a very few farms on their way to the east. This phenomenon is known to have been common throughout the oasis.

The most important factor in determining how agricultural land was taken up and occupied in holdings and plots was quite clearly the availability of irrigation water, the quality of soil being almost certainly of

secondary importance. In the following reconstruction of the situation characteristic of the oasis up to about 1950, two basic land units can be recognised. First, there was (and is) the plot, this being a large or small variously shaped, piece of land which acquired a water right. Secondly, there was the holding or farm which was made up of several plots, often widely separated.

The outstanding characteristic effect of the linking of water rights to specific land units was that the size of the holding was restricted by the water permitted to flow to that holding's plots for specific limited periods which were also determined and limited in their periodicity. In this way the farm owner could not enlarge his holding by the purchase of another piece of land because that purchase would not include any transfer of water rights. At the same time a potential purchaser would also not be allowed to apply water from his original water-right source onto a newly acquired parcel of land because his right to irrigation water was restricted both by time and for a particular plot of land.

The only ways in which the size of farms could be changed, therefore, were by the sale, gift or other transfer of a complete water-right, together with the whole plot of land associated with that particular right, by the opening up of a new water source and the associated exploitation of virgin land, or by the division, through inheritance, of water-rights and associated plots.

In the course of field interviews it appeared that

no-one could remember any past case of a complete water-right being sold. Other forms of transfer are noted below in Chapter 2.5.2. The possibility of exploiting unused water sources thereby creating new water rights and irrigable land seems to have been exhausted decades or even centuries before.

During the early period of the agricultural occupation of the oasis this process of creating new irrigable plots must have taken place. There is also evidence that as sand dunes advanced over cultivated land, particularly in the north eastern part of the oasis, it was also possible, for a time at least, for displaced villagers to move onto, presumably, unoccupied land (Vidal 1980). The division of property by inheritance, on the other hand, certainly led to a division of holdings between those heirs who wished to farm independently, although it seems, from local traditions, that water-rights and the associated plots were, if possible, not divided. Vidal (1980) however, points out that the coveted right to "first use" water, hurr, could be divided, this leading to a further complicating of the canal and channel system and possibly to the fragmentation of plots.

Another aspect of water rights in al-Hassa is that there appear to have been no written rules or regulations for reference in cases of disputes. There were also no institutions developed by local communities to regulate or administrate the use of springs, even though the spring water sources were not private property. No individual or

official seems to have had the right to offer to increase or decrease the amount of water allotted to any plot or landowner.

This absence of traditional institutionalised management is in great contrast to the huerta systems developed by the Arabs in south-eastern Spain (Houston 1964), and to the falaj systems of Oman (Wilkinson 1977).

In reality the distribution of water and the looking after of the main canals leading from the springs were the responsibility of the particular group that utilized specific springs. Another factor, which added to the complexity, is that as the springs differed in their size and strengths of flow so did customs and norms vary from one spring watered area to another.

From all this here it becomes clear that the interrelated issue of water rights and holding plots in al-Hassa oasis was a product of the evolving traditions and norms of Hasawi society.

The end result of a combination of these historical and social processes of the occupation of the oasis by irrigation farmers, and the irrigation technology analysed in Chapter 2.4 was the creation of what was a very rigid and inflexible system.

2.5.2 Land Tenure

One of the characteristics of the agricultural land in al-Hassa oasis is the small size of farms. This is normally a result of physical and sociological factors.

The main limiting physical factor was the restricted availability of groundwater restricted relative to the growing demand over centuries. A second factor is the topographic setting of the area (see Figs.3.3& 3.4) which determined the direction of water flow and the availability of cultivable lands, this partly diminished by the advance of moving sand. The climatic factor, (see Chapter 3.3) produced very high rates of evapotranspiration and therefore water demand; periodic strong winds resulted in moving sand dunes. The main sociological factor is that already mentioned, the division of holdings, according to the Islamic law of inheritance. This system normally results over time in small holdings, as well as the complex distribution pattern of water.

Technological limitations on the ability of farmers to work the oasis through centuries; the difficulty of cultivating extensive units; were the consequence of dependence on primitive tools and human effort supplemented only by animals. Therefore the unit of cultivation by a single family was small, although where a landowner could employ hired or slave labour the ownership unit could extend over several cultivation units. Until very recently also, dependence on transportation by pack or draught animal transport discouraged the build-up of large scale transport and marketing systems, which, in turn, discouraged any attempt to build up large farms.

Lastly, the main reason for cultivation was to produce crops for domestic and family consumption, mostly

by the resident villagers but also by those bedouin who controlled permanently cultivated land in the oasis. Up to about 1960 most families would have thought it shameful to sell surplus fruit or vegetables which were regarded normally as gifts to relatives, neighbours and the poor. Production was mainly subsistence rather than commercially orientated (even though a large total volume of dates was sold outside the oasis); to most holders of land there was little point in trying to expand their holdings beyond that which they needed for their families' consumption. Some notable families, however, did build up fairly large holdings but even then this was mainly to support the family group including retainers and servants.

Sources at our disposal mention five main types of land ownership in the oasis of al-Hassa:

(a) Individual independent ownerships.

(b) Multiple water-right ownership by several individuals who owned precisely delimited separate plots in one area, these plots being irrigated in common, but worked and harvested separately.

(c) Joint ownership, where a group of people own unequal shares of a certain unit of land which is worked, irrigated and harvested in common and the crop is usually divided among the owners in proportion to ownership of land.

(d) "State lands". There lands, which are called Bayt al-Mall, are government property, having been taken over from the Turks. Some of these lands are administered by the Ministry of Finance, some by the M.A.W.

It should be noted that neither Vidal nor those other writers who have drawn on his earlier work have presented any detailed data with regard to the most important types of ownership in al-Hassa i.e. individual, multiple and joint ownership. In fact, the author's own observations and the partial surveys carried out by H.I.D.A (1979), indicate clearly (although quantified data for the whole oasis are still not available) that these ownership types were dominant. Thus most of the cultivated land in al-Hassa is still found in large holdings varying from 500-1,000 maghras,* medium holdings 300-500 and small holdings 50-100 maghras.

With regard to "state land", by the time that traditional systems were becoming affected by the development of governmental bureaucratic administration i.e. between the 1910's and 1950's, in practice most of this land either:

(a) Belonged to the Ministry of Finance which administered land which had been taken from the Ottoman administration in al-Hassa by the conquest of the region by King Abd al-Aziz.

(b) Came under the control of the Ministry of Agriculture and Water as formerly uncultivated land (called al-Aradi al-Bur) which could be granted to would-be farmers.

One other type of tenure waqf, is not mentioned in other studies except for a brief mention by Speetzen (1974) who limits it to land held by a mosque. Actually, there

---

* Maghras (pl.maghāris), a local measurement usually equals 6 x 6 metres e.g. 500 maghras x 36 sq. m = 18,000 sq. m. The 6 metre unit is that generally used for the spacing of date palms (see Chap. 2.3.).

are two types of waqf land; the first refers to a piece of land given to endow a religious or similar institution such as a mosque, madrasah (school) or cemetery. The second is an endowment of land in the names of certain respected person or persons on conditions that he or they should give the landlord's proportion of income to the poor annually as alms.

Traditionally, therefore, land was owned under a system which conformed with Islamic Law and which had evolved during a long period in which customary practices were observed by tribally organised village and bedouin communities. Apart from the limited duration Ottoman administration there was no central authority or administration to regulate matters until the Kingdom of Saudi Arabia developed national government agencies and policies. Ultimately, land was equated with water rights and the survival needs of the inhabitants of the oasis.

2.5.3 Land Tenancy In Al-Hassa Oasis

Land tenancy in al-Hassa traditionally was based on an agreement between the landlord and tenant in which a fixed proportion of the harvest was paid by the latter to the former as an annual rent. However, Vidal (1955) Abul-Ela and Speetzen (op.cit) each state or repeat that the quantity paid by the tenant was determined by the landlord according to the best crop that the land had ever yielded, which in many cases would have a very bad effect on the tenant. In fact all the evidence personally collected by the author shows that agreements were not

generally dictated by the landlord but were preceded either : by negotiation between the two parties leading to a "gentleman's agreement"; or through a middleman, the tenant ensuring that the final agreement was as much to his benefit as possible.

Land was customarily leased for 3 to 7 years (which could be renewed) for a fixed annual rent usually stated as a proportion of the harvest crop but depending on the type of crops that could be grown given the land and water in question.

Most tenanted land is owned by waqf and Bayt al-Mūll property organisations. For the landowning organisations a responsible agent, the wakil, arranges the agreement with the tenant. Few individually owned holdings were (and are) tenanted because they were usually operated by their owners or by hired labour.

Very rarely are long leases for 33, 66 or 99 years arrived at by private agreement. In some cases leases were arranged for waqf land where the holder of such leases was unable to work the land, or dies.

The customary ways of holding land were, in fact, extremely complex and, as will be noted later, made any rearrangement of plots, holdings and water rights for purposes of improving general irrigation efficiency, very difficult.

2.6 TWO HYPOTHETICAL TRADITIONAL FARM HOLDINGS

In order to illustrate the way in which the various elements of traditional farming were combined in practice, an attempt is made here to reconstruct two hypothetical farms, one large, the other small, as they would have been at the end of the traditional period. The memory of older people in the oasis and the knowledge which the author has acquired concerning his own family's farms, have been put together with what other scanty evidence is available.

A. A large farm

The area of this large holding totals about 1,000 maghras, i.e. about 3.6 ha. The farm holding is made up of 3 whole cultivated plots and two parcels of land, one of which was in each of 2 other plots. One of the wholly owned plots had hurr water rights and one of them was tawayih water. The two separate parcels share hurr water with the other plot-owning partners, brothers of the owner of the holding. The farm-owner, of a sheikhly family, is also a merchant and most of his cash income comes from his business, the rest from the sale of dates. He spends very little time on working his land but together with one of his two sons looks after the rice cultivation on one of the parcels.

Plot 1 watered by saih irrigation has date palms, of which half are the Khalas variety. Plot 2 also saih watered carried date palms, 30% Khalas, the non-Khalas varieties intercropped with alfalfa grown to feed the

farm livestock. Of plot 3, half the area is occupied by old date palms which are being replanted, the other half under unproductive date palms or partly so. Plot 3 has saih irrigation but is surrounded by mugharraf irrigation land and has waterlogged saline soil. The second parcel of land has edge-planted khalas dates but is cropped by rice. After the rice harvest onions, okra, egg-plant, tomatoes and other vegetables are grown.

The owner and his family live in a village house not on the farmland. He hires 3 permanent labourers to look after the irrigation on the three plots and the rice growing parcel. The remaining parcel is irrigated and cultivated by a neighbour who shares the date crop with the owner. Up to eight additional temporary workers are employed at peak periods in the date gardens. Permanent irrigation labourers are paid partly in cash and partly in kind. Temporary workers at harvest time and other times are paid similarly. Only three donkeys are needed because there is no mugharraf irrigation. Two cows are kept in the household.

B. A small farm

The total area is about 270 maghras in one plot and two parcels in a different plot. The whole plot is irrigated by saih and has hurr water, the two parcels are irrigated by mugharraf and also have hurr waters. The plot carries khalas date palms and rice whilst the two parcels are used for Rizez dates, alfalfa, and for mixed fruit trees. The farmer's income comes mainly from cultivating his own land

but also he is hired as a permanent irrigation labourer on a neighbouring farm and also as a temporary labourer on another farm. At the date harvest and for the cleaning of the date palms he will hire temporary labour and receive help from a neighbour. Most of the male members of his family will work on the holding but will also act as hired workers, sometimes transporting goods by donkey, since donkeys are kept for mugharraf irrigation and three others for general use and hiring.

Conclusion

By the mid twentieth century a relatively inflexible system of irrigation farming had been established for centuries in al-Hassa oasis. The inflexibility arose because of the tight, logical, working inter-relationships between all aspects, technical, social and economic, of rural life as a response to specific resource opportunities and limitations. As will be seen, any alteration in the internal balances e.g. through the introduction of engine powered pumps, or external balances e.g. alternative sources of income were disruptive. At the same time the strength of attachment of the Hassawi to the ownership of farmland remains strong.

CHAPTER TWO

REFERENCES

Abder Rahman and Abdelhadi (1982), The Effects of Irrigation and Drainage Methods, Water and Soil Conditions on the Distribution of Date Palm Varieties, The First Symposium on Date Palm In Saudi Arabia, King Faisal University

Abdul-Ela, T.M., (1959), A Geographical Study of Man and His Environment in Al-Hassa Province, Saudi Arabia, (Unpublished Ph.D. thesis), Trinity College, Dublin.

Al-Ghazal, A.A., (1981), A Comparison of Date Production Costs, Returns and Marketing in al-Hassa, Saudi Arabia and Indio California For 1979. (Unpublished M.A. Dissertation) State University, Freson, California.

Bondok et al (1982), Tissue Culture As A Tool in Date Palm Propagation, The First Symposium on Date Palm In Saudi Arabia, King Faisal University.

Bowen-Jones, H., (1979), Land Use In Al-Hassa Oasis, Unpublished Report To the M.A.W. of the Kingdom of Saudi Arabia.

Cresswell (1978), Interim Report Prepared by the University College of North Wales Team at H.A.R.C. to Highlight Research Finding of Immediate Application to Saudi Arabian Agriculture.

El Prince, A.M. et al (1983), Use of Computer Graphics in Developing Density-maps For the Date Culture of al-Hassa Oasis, Saudi Arabia, The First Symposium on Date Palm, King Faisal University.

H.I.D.A. (1979), Land Use Survey, published by al-Hassa Irrigation and Drainage Authority, Al-Hassa,Saudi Arabia, (in Arabic).

Houston, J.M., (1964), The Western Mediterranean World, Longman, London.

Humaidan, S.H. (1980), Policies and Management Guidelines For Optimum Resource Utilization At al-Hassa Irrigation and Drainage Project, Saudi Arabia (Unpublished Ph.D. Dissertation), State University, Oklahoma.

Ied, S.Y., (1979), Agricultural Geography of al-Hassa Oases, Saudi Arabia, (unpublished Ph.D. Thesis), University of Cairo, Egypt, (in Arabic).

Lorimer, J.G. (1908), Gazetteer of the Persian Gulf, Oman, and Central Arabia, Vol.II, Calcutta, India.

The Holy Quran, Sura XIX 25 and 26, Translation of Abdullah Yusuf Ali, Dar al-Arabia, 1968.

Speetzen, H., (1974) Land Settlement Project and Agricultural Development, An Analysis of Development Factors and Processes based on Four Case Studies in China, Libya and Saudi Arabia, (Unpublished Ph.D. thesis), University of Durham.

Vidal, F.S. (1955), The Oasis of Al-Hassa, Dhahran, Saudi Arabia.

Vidal, F.S. (1980), Development of the Eastern Oasis: A Case Study of Al-Hassa Oasis; In King Faisal and the Modernization of Saudi Arabia, Ed. Beling, W.A., Croom Helm, London.

Wakuti Consulting Engineer (1969) Report, Final Design For the Project of Improving Irrigation and Drainage in the Region of al-Hassa, Saudi Arabia, Zug, Switzerland.

Wilkinson, J.C. (1977), Water and Tribal Settlement In South-East Arabia, Clarendon Press, Oxford.

CHAPTER THREE

PHYSICAL RESOURCES FOR AND PHYSICAL FACTORS INFLUENCING AGRICULTURE

Introduction

For more than two thousand years the use of traditional techniques by traditional societies, as described in Chapter Two, implied some deliberate modification of the natural environment through irrigation. However, this modification compared with what is now possible was very limited and the controls exerted by physical factors were very strong. In this chapter the nature and characteristics of the physical resources available to farmers are described and analysed in terms of the actual opportunities and constraints as seen by local inhabitants at that time.

3.1 The Basic Geological Controls

Al-Hassa oasis owes its existence to some basic elements in the geological structure of the Arabian Peninsula. The Peninsula itself, except for the extreme south-eastern corner, is formed by a single tectonic plate composed of ancient sedimentary and volcanic rocks, deformed and metamorphosed, and injected by plutonic intrusions.

At the beginning of the Cambrian period, a great sedimentary geosyclinal basin had developed north and east of the Arabian Plate in the area now occupied by Turkey, northern Iraq, and southwestern Iran (Al-Sayari & Zött 1978). Throughout Paleozoic, Mesozoic, and early Cenozoic times many thousands of metres of sediment accumulated in this deep, slowly-sinking trough aligned along the junction

between the Arabian and Iranian plates. In the Late Cretaceous, marine strata in the geosyncline were buckled into great folds and sliced by great overthrusts.

In the Middle Tertiary, along the line of what was to become the Red Sea, the Arabian Plate's movement away from the African Shield accelerated and whilst there was a general eastward dip of the basement throughout the Paleozoic and Mesozoic and during the Tertiary orogeny, the Arabian Plate remained relatively stable, and its cover of shelf sediments was barely disturbed (ibid) (See Fig.3.1).

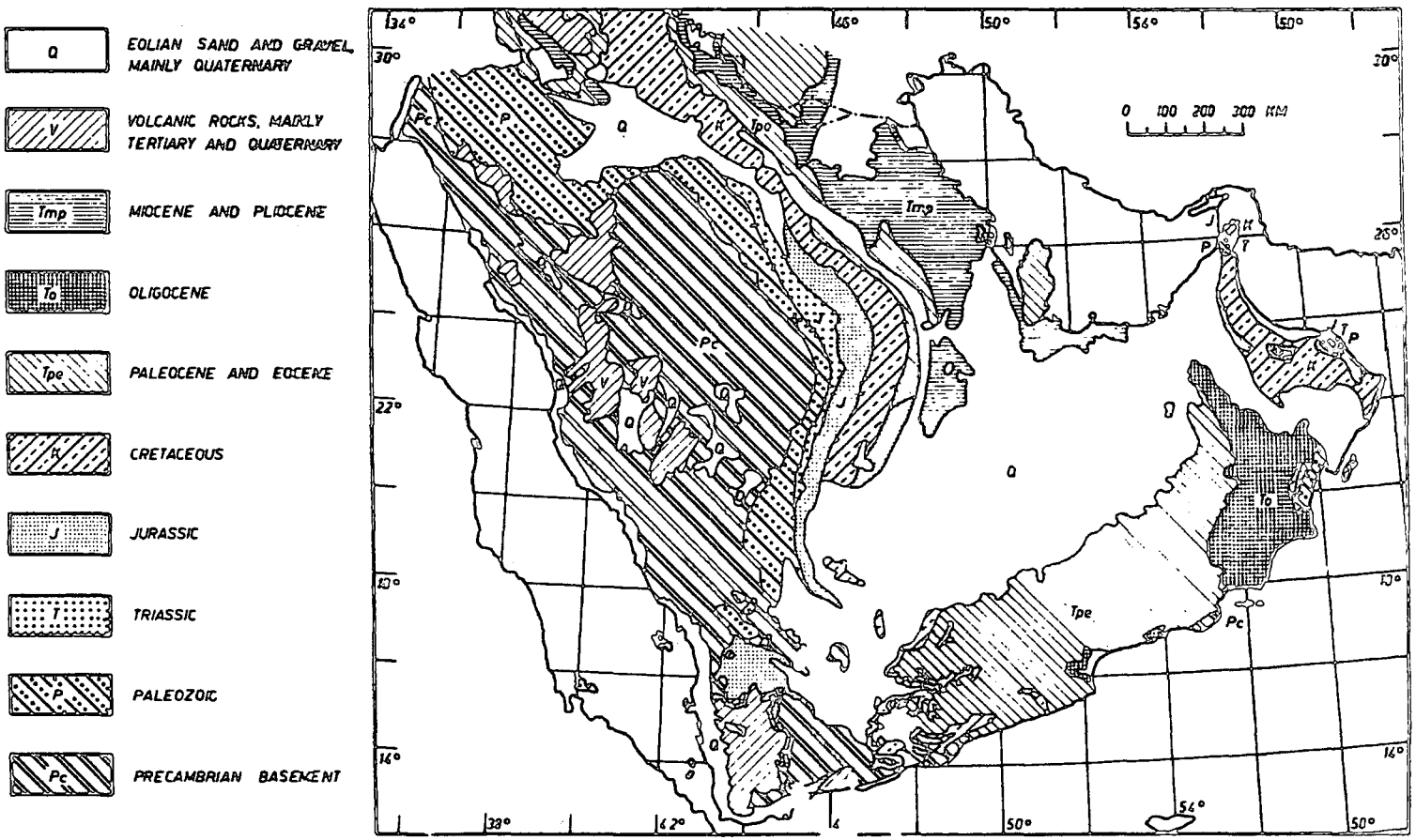
Geologically, the al-Hassa region is a part of the Arabian Shelf on which the Mesozoic and Cenozoic series of strata dip slightly towards the east, overlying older formations (Saxen 1967). In the region the outcrops consist only of Tertiary and Quaternary sedimentary rocks. The topography and the hydrology of this region is strongly influenced by the Ghawar structure formed by Cretaceous and Lower Tertiary tectonics (Al-Sayari & Zött 1978).

The surface geology as shown in Figure 3.2 is relevant here in its relationship to topography, soils and hydrology :

1. Hofuf, Dam and Hadrukh formations

(a) Hofuf formation (THF): this is cream and white sandy marl and cream tan rubbly sandy limestone with minor calcareous sandstone and shale; in some areas marly quartz gravel layers occur in lower part; no marine fossils. Of Pliocene age.

Fig. 3.1 Generalised Geologic Map of the Arabian Peninsula



(b) Dam formation (Td): this is pink, white and gray marl and red, green and olive clay; minor sandstone and white and cream marly and chalky limestone and coquina; marine fossils at many horizons. Of Miocene age.

(c) Hadrukh formation (Th): this is gray, green, white, and pink calcareous silty sandstone, sandy limestone, and marl; locally cherty; at places contains non-marine fossils; Marine fossils found only near Qatif in a few thin layers of upper part. Of Miocene age.

Where Hofuf, Dam, and Hadrukh formations are not divided, equivalent beds of brown, red, tan, white, and pink marly sandstone, sandy marl, and sandstone, sandy marl, and sandstone (locally cherty) are found.

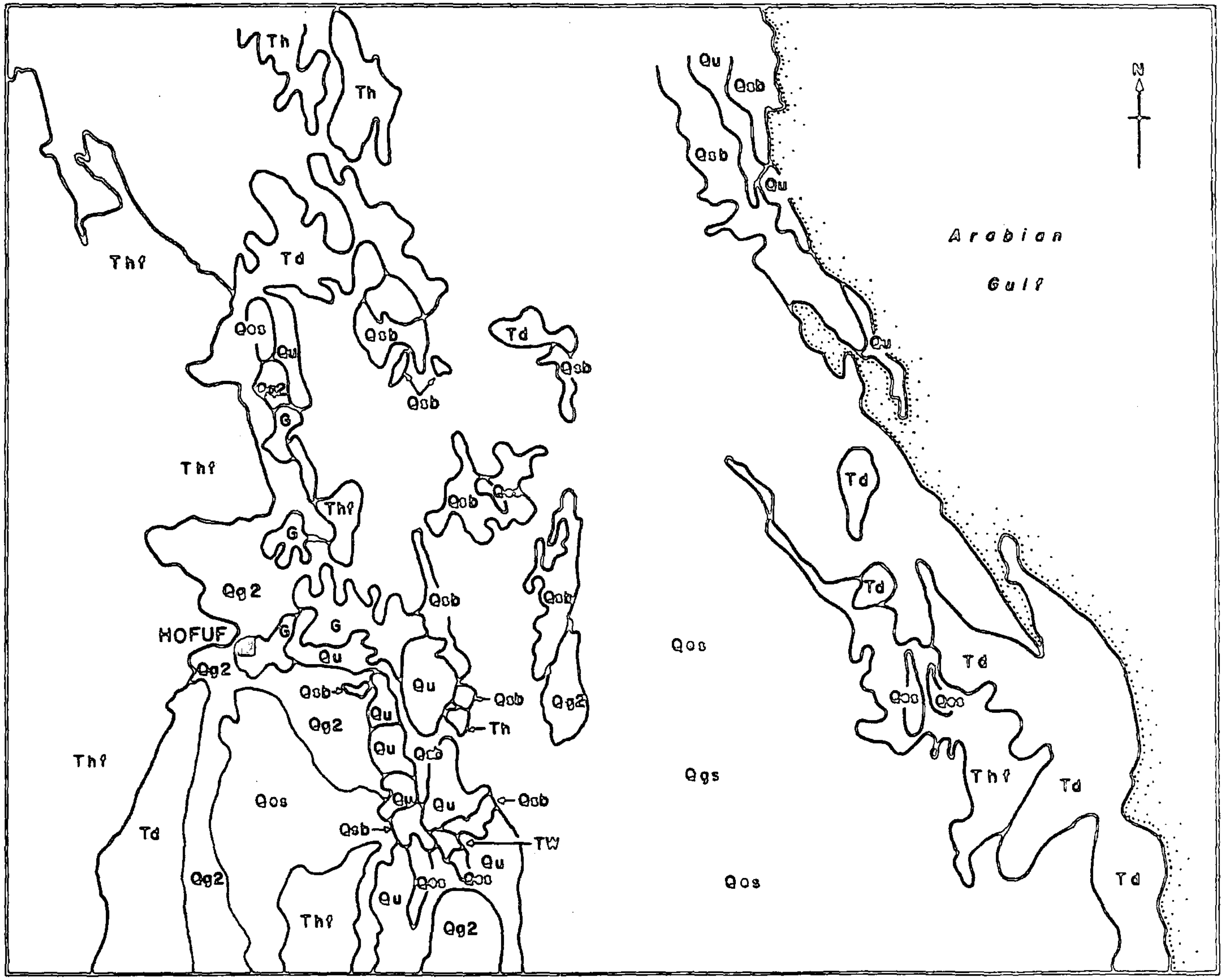
2. Unconsolidated Sedimentary material

Quartz or mixed limestone and quartz gravel in terrace deposits obviously related to present or recent drainage (Qgl); sheetlike lag gravel deposits of quartz and other pebbles from the basement complex (Qg2).

3. Silt and Gravel

Silt and associated fine sediments including caliche-like and gypsiferous deposits in undrained depressions (Qs); gravel composed chiefly of limestone and other gravels in some areas (Qg); unconsolidated surface deposits of silt, sand and gravel; may include unrecognised equivalents of other units of quaternary age (Qu).

Fig. 3.2 Geological Structures (for key see text)



Source: Directorate General of Petroleum and Mineral Affairs Survey, Miscellaneous Geologic Investigations 1958 AD, 1378 AH, 1:500,000

4. Sabkah deposits

(Qsb), silt, clay, and muddy sand, commonly saline, underlying coastal and inland playas.

5. Qee, Aeolian sand

(a) Transverse dunes; predominantly simple and compound Barchan dunes in areas of more mobile sand and/or simple rounded ridges, both oriented transverse to the prevailing wind direction.

(b) Longitudinal dunes; primarily dakākah and various types of undulating sand sheets, in general characterized by elongation of individual topographic forms parallel to the prevailing wind direction, often partially stabilized by sparse vegetation.

6. The Plains of the Hofuf area

This formation belongs to the Quaternary system and can be divided into two areas:-

(a) The area which is only partly cultivated consists essentially of unconsolidated deposits of silt, sand and gravel. In some parts also sheet-like gravel deposits of quartz and other pebbles from the basement complex are to be found (Wakuti 1969).

(b) The cultivated areas are mostly formed of Aeolian sand sediments covering partly the older Quaternary layers and mainly the Young Tertiary sandy marls or calcareous.

It can be concluded that most of the region under discussion consists of sandy formations which consequently affect the soil types and hydrology, as well as the topographical structure of the area.

3.2 Topography of The Al-Hassa Region

Figure 3.2, surface geology, indicates how the basic geological structural elements are distributed in the area. Geomorphological processes have, since Late Tertiary times, finally moulded the landscape, Fig. 3.3.

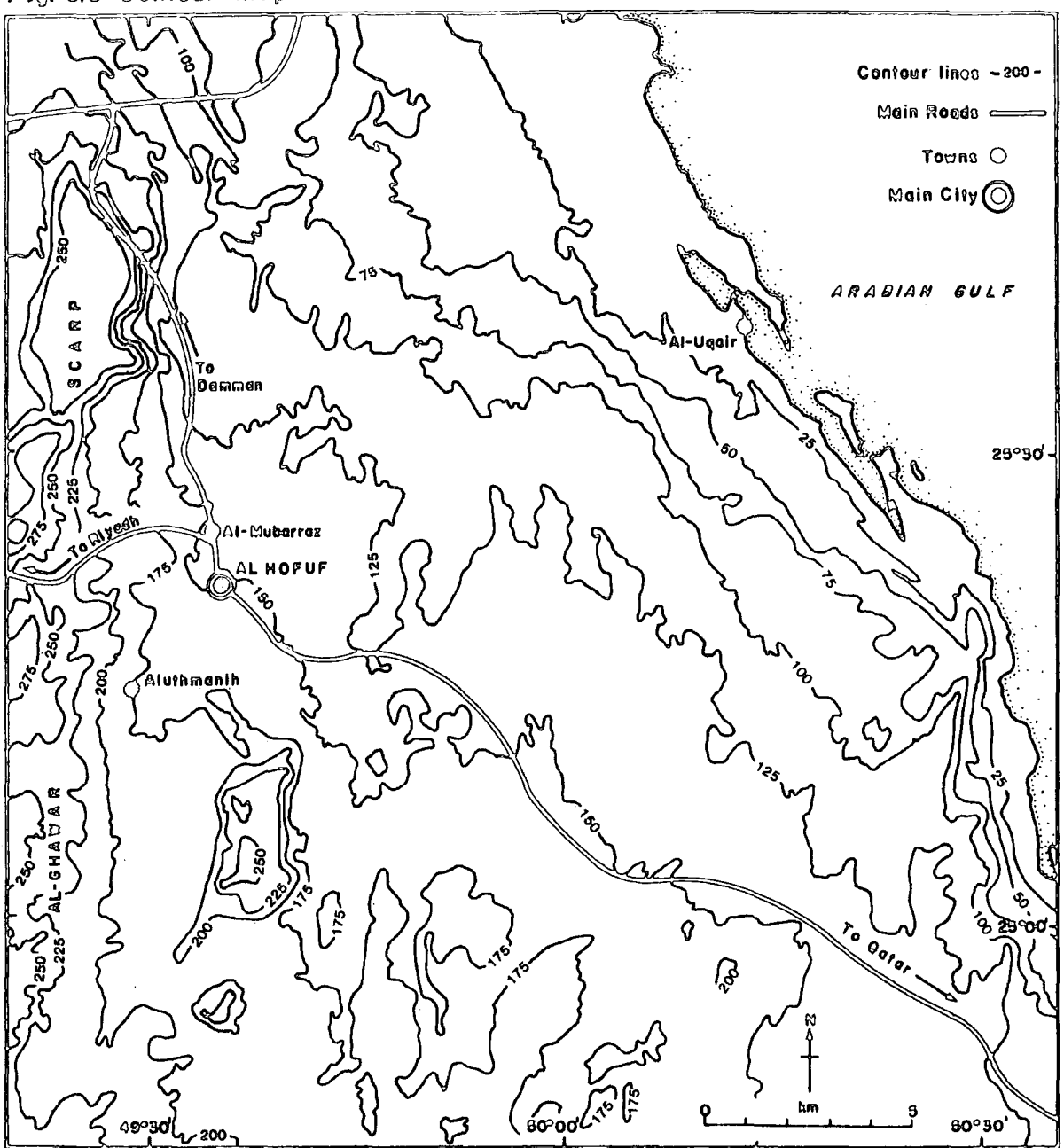
Al-Hassa itself is situated between the rock desert of al-Ghawar scarps - the easternmost part of the al-Summan plateau - in the west, and the sand dunes covering the adjoining plain in the east. Most parts of the oases lie between 100 and 125 metres above sea level.

The plain between the scarpment and the coast, has a very low gradient towards the east, of about one metre per kilometre (Al-Sayari and Zött 1978), and is largely covered by the sand dunes of Al-Jafurah. Westwards the steep scarp of al-Ghawar rises to an altitude of 250 metres above sea level. The oasis owes its existence to large karst springs at the al-Ghawar scarp foot.

The topography of al-Hassa region has probably not changed much since the Plio-pleistocene. The most striking morphological features such as the al-Ghawar scarps and its outliers (Burayqas Jabal al-Qarah and al-Arba hills), the plain towards the Gulf and other features essentially developed in the Upper Pliocene. The Quaternary mainly produced an erosive activity of wind as well as aeolian transport and its ensuing deposition (ibid).

Figure 3.4 illustrates the main topographical features of al-Hassa oasis and its immediate hinterland as they now exist. The area which in general has relatively low relief

Fig. 3.3 Contour Map



Source: Based on survey carried out by B.R.G.M. for Ministry of Agriculture and Water, 1977

is composed of landform types as follows:-

The central plain lies east of the west-facing al-Ghawar scarps which extend without interruption roughly 220 kms from north to south. The plain is between 25-55 kms in width from west to east, in elevation base ranging from about 175 metres to 300 metres above sea level. The scarp is believed to be the result, in part at least, of wave erosion during a higher stand of sea level (ibid).

The eastern edges of this escarpment tend, in general, to slope towards the north and south; nevertheless there are isolated rugged cliffs to the north and south such as Jabal Umm al-Ghirban west of al-Mutairifi and the northern side of Nalat Shadqm in the northern part of the oasis.

Within the general central plain area are several isolated mesas or tabular hills standing about 100 metres above the land surface. The most important of these are as follows:

Al-Korma which is situated in the south and extends about 40 kms from north to south, the width is about 20 kms, the mesa having an elevation of 250 metres above sea level; Burayqa which is situated in the north-east of al-Shaibah village, is about 15 kms. long and 8 kms. wide, lying at 216 metres above sea level; Jabal al-Qarah about 10 kms. east of al-Hofuf, is one of the completely isolated erosional remnants in the front of the scarpment, at its peak reaching 205 metres above sea level. It consists of marl and marly sandstone of Hofuf Formation. There are similar hills in the north such as Abu-Shidad, Ghar-Ibn-Taflan,

Taf and Al arba'ah (the four hills), which are located about 10 kms south of al-Qarah hill.

There are also low lying depressions called sabkhahs. These are saline flats underlain by clay, silt and sand, and often crusted with salt. They represent drainage areas for the adjacent irrigated oasis but have always been the areas to which any surface water has flowed. (see Fig.3.5). Most of these are now reclaimed, covered and served by the New Irrigation and Drainage Project. This saline drainage water, as well as the groundwater which rises to the soil surface by capillary action, is usually evaporated leaving a salt crust behind.

The main sabkhahs before recent reclamation during the 1960's were : al-Asfar, part of which was occupied by al-Asfar Lake. Located in the north east of the oasis area, some 100 metres above sea level, it lay on average about 10 metres below the general land surface, with an area of about 6000 has. In addition there was al-Sfalah Sabkah which is located to the north of al-Uyun area with an area of about 5000 has. This sabkhah is still exploited for salt at a daily production rate of the order of a few tons. Its surface is covered with salt and considerable aeolian sand as well as holding saline water in the deeper spots.

The third largest sabkhah is al-Taraf which is located in the southern part of the oasis, about 11 kms to the east of al-Hofuf. It consists of many scattered depressions and it extends towards the south, to the vicinity of al-Arba'a hills (see above).

In addition there were many small sabkhahs such as al-Keshet which is located between al-Hofuf and al-Mubaraz, and around al-Seefah which is located to the south west of al-Hofuf. Many of these sabkhahs are now reclaimed and utilized for urban purposes.

The oasis of al-Hassa itself lies in the Central Plain (Vidal 1955) and has the shape of an "L" with al-Hofuf-al-Mubaraz being located at the junction of the two arms. The guard station, al-Jadidah, lies at the northern limit of this central plain and the village of al-Jishshah at the eastern.

The oasis can be divided (see Fig. 3.4) into six areas on the basis of the ground surface gradient as follows:-

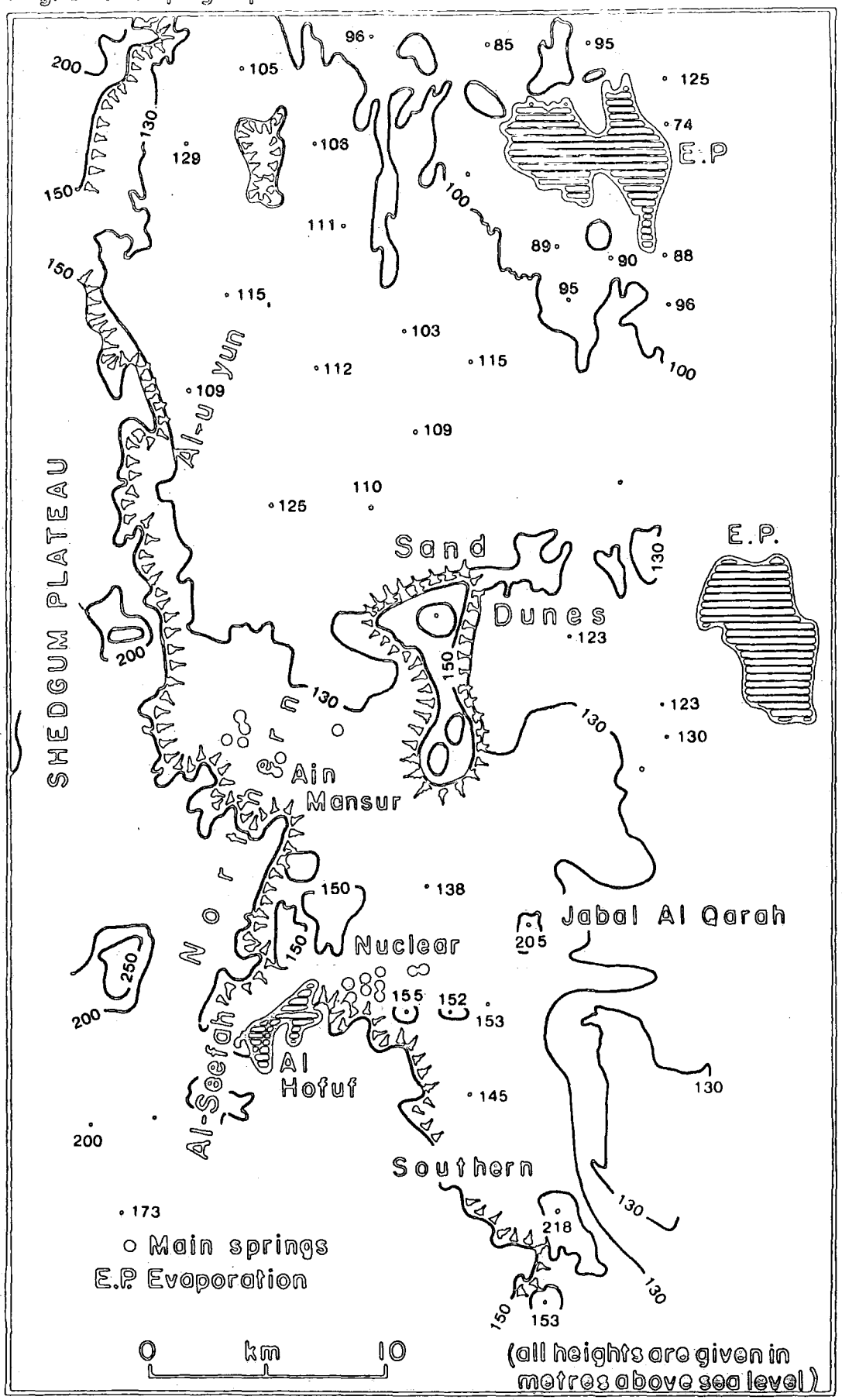
A. The al-Uyun area

This area consists of flat lowland areas as well as some scattered relatively low hills and depression. The land surface rises gradually eastward to sand dunes which have an elevation of 120-130 metres. It also rises gently northward, whilst to the northeast the land surface slopes gently down to al-Safala depression.

B. The northern area

This area consists of the low plains which are located betwen al-Uyun area in the north and the sandy strip of Mohars in the south. These low plains comprise scattered cultivated areas, separating between them some sabkhahs and sandy areas. The land surface of this district generally slopes from the west to the north and east.

Fig. 3·4 Topographical Features of Al-Hasa Oasis



Source : Al-Sayari and Zötl (1978)

C. The nuclear area

This area is located to the east of al-Hofuf-al-Mubaraz City. Oval in plan its total area is about 98 kms. It consists of lowlands that are aligned east-west, its surface sloping gradually from west to east, gradient about 1:1000. (Ied 1979). The 135 m. contour line is the separation line between two sections, the western and the eastern. These areas together form the chief block of cultivation and settlements.

D. The al-Seefah area

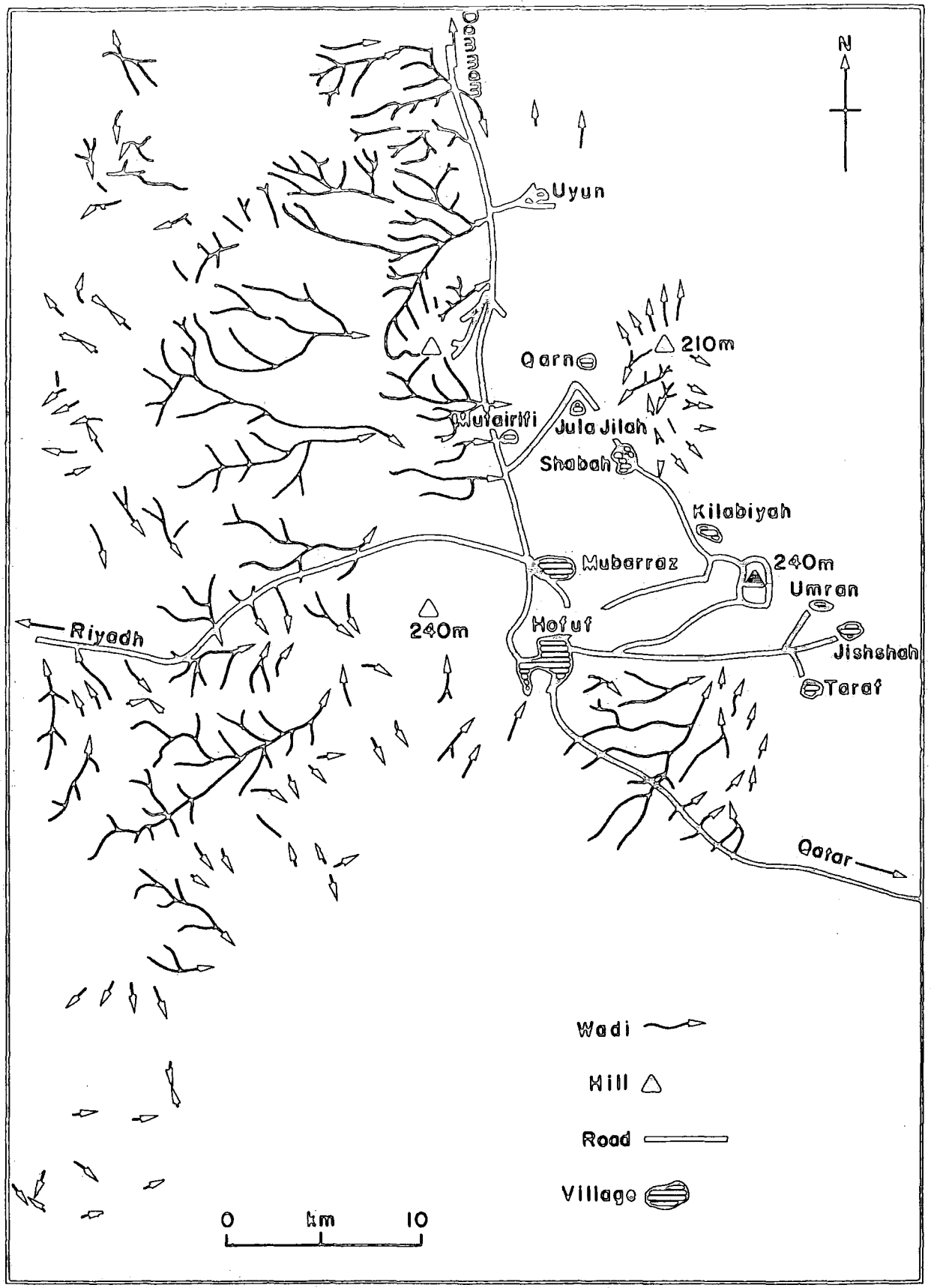
This area consists of a lowland cultivated area to the southwest of al-Hofuf and can be regarded as an extension of the nuclear area. The land surface slopes towards south-west of Hofuf and eastwards. Also this area is the part of the oasis most heavily so far affected by the boom expansion of al-Hofuf settlement, particularly early in the 1970's.

E. The southern area (The Qatar Road Area)

This area is located southeast of Hofuf and consists of 5934 ha. (Hajrah 1970). This land, which is regarded as in public ownership, was distributed during the 1970's in 5-10 hectare plots, granted without charge to farmers under certain conditions and enjoys priority in investment and loans by S.A.A.B. Future development will require construction of an adequate system of drainage, the need for which is already apparent (see Chap.3.4).

This area lies outside the main irrigation and drainage project area. It is now irrigated by drilled

Fig. 3-5 Surface Drainage System in Al Hassa



After Al-Elawy, 1976

wells, but has no proper drainage system, relying on natural drainage using the general incline to the northeast (see Fig.3.5). Generally, this area consists of unconsolidated materials, including pebbles, gravel and sand, gravel and silt, and various Quaternary sedimentary deposits.

F. Sand Dunes Area

The northern, eastern and southern boundaries of al-Hassa fade into the al-Jafurah desert. The sands surrounding the oasis, due to the periodically strong north, northwest and south winds, (see Chap. 3.3) are mobile and have for many centuries been encroaching upon the cultivated land and endangering the entire al-Hassa oasis.

The wide belt of drifting sands of the al-Jafurah desert, is part of a mobile sand complex affecting the whole Gulf coastal region. Al-Jafurah is narrow here but widens rapidly to the south where it eventually merges with the sand area of al-Rub' al-Kali (the Empty Quarter).

There are groups of sand-dunes which come from the al-Jafurah sands. The main dune areas are; Kanzan in the north which rises about 125 metres above sea level, and Muraqib which is located at the eastern part of al-Jishshah village and rises about 130 metres above sea level. Further south, there are chains of dunes which rise about 175 metres above sea level (Al-Sharef 1977) such as al-Madbaiah dune.

In the eastern part of al-Jafurah, there are elevations called the al-Uqayr hills, rising about 25 metres above sea level (ibid) and running from the north-west to the south-west, parallel to the coast.

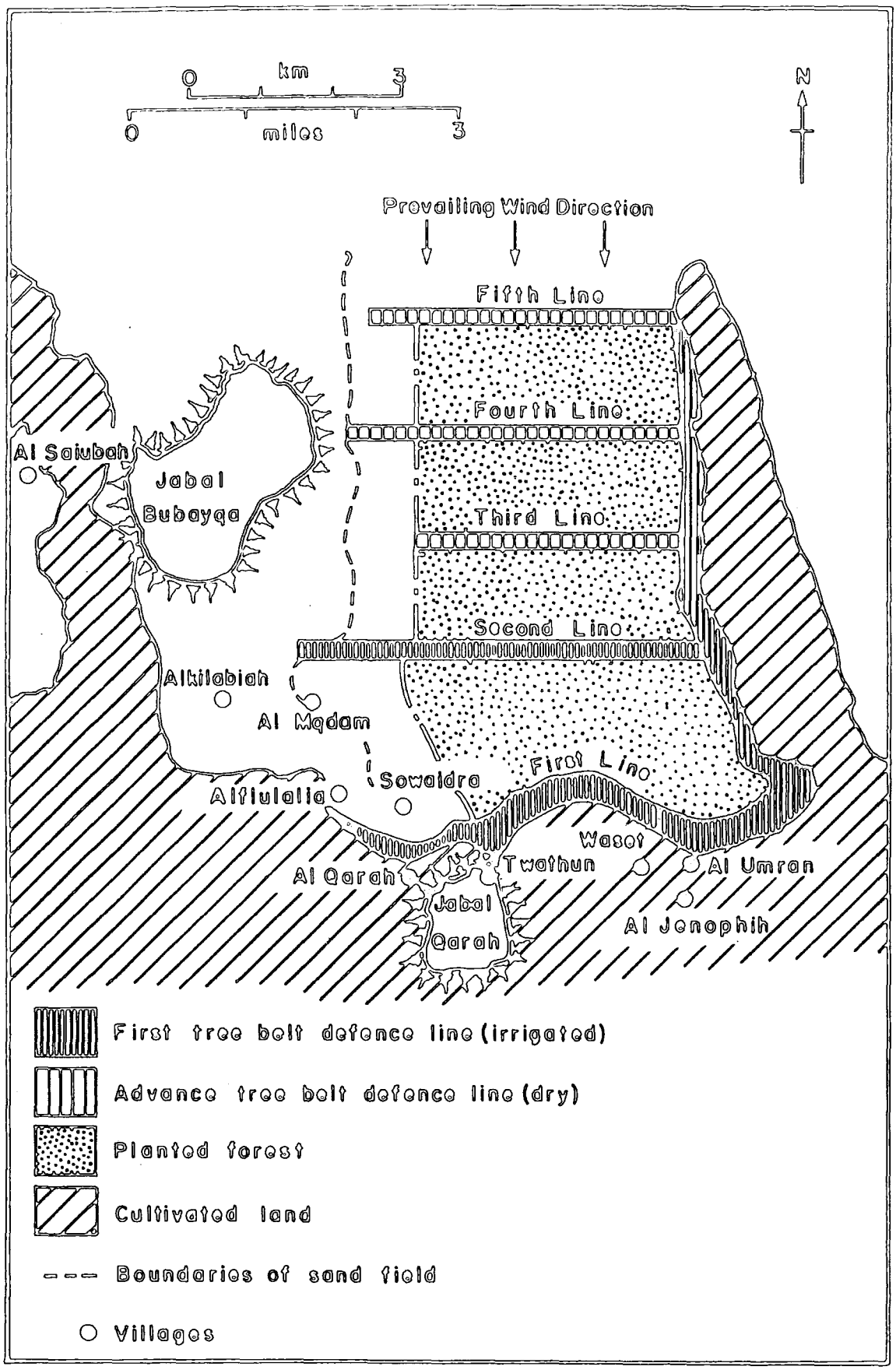
Al-Hassa oasis has been in a state of retreat for several hundred years due to an active sand dune field 35 kms. long, which has been advancing southward along a 12 kms front, carrying with it 225,000 cubic metres of mobile sand and covering about 84,000 square metres of land per year (Labban, 1974). For instance, a site containing ruins of a mosque, well and settlement lying 3 kms. north of the present cultivated area was discovered in the 1960's and is thought to be Juwatha, which was well known as an important settlement in al-Hassa oasis at the dawn of Islam, about 1,400 years ago, and which has since been covered by the dunes.

A 1960 Aramco survey showed that individual efforts by the inhabitants of the oasis were barely able to keep the gardens, the villages and main drainage canals from being overrun by the sand. It also showed that the conditions had become very critical as deteriorating drainage gave rise to high water tables and increased soil salinities. The survey indicated that 14 villages and many gardens were about to be overcome by the moving sand which was 24 to 33 feet in height, and villages such as al-Ummran and al-Shamaliyah would be inundated by the sand field in about 7 years

It was apparent that if the al-Hassa oasis was to survive, the entire sand field movement had to be stopped completely.

In the late 1950's Aramco suggested stabilizing the dunes by covering them with a layer of asphalt. This suggestion was rejected, but the M.A.W. carried out further studies in 1960 to find a more permanent solution. As a

Fig 3.6 Sand Stabilisation of Al-Hassa Oases



result, initial fieldwork to implement the project was started in 1962. By the end of 1967 three belts of vegetation each some 50 to 100 metres wide and 8 kms. long were completed (Al-Shuaiby 1976), and 1800 ha of land were planted with approximately 6 million trees and shrubs (Al-Abdulwahed 1979).

The planting of two further belts of trees was started in 1975 using the new dry farming system. This method depends on utilising the moisture in the sand dunes, and uses one metre long Tamarix cuttings which are planted directly in the dunes without any levelling, covering with soil, or construction of wells and irrigation canals being necessary. More than 1300 ha have been planted using the dry farming method (ibid). Figure 3.6 shows the location of the five tree belt defences.

Conclusion

In conclusion, the central plain of al-Hassa oasis, from a topographical point of view, slopes relatively gently eastwards from the steep escarpment which forms its western boundary. This central plain contains numerous wadis, particularly in the west, isolated rocky hills, depressions, and strips of sand dunes.

The topography of the oasis as noted in Chapter 2 helped to determine the sequence of land occupancy, of the alignment of water channels and the layout of plots. As also noted in Chapter 2.3 the distribution of the different varieties of dates also reflects topographical variations. More fundamentally important is the relationship between topography and the details of hydrology (see Chapter 2.4).

In general, the eastern plain has been developed on Quaternary sediments and different types of soil are associated with differences in parent material. The areas which are only partly cultivated consist essentially of unconsolidated deposits of salts, sand and gravel. In some parts also sheet-like gravel deposits of quartz and other pebbles from the basement complex are to be found, the poorest lithosols.

The cultivated areas are mostly formed of aeolian sand sediments covering partly the older Quaternary layers and mainly the young Tertiary sandy marls or Calcareous sandstone, and in the lower lying sabkhah areas silt, clay and muddy sand are deposited on the underlying inland playas (Wakuti 1969) (see Chapter 3.4).

During the centuries of human occupation many villages have been established in the oasis and the controls on their first location exerted by geomorphological and hydrological factors are no longer obvious. In general, the point should be made that al-Hassa oasis is by no means a homogeneous flat depression, and the details of morphology have influenced and still influence most of the patterns of agricultural development.

3.3 Climatology

General

Al-Hassa oasis is situated within the subtropic arid zones of the northern hemisphere, extending from Northern Africa through the Arabian Peninsula, Iran and Afghanistan to Mongolia. This aridity of climate, whose potential evaporation exceeds precipitation, is characterized by very hot, dry summers and cool, relatively dry winters. The oasis is situated within the air-mass divergence zone where the air masses are already heated at high altitudes, leading to the absence of clouds, high solar radiation and high summer temperatures. During the seasonal movement of the trade winds system, al-Hassa area is located within the Inner Tropical Convergence Zone (H.A.R.C. 1973). During the winter season, therefore, the circulation may move so far to the south that occasionally a cyclonic weather situation may develop, leading to sporadic precipitation during the winter season.

Therefore, the climate of al-Hassa oasis is under the influence of the Continental Central trade winds and the trade winds transition climate with winter cyclonic weather and extremely low precipitation.

At no time is precipitation sufficient in itself to support vegetation and both wild and cultivated plants derive their water requirements from groundwater. Climate factors also raise the levels of consumptive use of water by plants. So the climatic elements and aspects studied here are considered in the following sequence: temperature, precipitation, relative humidity, winds, solar radiation

and evapotranspiration rates. The nature of these elements in combination have dominant effects on agricultural practices in al-Hassa oasis.

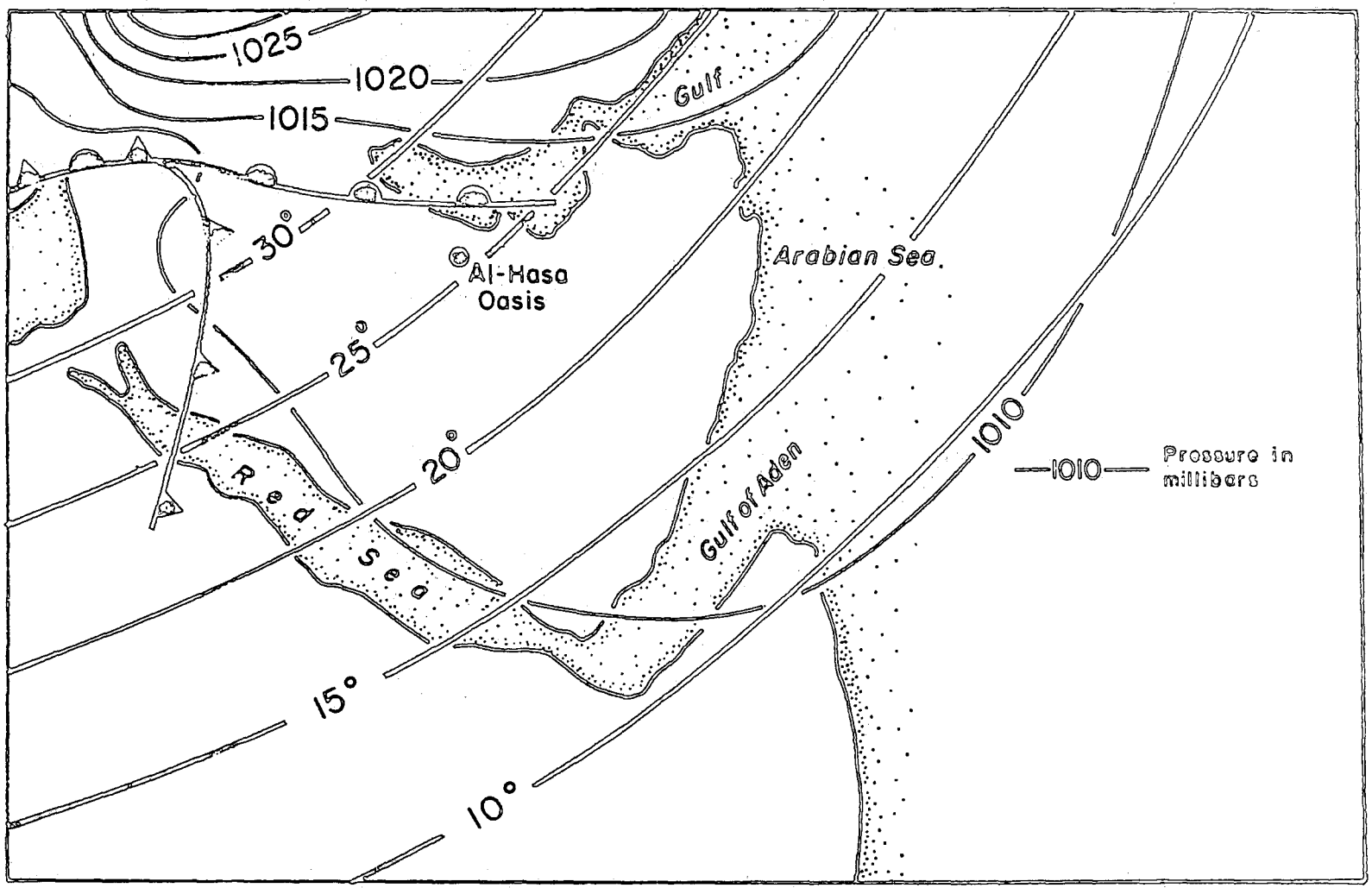
3.3.1 Air pressure and winds

In winter, the high pressure is dominant over Central Asia and extends to the Middle East. Dry and cold winds blow from these areas to the oasis during most months in winter. In addition, warm, dry winds blow occasionally to the oasis from Rub al-Khali. However, relatively moist air is drawn to the oasis from the Mediterranean Sea and can cause some rains. Nevertheless the oasis' location far distant from the Mediterranean Sea ensures that incoming humid cyclonic air has lost most of its moisture by the time of arrival at the oasis. See Fig. 3.7.

In Summer, the oasis' weather conditions are affected by the low pressure which extends from India to the Arabian Gulf. The associated dominant northerly winds are dry and relatively cool because they blow from arid and cooler lands compared with those on the oasis. Therefore, they relatively reduce the temperature on the oasis in this season. On the other hand dry hot air is carried occasionally from the lower pressure cell near Cyprus to the oasis across the Mesopotamia Plains and the Gulf and brings to the oasis periods of great heat and humidity. See Fig. 3.8.

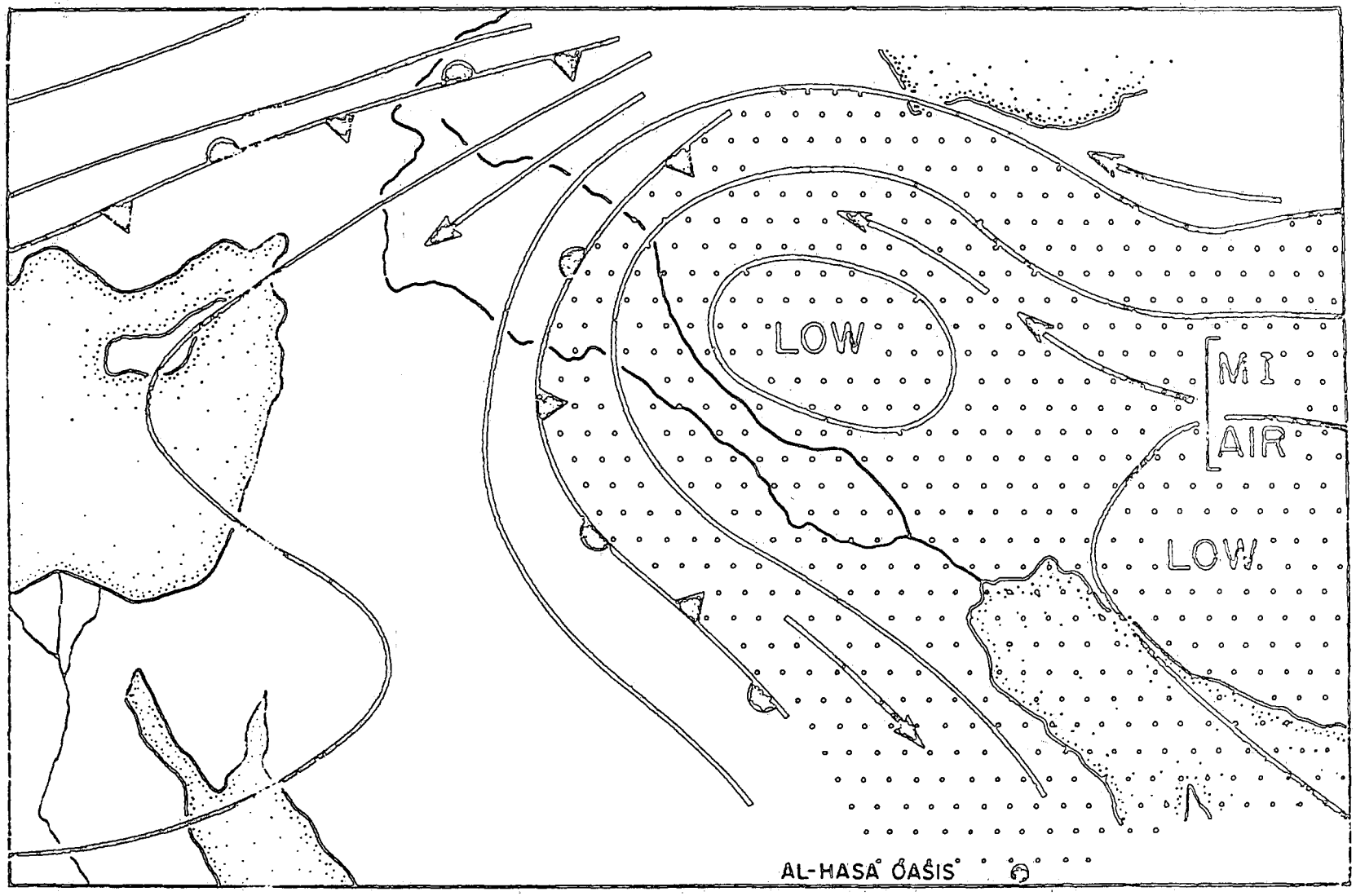
It has already been pointed out that the predominant winds blow from the north during all seasons. When they originate from northern Continental airmasses in winter they tend to be dry and cool but local turbulence can be associated

Fig. 3.7 Weather Conditions in Winter



Source: H.A.R.C., 1973

Fig. 3.8 Weather Conditions in Summer



Source: Fisher 1978

with rains in winter. These winds are known locally as Al-Shamal. Dry and hot winds carrying dust and sand during summer are known locally as al-Samoom and are essentially local or regional winds, blowing from both north and south. They are equivalent to the Egyptian khamsin and al-Habub in Sudan.

Table 3.1 shows that the prevailing wind in the oasis comes from the north, 50% of the total wind movement. South winds blow with less frequency, 14%. The peak frequency northern wind takes place from June to August and a minimum in spring. However, the peak frequency of southern wind occurs in winter and a minimum in summer. (see Fig. 3.9).

Table 3.1 Mean Yearly Frequency of Wind Directions in % (1969-1976)

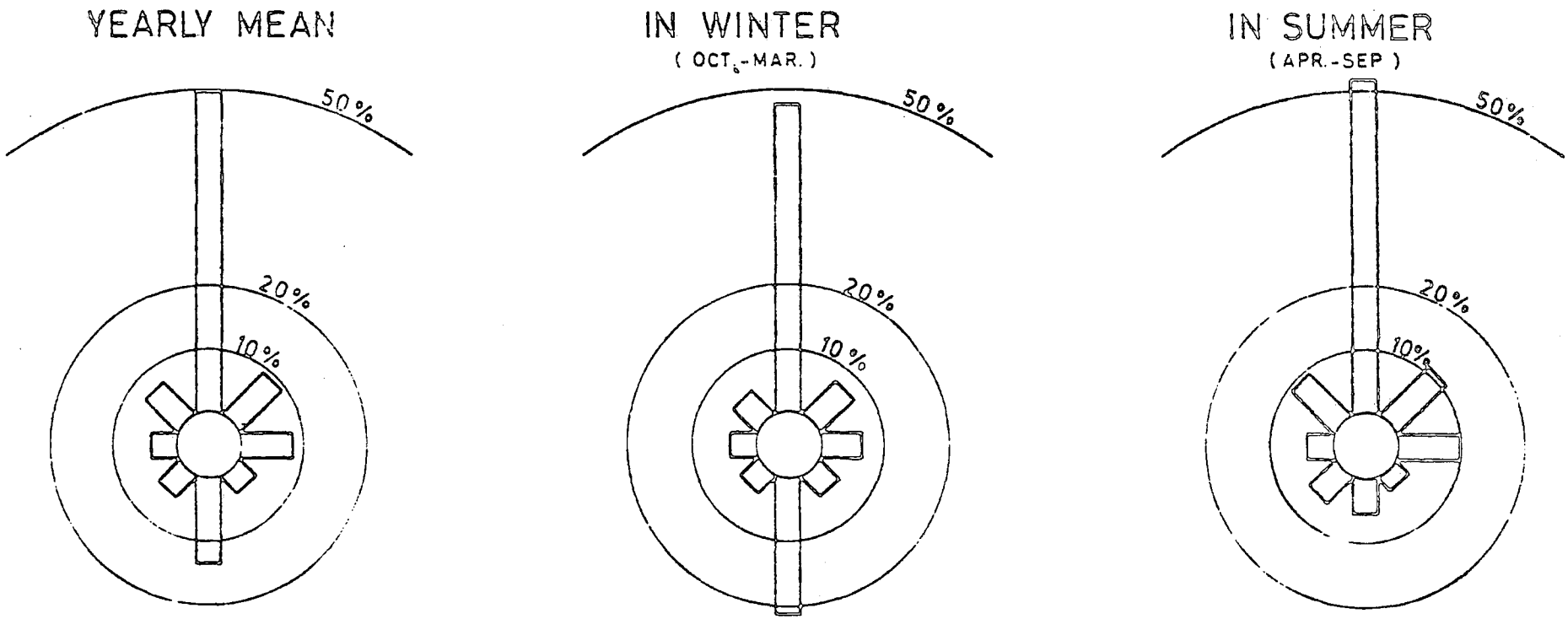
Wind direction	N	NW	W	SW	S	SE	E	NE
Percentage %	50	7	4	5	14	3	8	9

Source: H.A.R.C (1978) No.26 p.16.

Generally, winds have higher speed in day time than during the night time. Figure 3.9 shows that these winds also have less speed in winter than summer. Additionally, the northern winds have higher speed than the other winds.

In relation to agriculture there are two main effects of wind direction and velocity. The first relates to the movement of sand, and this is considered in Chapter 3.2 in terms of the sand stabilization project. However, the carriage of dust and sand into the oasis also has other

Fig. 3·9 Compass Cards for Al-Hassa 1969-1976



Source: H. A. R. C. 1976

effects, on atmospheric pollution, on human discomfort and also brings aeolian phase material to the soils. As noted in Section 3.4, the uncultivated soils of Al-Hassa contain both coarse and fine wind carried sediments as well as locally derived material. The result is considerable spatial variation in texture further complicated in the oasis by centuries of irrigation and cultivation.

Secondly, wind velocity and variations in humidity have a striking effect on plant growth through changes in evapotranspiration rates. At one extreme there may be periods of relatively still air with high humidity and temperatures, particularly within the main date-garden areas where the trees give wind protection. During these periods bacterial virus and mould growth can be rapid and plants may suffer from disease. At the other extreme, particularly in areas of field crops - the most important crops for recent development - high winds, often of low humidity, can raise the evapotranspiration rates from plant surfaces lethally above wilting point. The ground surface evaporation is also raised markedly which encourages upward capillary action of ground water and results in the concentration of salts on the surface.

3.3.2 Temperature

Table 3.2 shows that the annual average temperature is 25.24 C. varying from year to year. See Table 3.2.

Table 3.2 Mean monthly minimum and maximum temperatures °C (1969-1981)*

Month	Mean Minimum	Mean Maximum	Average
Jan.	8.3	20.4	14.35
Feb.	9.11	23.18	16.14
Mar.	13.44	27.26	20.35
Apr.	17.63	33.27	25.45
May	22.17	40.94	31.55
June	24.17	41.79	32.98
July	25.61	42.74	34.17
Aug.	24.50	42.53	33.51
Sept.	21.86	40.33	31.09
Oct.	17.86	35.28	26.57
Nov.	13.52	28.50	21.01
Dec.	8.6	22.79	15.69
Average	17.23	33.25	25.24

Source : (1) H.A.R.C 1979 (2) H.A.R.C 1977-1981.

* Data for 13 year period 1969-1981 only are available for mean monthly temperatures, humidity, monthly means of rainfall and absolute maximum daily rainfall.

Generally, the temperature during summer is markedly higher than in winter; the coldest month is January in which the mean temperature is 14.35°C. The minimum and maximum temperatures are 8.3 and 20.4°C respectively. The hottest month is July in which the mean temperature is 34.17°C, the minimum and maximum temperatures being 25.61 and 42.74°C respectively. However, the absolute extreme temperatures

Table 3.3 Monthly means of rainfall (mm)

Month \ Year	1969	1970	1971	1972	1973	1974	1975	(1) 1976	1977	1978	1979	1980	(2) 1981	Aver-age
Jan.	74.3	10.9	1.8	22.8	8.6	6.0	18.8	18.4	45.6	1.5	2.8	19.8	2.8	18.00
Feb.	11.1	0.5	5.5	2.8	-	3.0	12.0	35.1	-	8.4	0.4	58.0	6.8	11.04
Mar.	1.6	5.6	3.7	30.7	-	49.6	3.1	52.7	13.4	0.8	1.7	15.0	18.0	15.06
Apr.	29.0	-	38.2	17.9	8.9	1.0	11.8	15.7	9.6	1.3	-	-	-	10.26
May	-	0.4	-	-	-	6.9	-	4.2	0.8	-	-	-	-	0.94
Jun.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
July	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aug.	1.0	-	-	-	-	-	-	-	-	-	-	-	-	0.07
Sep.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oct.	1.2	-	-	-	-	-	-	9.5	2.4	-	-	-	-	1.00
Nov.	0.7	-	8.8	-	-	-	-	-	0.3	1.7	-	-	-	0.88
Dec.	-	-	2.3	8.1	9.8	9.6	15.9	10.7	1.8	-	1.4	-	-	4.58
Total	118.9	17.4	60.3	82.3	27.3	76.1	61.6	146.3	73.9	13.7	6.3	92.8	27.6	61.83

Source: (1) H.A.R.C. (1978), pub. No.26 p.35.
(2) Fieldwork 1982.

range from zero during some nights of December and January to more than 50°C in some days in July and August. The absolute minimum temperature was recorded on December 23 1971, -0.4°C, while the absolute maximum recorded at the al-Hassa station was on June 22, 1974, 46.5°C. The absolute difference amounts to 46.9°C [H.A.R.C. 1978] . The temperature variations increase during the summer days due to the absence of cloud and high radiation and low relative humidity, as well as the differences of the wind temperature and speed between day time and night time in summer. But in winter these variations decrease because of the high humidity, presence of some clouds and small differences in the wind speed and temperature between the day and night time. See Fig. 3.10.

3.3.3 Precipitation

Rainfall is associated with the passage of Mediterranean depressions which cause the in-blowing of eastern moist air from the Gulf.

Table 3.3 and Figure 3.10 show that the annual rainfall totals 61.83 mm. However, this amount is markedly not enough to sustain cultivated plants' consumptive use requirements. The rainy season usually occurs in winter months from December to April, while the summer months are absolutely dry. The highest mean amounts fall in January, March and April, 18, 15.06 and 10.26 mm respectively.

Table 3.4 shows that the absolute maximum daily rainfall also occurs in January, March and April. For example, in January 1969 the maximum daily rainfall was 47.2 mm and in

March 1974, 43.3 mm. These amounts occasionally replenish the soil moisture and supplement the irrigation supplies which otherwise have to be obtained from groundwater flows originating in the interior and Western Highlands of Saudi Arabia.

Both extremes of high and low temperature impose physiological strains on plants and animals and through their effect on the germination of seed, flowering and seed-sett of plants and natural breeding cycles of animals, produce a marked seasonal agricultural regime.

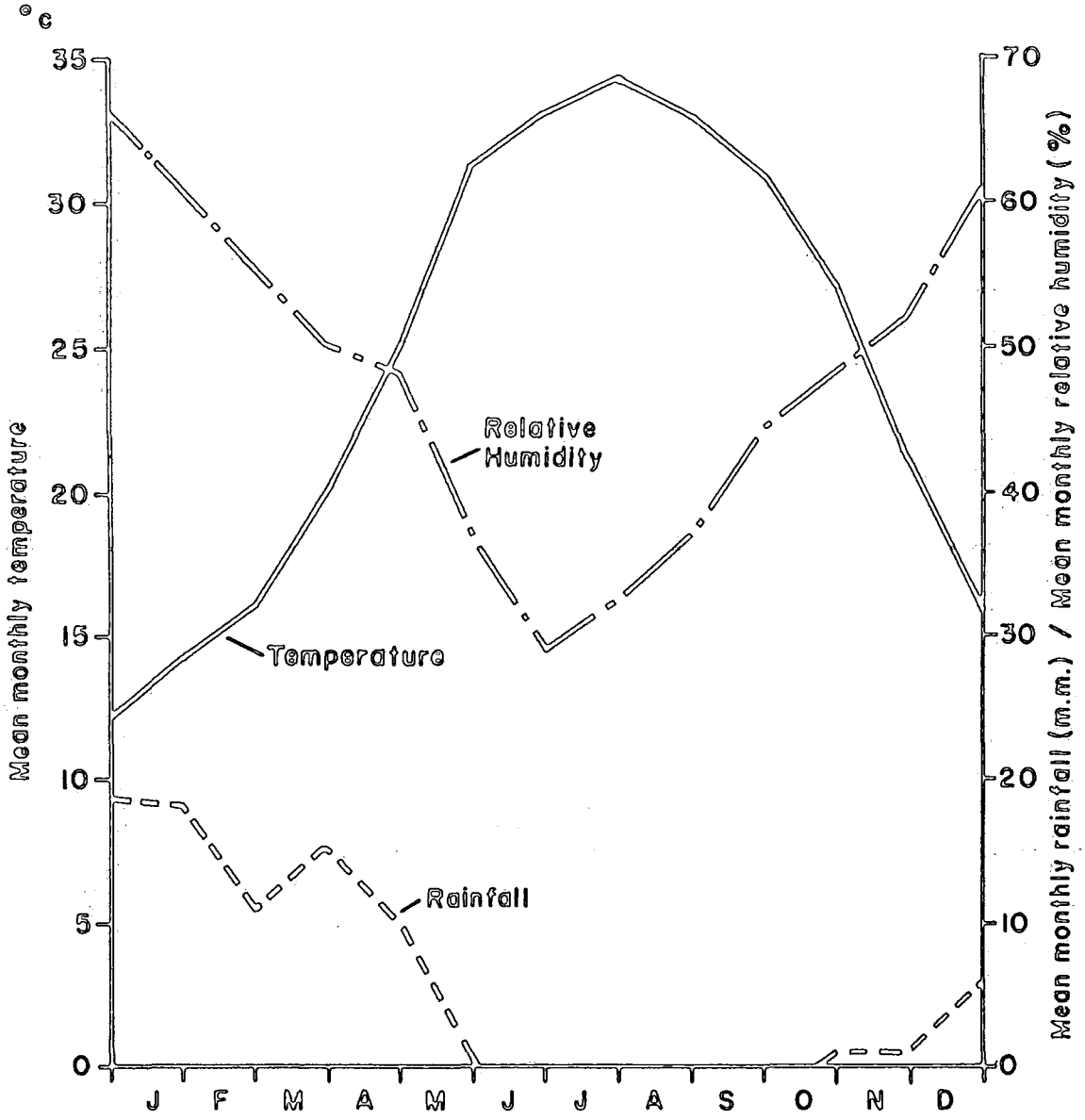
Table 3.4 Absolute Maximum daily rainfall (mm)

	J	F	M	A	M	J	J	A	S	O	N	D
1969	47.2	8.0	0.7	13.8	-	-	-	-	-	1.2	0.6	-
1970	4.7	0.3	3.7	-	0.4	-	-	-	-	-	-	-
1971	1.8	4.9	1.5	18.5	-	-	-	-	-	-	8.8	2.3
1972	10.1	1.5	14.1	10.1	-	-	-	-	-	-	-	3.3
1973	5.0	-	-	5.3	-	-	-	-	-	-	-	5.9
1974	3.8	1.0	43.3	0.5	4.5	-	-	-	-	-	-	4.5
1975	8.3	7.5	2.4	6.5	-	-	-	-	-	-	-	9.9
1976	12.9	13.2	17.2	7.1	3.8	-	-	-	-	9.5	-	6.5
1977	26.1	-	10.3	7.0	0.8	-	-	-	-	2.4	0.3	1.8
1978	1.5	7.3	0.5	0.8	-	-	-	-	-	-	1.5	-
1979	-	-	3.9	-	-	-	-	-	-	-	-	0.8
1980	13.0	50.6	14.0	-	-	-	-	-	-	-	-	-
1981	2.3	6.1	15.2	-	-	-	-	-	-	-	-	-

Source: (1) H.A.R.C (1978) Pub.No.26, p.36.

(2) H.A.R.C. Unpublished records consulted by the author 1982.

Fig 3·10 Climatic Diagram for Hofuf (1969 – 1981)



3.3.4 Relative Humidity

Table 3.5 shows that the average value of the relative humidity is 46.28 percent. This average varies considerably between the summer and winter due to the differences in air movements over the oasis. The highest monthly average is recorded in January, 61.37 per cent, whilst the lowest was registered in June, 29.23 per cent.

Table 3.5 Mean monthly maximum and minimum of relative humidity % (1969-1981)*

Month	Mean maximum	Mean minimum	Average
Jan.	80.32	42.43	61.37
Feb.	79.00	33.36	56.18
March	73.23	27.73	50.48
Apr.	66.71	25.4	46.05
May	53.32	20.66	36.99
June	41.33	17.14	29.23
July	45.57	19.06	32.31
Aug.	54.53	19.96	37.24
Sept.	67.06	21.19	44.12
Oct.	71.88	23.43	47.65
Nov.	75.43	32.6	54.01
Dec.	79.33	40.12	59.72
Average	65.64	26.92	46.28

Source: H.A.R.C. Pub.No.26.1978 and 1981 (recorded data)

* Data for the 13 year period 1969-1981 only are available for mean monthly daily temperatures and humidity.

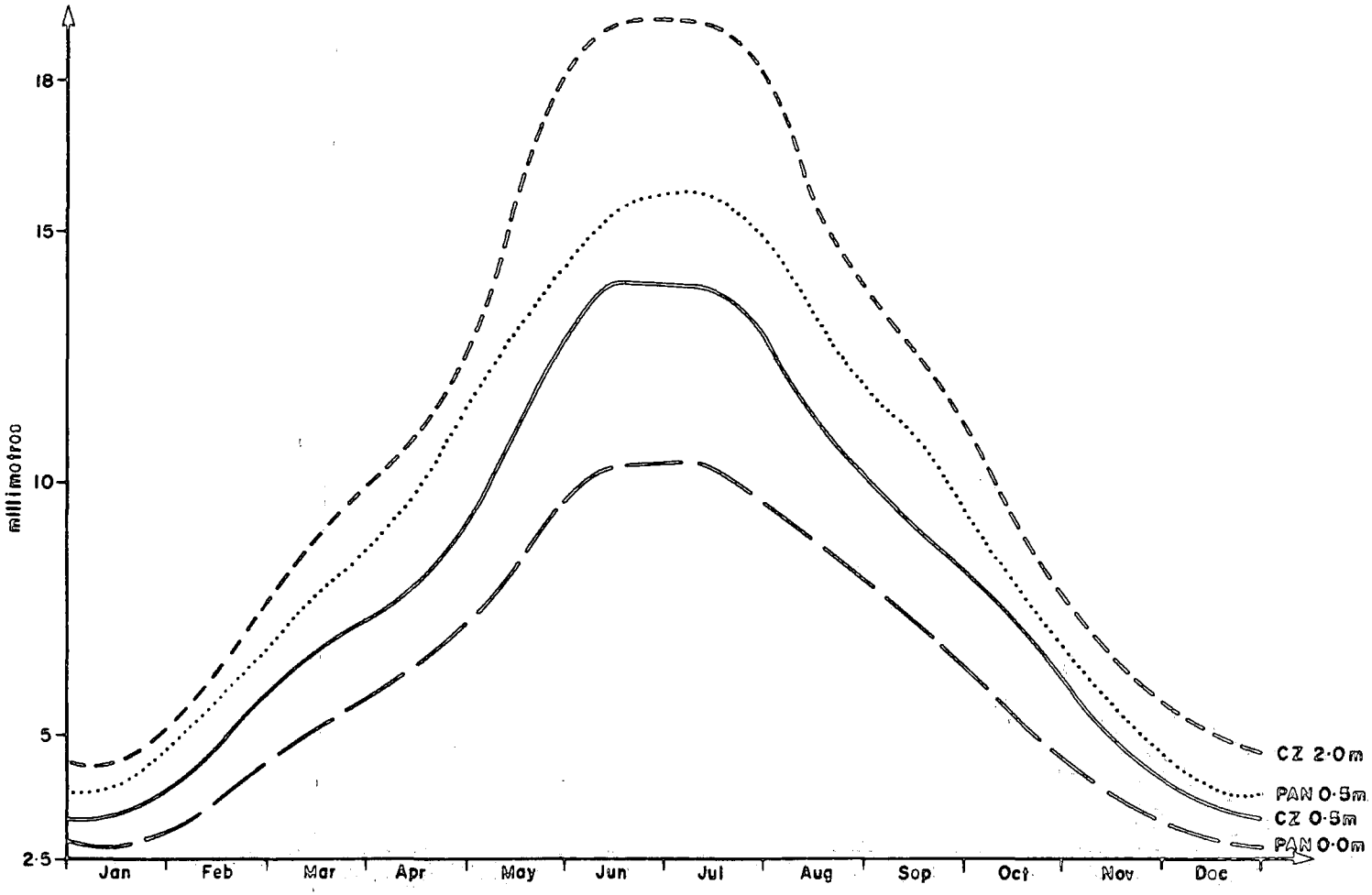
Generally the higher relative humidity averages are recorded during winter, whilst the lower humidity during summer. This is because of the variation of the humidity content of the air between both seasons. However, extreme low humidity is recorded in summer which reaches 10% while the extreme high values can be noted in winter, about 91% (see Fig. 3.10). Periods of low relative humidity are relevant to agriculture in that evapotranspiration rates are raised (see below). High relative humidity is mainly important in that in combination with still air and high temperatures it encourages plant disease of the virus and mould type and imposes considerable physiological strains on man and animals.

3.3.5 Evaporation

It is to be expected that the evaporation and transpiration values are generally high in the al-Hassa oasis as a result of high dry-wind speeds, high temperatures, low cloud amounts and seasonally low relative humidity. See Table 3.6.

Table 3.6 and Figure 3.11 show that the mean daily evaporation, which measured by Pan Class A, is generally high at 9.5 mms. This value increases during summer months. The highest values are recorded in June and July 15.4 and 15.7 mms respectively due to the increased effects of the factors above mentioned. However, this value decreases in winter months and the lowest are registered in December and January, 4 and 4.1 respectively. The high evaporation rates have adverse effects on the water requirements of crops, i.e. increase the water requirement.

Fig 3·11 Mean Daily Evaporation of Pan Class A and Ceramic Disc (Monthly means, 1969 - 1976)



Source: H.A.R.C. 1978

Table 3.6 Mean daily evaporation measured by mean of Pan-Class A (mms)

Month	1969	1970	1971	1972	1973	1974	1975	1976	Aver-age
Jan.	3.7	3.7	4.9	3.7	4.6	3.7	3.8	3.7	4.0
Feb.	5.6	6.4	6.7	5.7	6.6	4.7	5.0	4.1	5.6
Mar.	9.4	8.6	8.9	7.6	9.6	6.2	8.3	4.7	7.9
Apr	10.0	11.2	10.0	8.5	10.1	11.1	9.0	7.5	9.7
May	14.2	15.5	12.1	12.5	12.3	11.4	13.3	12.1	12.9
June	14.1	17.4	14.8	14.7	16.8	14.1	16.0	15.5	15.4
July	15.8	16.8	16.2	16.0	15.1	15.4	15.5	15.0	15.7
Aug.	13.2	15.0	14.8	12.4	11.0	14.7	12.9	12.5	13.3
Sep.	10.8	12.4	11.3	11.2	10.4	11.2	9.7	11.1	11.0
Oct.	8.2	9.3	8.9	6.4	7.8	7.2	8.4	7.7	8.1
Nov.	5.6	5.7	5.6	5.8	5.8	5.4	5.4	5.1	5.7
Dec.	4.7	5.1	4.6	3.7	3.7	3.7	3.7	3.7	4.1
Ave.	9.6	10.6	9.9	9.0	9.5	9.1	9.3	8.6	9.5

Source: Hofuf Agricultural Research Centre. Saudi Arabia. Pub.No.26.Agrometeorology of the al-Hassa oasis (1969-1976).

Seasonally varying but high evaporation rates express the effect of temperature and wind on plants, soil moisture etc., in ways significant for agriculture. First, high transpiration and evaporation rates in summer directly inhibit the growth of some plants, even given irrigation, particularly with leafy vegetable crops, whilst the date palm is biologically fitted to withstand the conditions.

Secondly, evaporation from wetted soil surfaces is extremely rapid, encourages upward capillary movement of

groundwater and therefore the maintenance of highly charged water in the upper horizons. The only counter measures in irrigation are to either increase the leaching water duty ot to reduce evaporation. The first can increase the volume of water applied by up to 30%-50% with consequent depletion of groundwater and possible deterioration in drainage effectiveness. The latter implies the use of shade crops or artificial environments such as coolhouse/greenhouse units. The latter are now becoming important in maintaining reasonable humidity levels and reducing evaporation. They also require non-traditional technology, skilled labour and financial investment.

The extra demands on groundwater have had complex effects on the irrigation system. As noted in Chapter 5 the al-Hassa Irrigation and Drainage project adopted the principle of single use of water for crops between distribution and drainage canals. Since the late 1970's the relative shortage of water compared with potential demand has led to the study of the possibility of using water on more than one irrigated area before discharge to the main drain. The very high evaporation rates, together with the medium to low quality of water available makes such a change rather hazardous and also introduces new factors into the management and engineering of the project.

3.3.6 Radiation

Although the radiation is considered to be high on the al-Hassa oasis due to its location relatively on the northern tropic, the amount of the radiation reaching the oasis is lower because part of it is absorbed and scattered through

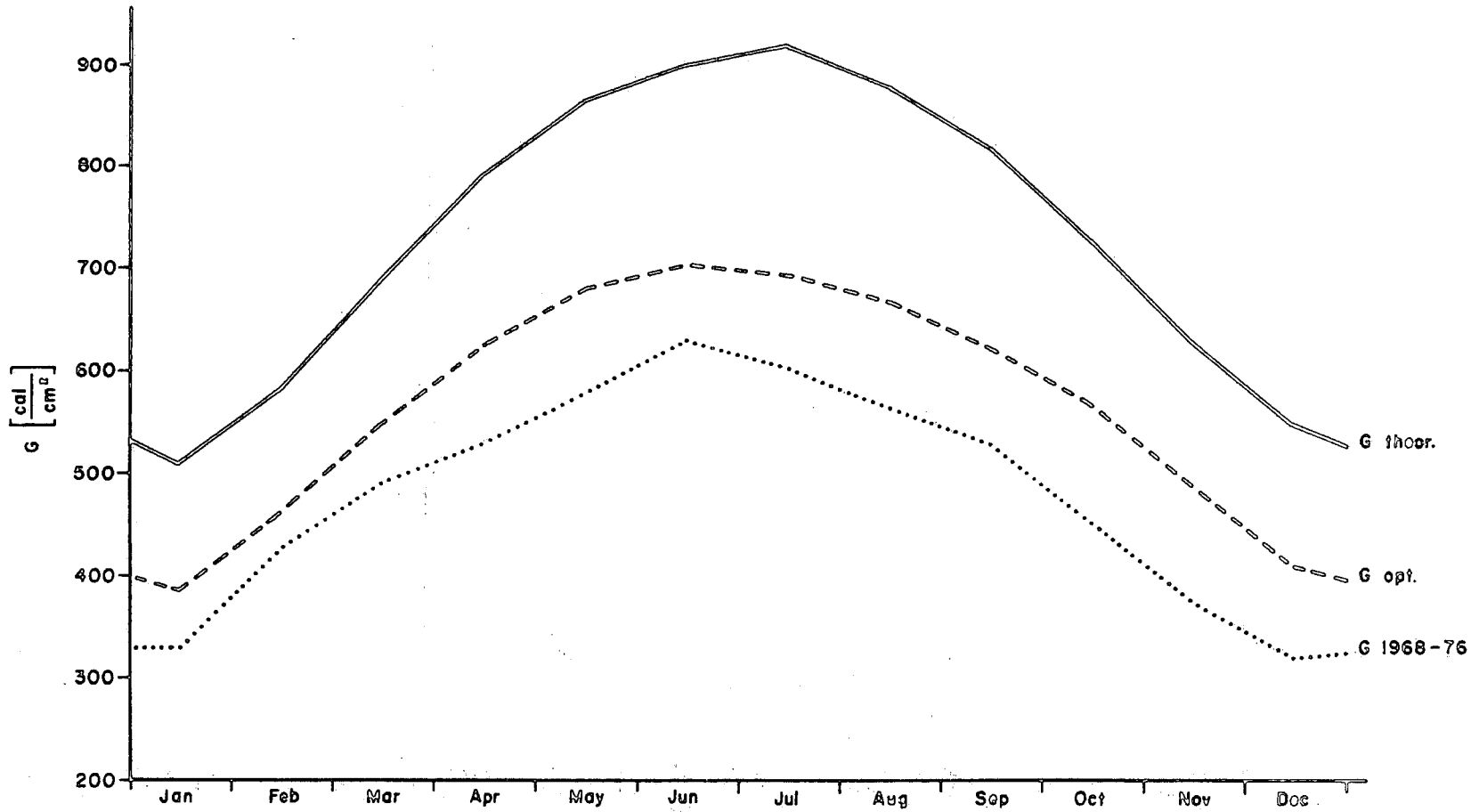
passing the atmosphere. Figure 3.12 shows the possible ideal values of the global radiation that practially are not attainable. This amount varies seasonally i.e. increases during summer months and decreases in winter due to the differences of the radiation angles from the sun against the oasis. The above Figure 3.12 further shows that the absolute maximum daily values of the global radiation also vary with time. However, the actual annual variation is typically different from the optimum curve, see Fig.3.12. During the winter months the amount of radiation decreases as a result of the existence of clouds. However, during summer the average values are lower than the optimum ones. This is because of the turbidity of the air and dust. Table 3.7 and Figure 3.12 show that the highest amounts can be observed during summer months particularly in June 661 cal/cm and the lowest amounts in winter, particularly in January, 347 cal/cm . The amounts of radiation have an effect on evapotranspiration, higher radiation, higher evapotranspiration and vice versa.

Table 3.7 shows main daily global radiation value in the observation period of three years has the following mean values (cal/cm)

Month	J	F	M	A	M	J	J	A	S	O	N	D
Values	347	465	556	556	631	661	626	599	560	480	394	357

Source : H.A.R.C Pub.No.7 1973 p.20.

Fig 3·12 Mean Daily Solar Radiation (G)



Source: H.A.R.C. 1978

It has already been explained that the climate of the Al-Hassa oasis is characterized by high temperatures, low relative humidity, high wind speed, high radiation and low rain and very high evaporation rates. In the light of these facts it is expected that the consumptive use of water for plants growth is high as well. Consequently, the evapotranspiration is generally high, increases in summer months and decreases in winter months due to the variation of the effects of the factors mentioned above. That, in turn, means the surface irrigation is necessary and the plants require far more water in summer months than in winter months. This, then, severely limits the total area which can be irrigated in summer. The balance of use between different parts of the oasis i.e. the older date gardens and the newer area under field crops and vegetables is then determined by the socio-economic attitudes to land.

3.4 The Soils of Al-Hassa

A. General Aspects

The main soils in Al-Hassa region are derived from parent material and are generally variants of sandy loams or clayey sandy loams together with windblown sands. The dominant types in this region are the desert lithosols outside the oasis and on solid outcrops, sandy and sandy, loam soils and sandy clay loams.

In Al-Hassa oasis, farmers have been cultivating such soils for centuries, using simple irrigation techniques. With limited capabilities of water extraction and as a result of survival dependence on agriculture, even in the absence

of artificial drains a degree of ecological stability was maintained for over 5,000 years of cultivation. Sand encroachment has been a problem for a long period (see Chapter 2) and some slow deterioration in soil condition became more rapid after about 1950. By the use of organic manure, particularly from poultry units some farmers have recently also utilised almost pure sand as a growing medium.

Investigation in the region under discussion showed that by 1965 the irrigated area of Al-Hassa had decreased to approximately 4,000 ha (Bowen-Jones 1979) due to increasing salinization of the soil, water-logging and the encroachment of the sand-dunes. However, the Al-Hassa improvement project was started in 1967 with the aim of increasing to 20,000 ha the area under irrigation and drainage with completely newly built water distribution and drainage systems. This aim has not been fully achieved, however, as we see in Chapter 6. In addition, a major project has been carried forward to stop the movement of sand-dunes, as outlined in Chapter 2.

The soils of Al-Hassa are for the most part sandy in texture, with small percentages of silt and clay. Soil studies carried out by the Leichtweiss Institute have shown that the average soil texture of the Western margin of the Al-Hassa area consists of 71-70% sand, 11-16% silt and 9-13% clay (H.A.R.C. pub.27, 1978). Thus soils are classified as sandy loam. The upper soil layers, by virtue of their dominant sandy structure are characterized by high infiltration rates, good aeration and rapid drainage, but on the other hand, plant growth in these soils requires more irrigation water compared with the heavy

soil. However, in most of the lower lands in the oasis there is a nearly impermeable layer of calcium carbonate which is found at a depth varying between 0.40-3.0 cm.(Ibid) below the soil surface. This layer prevents the infiltration of water into deeper layers.

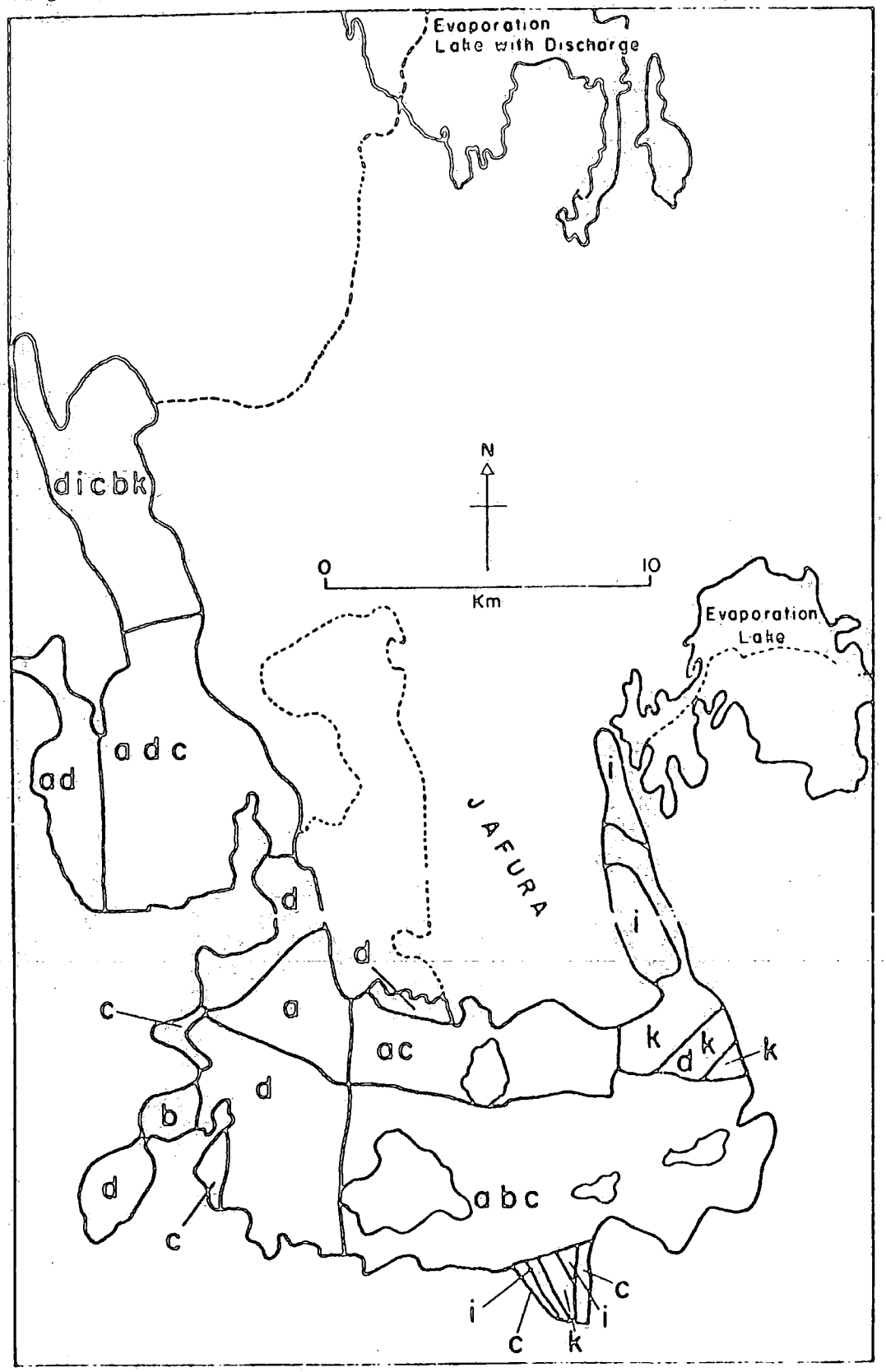
Soil analyses have shown that sodium chloride forms about 90% of the salts content (Labban, S., 1974). Medium to high salinity in the soil is indicated by E.C. levels of 1.5 to 2 m.mhos, but can be kept under control with proper water management practice. Sandy textured soils, such as those in the al-Hassa oasis have an extremely low water holding capacity, consequently irrigation requirements are significantly higher than on heavier soils. Sandy textured soils are also easy to be eroded since they have a weak structure and low organic content. Most of the area is exposed to the Northern winds which bring with them sands to the cultivated areas. So planting of wind-breaks, maintenance of crop cover and the addition of organic matter can reduce this hazard.

B. Soil Classification of Al-Hassa Oasis

The soils of the Hofuf Agricultural Station which were the basis for the Leichtweiss description of the characteristics of sandy loams are found in various combinations with other soil types in "Soil Complexes" within the oasis. Soil characteristics have also, in most of the oasis proper, been modified by cultivation.

The main soil complexes and their characteristics relevant to agriculture have been adequately described in Wakuti Surveys (1964) - see Fig. 3.13.

Fig. 3.13 Al-Hassa, Soil Types (for key see text)



Source: Speetzen, 1974

Class A.

This class is generally developed under high density palmtrees. It has therefore relatively high organic matter, 0.6% carbon in the root zone. The depth to ground water and solid rock is about 70-120 cm. The upper layer consists mainly of sand, this layer underlain by an impermeable layer comprised of marl-clay. The upper layer has a high root-content. The lime content of this soil is generally high, 20% CaCo by volume. Its EC value ranges between 1.5-4 mmhos/cm. Therefore, it is considered as low to medium salt content while the EC of the ground water is very high, ranging between 3-10 mmhos/cm. Its salt content consists mainly of sodium chloride.

At a depth of approximately 1 m. sandy-clayey tertiary marls are found which are nearly completely impervious. These areas are covered with palm trees and a few subcultures such as lemons, pomegranates and figs. These areas traditionally had a sufficient and well operating irrigation and drainage system which balanced the distribution and discharge of irrigation water and drain water. The soil of these areas can be improved by adding organic fertilization.

Class B

This soil is similar to Class A as far as texture and geological parent rock is concerned. The main differences are the depth of the organic horizon and the salt content of the soil. The organic horizon is only 20 cm. depth and contains many roots, while the lower horizon 20-70 cm. is less rooted and has a higher salt content.

Class C

This class comprises encrusted salty soils of different kinds due to insufficient drainage, resulting in the evaporation of irrigation and ground water. Therefore, salt is concentrated in the upper horizon and salt crusts are formed. The texture of this soil is loamy sand which was blown to this area and covers tertiary sand-marl which is generally found in a depth of 60-130 cm. This kind of soil requires regular irrigation and as the upper layer has a good permeability the result of leaching will be good. However, during the first year leaching should be intense, which means about 40-60% of the irrigation water goes off as drainage water which will leach the very high salt content.

Class D

This class of soil is characterized by the fact that ground water is found in a depth of 90-130 cm. or deeper; in some parts it is found at a depth of more than 200 cm. The Aeolian fine sands covering the tertiary material which formed the soil often have a depth down to 130 cm. and more. The humus content in these soils is very low, but in areas which were formerly cultivated, there is a little humus. Therefore this soil requires humus supply as well as mineral fertilizers.

Class I

This class of soil is located in the sabkhah border areas and is slightly influenced by groundwater. The soil shows no waterlogging of the surface and consists of sandy loam, rich in silt. Also the soil materials have

been transported by water and wind. The salt content is very high in the upper horizon down to 30 cm, where the EC exceeds 20 mmhos/cm. In the lower layer of this soil, the values of EC are between 7-12 mmhos/cm. Generally this soil has a medium humus content and has little density and is characterized by many cracks.

Class K

This class of soilsis very silty and strongly influenced by ground water as they are lying lower than the soils of Class I along with insufficient drainage. Therefore here saline swamps (sabkha areas) were formed. These soils often now have been drained and partially under reclamation. The organic matter content in the root horizon down to 40 cm is relatively high. Because of the constant water logging of the soil, the organic substance of root remainders cannot be quickly decomposed. This resulted in the organic matter concentration. The organic matter partly originates from former cultivation as many areas were cultivated in former time, but were then abandoned due to waterlogging. As a result of the high salt content, salt crusts of some mm depth are found.

These areas can be improved but as they are low-lying and very silty, especial care must be taken first of all for a lowering of the ground level by good drainage; second by the following irrigation the salts may be leached. Furthermore, the soil must be improved by organic matter supply and mineral fertilization in order to get good yields.

Soils and Agriculture

Salinity is the major problem facing the development of agriculture, and is due to the high concentration of soluble salts in the irrigation water, over-irrigation (basin irrigation), the evaporation rates and the existence of an impervious layer which causes poor drainage in some parts of the oasis. Over long periods of irrigation the existence of such a layer prevents the downward movement of water and causes development of a new perched groundwater table. This condition can then be influenced by the amount of irrigation water applied i.e. more irrigation, rising ground water table and vice versa. The only effective remedy is deep ploughing to destroy the pan.

Throughout the 1950's, as a result of the rapid development of irrigation along with inadequate drainage, deterioration inside the oasis was accelerated, whilst in the 1970's outside the project area (see 3.2 - the Qatar road area), two problems were created: waterlogging and salinity, particularly in the south and east of the oasis. The seepage took place as a result of using open-earth canals. The seepage water percolated into the soil to be regarded as a water loss, and contributed to the waterlogging phenomenon. This fact, as well as the existence of the impermeable layer along with over-irrigation, also contribute into increased waterlogging. The water resulting from waterlogging is exposed to the high evaporation rates which leads via capillary action to salt concentrations in the upper horizons and on the soil surface.

The soils in this region clearly require careful soil-water management and here a contrast can be made between the oasis proper and the fringe areas outside and to the south-east of the project area. The Irrigation and Drainage Project surveys identified some 20,000 ha. of reasonable quality irrigable soils with what was then thought to be sufficient water potential (see Chapter 3.5). However, the public lands distributed outside the project area from 1970 onwards were insufficiently studied. These consisted of gravel covered silty lithosols, slightly higher than the average oasis levels. Local farmers never succeeded in cultivating this land and after distribution, the application of the available saline groundwater to crops without skilful management leads to deterioration of soil and water conditions.

In the project area, a well designed artificial drainage system led to the improvement of the soil-water complex, but in the distributed lands no drainage system was installed. The result has been the formation of perched water tables and in part at least the lateral movement of highly charged groundwater into the neighbouring oasis plots.

The soils of the oasis and the surrounding area, whilst not being of high quality are still satisfactory for irrigation if soil and water management is adequate. The traditional farming and irrigation systems described earlier were only suitable for al-Hassa soils when the pressure of use allowed natural drainage to operate reasonably well. As more and more land was irrigated the breakdown of the natural soil and water system become inevitable. Since the Irrigation and Drainage project was started the aim has been to maintain soil and water stability at a high level of use.

3.5 Water Resources

As shown in Chapter 3.3 precipitation is inadequate to support agriculture in al-Hassa and, as noted in Chapter 2, for many centuries farmers have used groundwater for irrigation. The availability of groundwater is determined by the hydro-geology of the area. The main features of the geological structure have been described in Chapter 3.1.

To some extent there is some permeation of surface deposits by precipitation. Although the annual average rainfall at Al-Hassa is only some 62 mm, there are periodically heavier falls. For example on 17/6/1404 (March 1984) 15.6 mms fell, followed by 42 mms on the following day (Al-Jazeera daily newspaper 1404). In aggregate the total recharge of the higher aquifers through percolation is considerable (Beaumont 1981), and for many centuries this was sufficient to balance extraction.

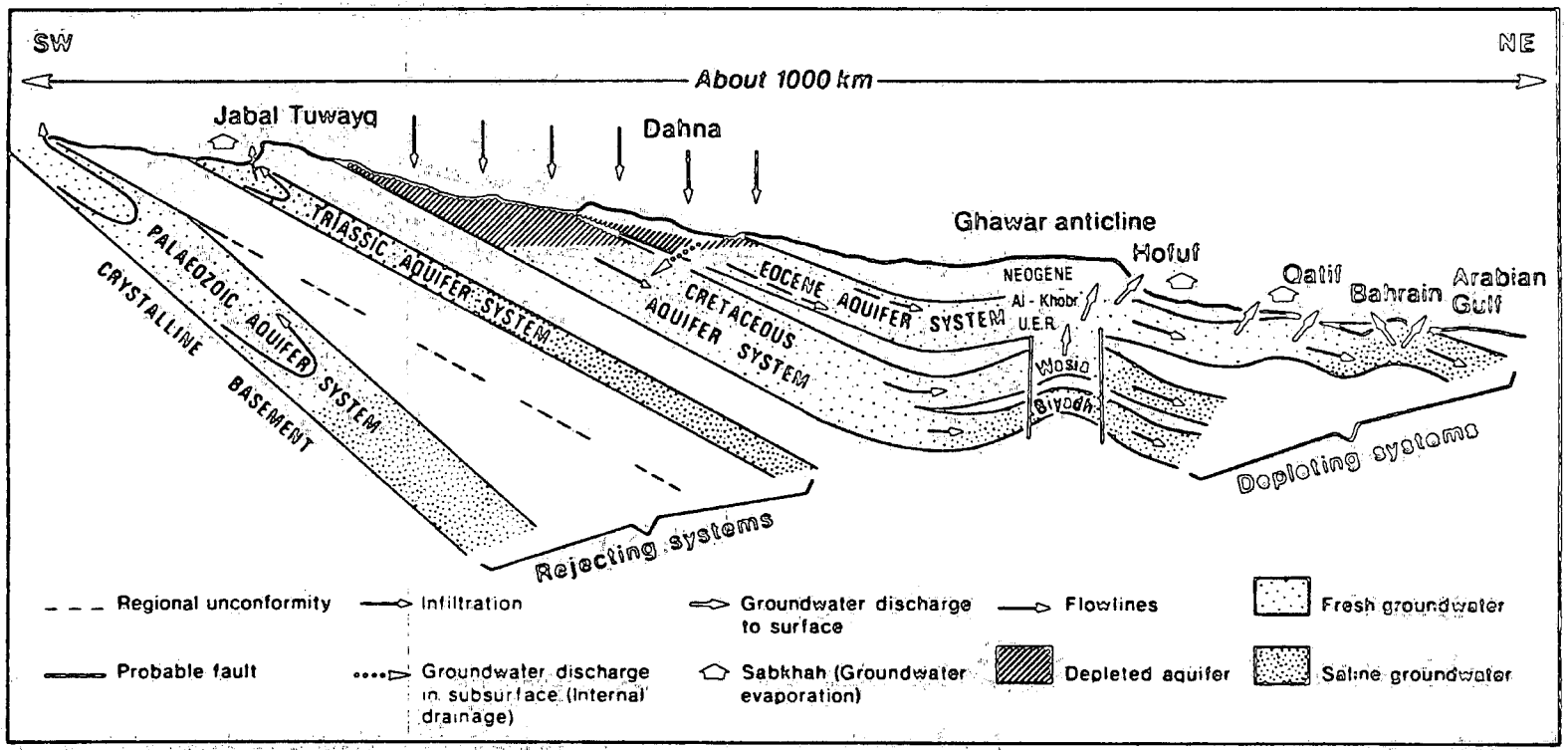
There are actually four identifiable aquifers in al-Hassa which from the surface downward are as follows (Fig.3.14).

i. The Neogene formation

The depth of this formation ranges between 0-180 m. and the static water level is about 145.6 m. above sea level (Al Sayari & Zötl 1978). This formation appears as a large intake zone with annual recharge occurring either through direct or delayed infiltration of run-off over the Neogene outcrop zone .

The general flow of this aquifer is from the west and southwest. The Neogene is the major aquifer system feeding water to al-Hassa springs, the water supply being a mixture of

Fig. 3.14 Schematic Hydrogeological Cross Section of the Arabian Sedimentary Basin



Source : After Italconsult No. 38907

fossil and recent water recharge. The percentage of recent water content has been estimated at between 10% and 20% (Saxen 1968). The age of the fossil water has been estimated at 9,000 to 23,000 years (El-Katib 1980). This mixture of water indicates that though the Neogene series form the spring sources there is also a flow of water into the Neogene from lower aquifers containing fossil water of more distant origin.

ii. The Khobar formation

The depth of this aquifer ranges from 180-230 m. and consists of limestone. The static water level is between 133-139 m. above sea level (El-Katib 1982).

This formation communicates with the overlying Neogene and the underlying Umm Er Rdhuma aquifers. This formation also has a thin layer of limestone, the Alat, which forms part of the Dammam formation and consists of low water bearing limestone units separated occasionally by thin shale units. The general flow is from south-west to north-east.

iii. The Umm Er Rdhuma formation

The depth of this aquifer ranges between 280-600 m. and the static water level is about 154 m. above sea level (Al-Sayari & Zötl 1978). The general flow is from south-west to north-east.

In volume, the Umm Er Rdhuma aquifer gives less plentiful water than the higher aquifers and quality is generally poorer in terms of dissolved salts.

iv. The Wasia formation

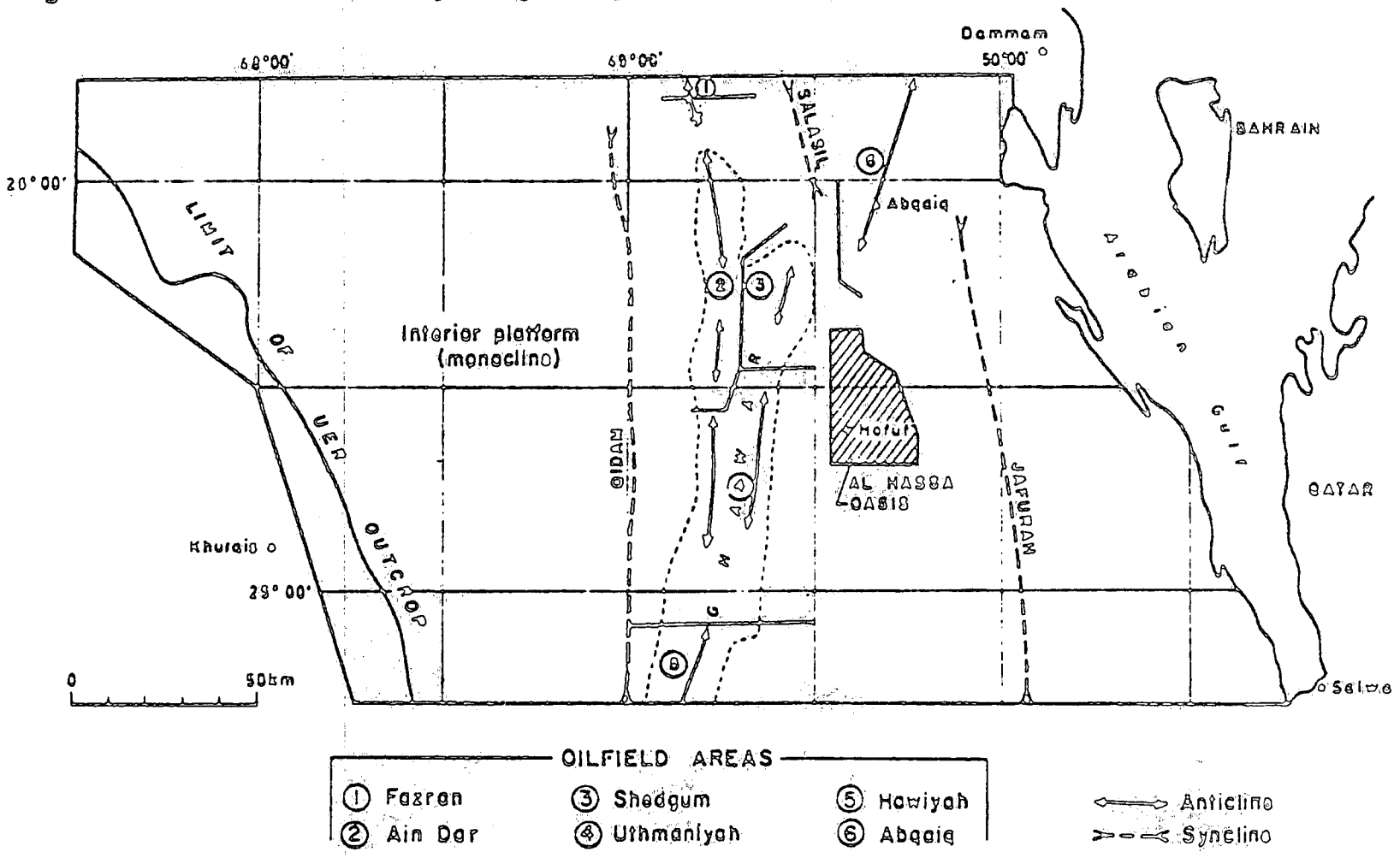
The depth of this aquifer is about 900-1330 m, its static level being about 169 m. above sea level (op.cit.). It consists of shale, marl, shaley limestone at the top and sand with some clay or marl at the bottom. This upper Cretaceous formation carries water which has infiltrated the land in the central peninsula zone where this formation is extensively exposed. This aquifer has been said to contain more water than there is in the Arabian Gulf (Aramco Handbook 1968), and is now being exploited heavily in the Central region.

The structural and lithological breaks associated with the Ghawar anticline have resulted in considerable upward vertical movements of water between the various aquifers. Traditionally, irrigation water was obtained from the freeflowing springs in the surface Neogene and this is still the source of water for the oasis. However, changes in extraction rates and the development of deep wells around the oasis have somewhat changed the nature of water available in the oasis. As indicated in Chapter 3.1 and in Figure 3.15 al-Hassa oasis must be viewed hydrologically as part of a region and not merely in isolation.

3.5.1 Morphology of the springs

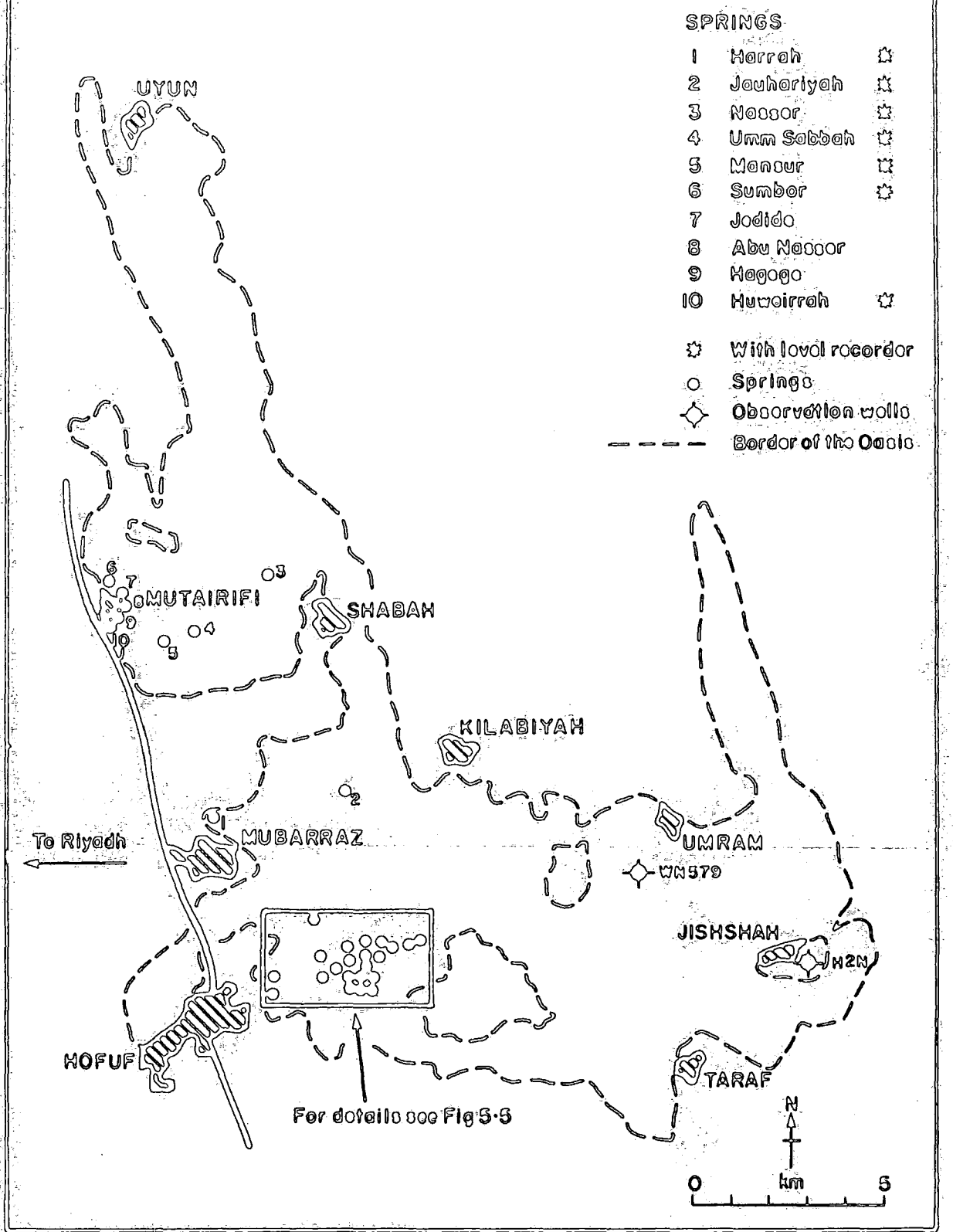
Most al-Hassa springs are found in two main groups within the oasis as shown in Figure 3.16, but springs are scattered throughout the oasis area. Generally, the main springs lie very close to the 145 m. contourline which runs in a south-south-west to north-north-east direction, see Fig. 3.17.

Fig. 3·15 Al-Hassa — Hydrogeological Setting



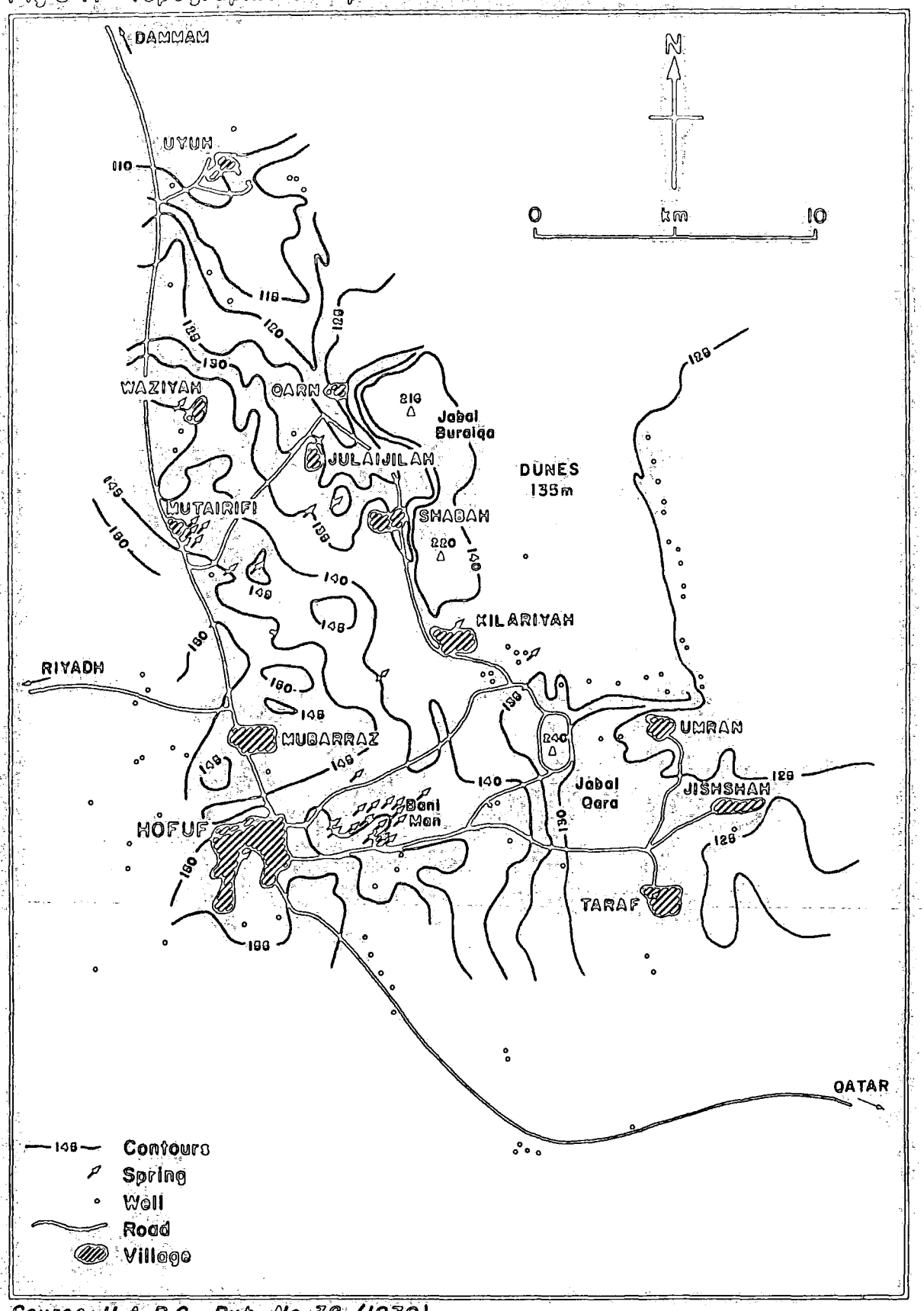
Source : Reproduced from B.R.G.M. (1977)

Fig 3.16 MAIN SPRINGS OF THE AL HASSA OASIS



Source: H.A.R.C., Pub. No. 38, (1979)

Fig 3·17 Topographical Map of the Al Hassa Oasis



Source: H.A.R.C., Pub. No. 38, (1979)

The first group is located to the east of Hofuf, consisting of 22 springs between Hofuf and Bani-man village. The second group is located around the village of al-Mutairifi on the middle western border of the oasis, see Fig.3.16, consisting of 7 springs. The other springs are Ain al-Harrah near al-Mubarraz, Ain al-Jauhariyah near Barraliyah and Ain Nasser near al-Shabah.

In the past the springs of al-Hassa oasis were 1-3 m. deep pools of oval or round shape with diameters ranging from a few metres to 90 metres (H.A.R.C. 1979). By the 1960's many springs were silted up or blocked by palm trunks which used to be thrown into the outlets of the spring to reduce the natural discharge and to avoid the gardens being over-flooded. The more common way used to control the natural discharge was to build a small temporary stone wall or earth dam sluice across the outlet (Jussah) and so raise the water level. Flow was not controlled until after the new engineering works were completed in 1972. After this many wells were tapped and controlled.

3.5.2 The discharge of the springs

First details of the discharge of al-Hassa springs were given by Twitchell in 1944. He gave an estimation of the total discharge of al-Hassa's nine main springs as about 93,300 galls a minute, the capacity discharge of these individual springs being as follows:

Table 3.8 Estimated capacity discharge of nine springs in al-Hassa Oasis

Name of Spring	Gallons/Minute
Al-Hayl	22,500
Al-Khudud	20,000
Al-Harra	20,000
Umm Sabah	20,000
Ain Mansur	4,000
Jaharia	3,000
Huaira	2,000
Thuraib	1,000
Bahali	800
Total	93,200

Source: Twitchell, K.S. (1944) Water Resources of Saudi Arabia, Geographical Review, Vol.34, p.384.

Investigations carried out in 1963/64 by Wakuti Consultant Engineering measured the discharge of all springs and wells at 14.1 m^3/s (H.A.R.C. 1978), as follows:-

i. The total wells numbered 336, some free flowing, others pumped. The average discharge of each well ranged from 0.5-10l/s. Thus, the total discharge was about 1.7 m^3/s.

ii. Small springs totalled 83, the discharge from each spring ranging between 0.5 and 20 l/s, the total discharge from these springs averaged 0.3 m^3/s.

iii. Large springs totalled 43 with an average discharge ranging from 25-1700 l/s, the total discharge of these springs being 12.1 m^3/s.

The water discharges have certainly decreased continually because:-

The original survey and estimate of available water were based on the assumption that 42 of the existing 162 springs would be tapped to supply the project whereas, in fact, only 32 springs were used. This might account for the difference between the consultant's forecasts of the amount of water that would be available, and the discharge rates actually experienced since the project's completion.

Extensive withdrawals of water from the neogene aquifer and/or other connected aquifers were made until recently for oil production purposes in the adjacent areas west of al-Hassa oasis (see Fig.3.15).

Water withdrawal for land reclamation purposes within and around the oasis, particularly drilling activities south-east of Hofuf, the Qatar Road area, has continued. These new wells provide irrigation water for the most important newer area development under field crops and vegetables outside the oasis proper. By 1967 there were 387 wells in and around the oasis most of which were pump assisted (H.A.R.C. 1976).

In the past there was no proper urban sewage system in Hofuf and Mubarraz: each household, in addition to its own hand dug well for domestic water, sank a shaft up to 20 m. deep for the disposal of sewage. Now, a new system, to which the villages are also being connected, has been constructed taking all waste eastwards to the edge of the oasis, thus preventing recharging of the aquifers from the infiltration of this waste water.

Lastly, there is the continuously increasing demand for groundwater by the domestic and industrial activities in the numerous and rapidly growing villages and urban areas within the region.

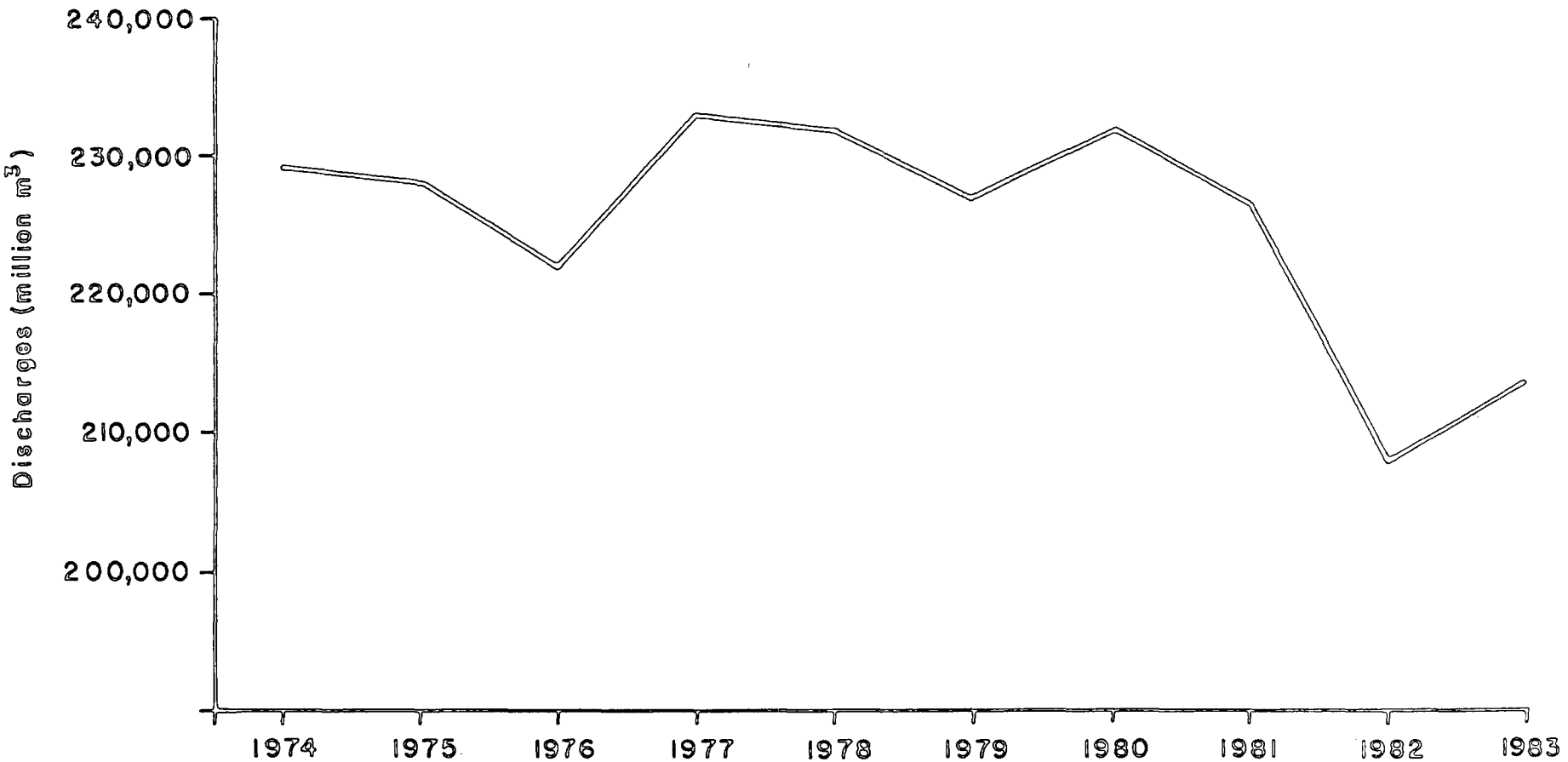
Table 3.9 and Figure 3.18 illustrate the annual fluctuations in the discharge of the 32 major springs. Although 1982 shows a very considerable drop over previous years, the general level since 1974 has remained remarkably constant. No certain correlation between discharge and precipitation can be established because of the uncertainty over the part played by contemporary rainfall change (see Chapter 3.3) and over the interconnections of the various aquifers. Nevertheless, it seems likely that the drop in total discharge may be due to the fact that there has been insufficient precipitation during the periodic droughts, which in the experience of local inhabitants usually last about seven to ten years, to recharge the groundwater levels.

Table 3.9 Total monthly discharges from 32 springs (million m)

Year	Discharges
1974	229,016
1975	228,913
1976	222,422
1977	233,520
1978	232,000
1979	227,436
1980	231,056
1981	222,552
1982	207,383
1983	213.541

Source : Unpublished records of H.I.D.A. consulted personally during fieldwork 1982 and 1984.

Fig. 3.18 Total Monthly Discharges from 32 Springs (million m^3)



3.5.4 Water quality

Investigations about the water quality in al-Hassa oasis have shown that the total dissolved salts increase from south-west to north-east with the hydraulic gradient of the groundwater (H.A.R.C. 1978).

Generally, the salinity of the groundwater is considered low - about 2.42 mmhos/cm average E.C. (see Table 3.10).

The average salinity of the groundwater varies from month to month (see Fig.3.5). There is some indication that salinity as measured by electrical conductivity tends to be highest in the summer months.

This water is, in general, considered suitable for irrigation purposes according to the U.S.D.A. classification of irrigation water from the point of view of salinity. However, there is some indication that water quality has been deteriorating. Figure 3.19 shows that average annual electrical conductivity has been increasing during some periods.

3.5.5 Water extraction and utilisation

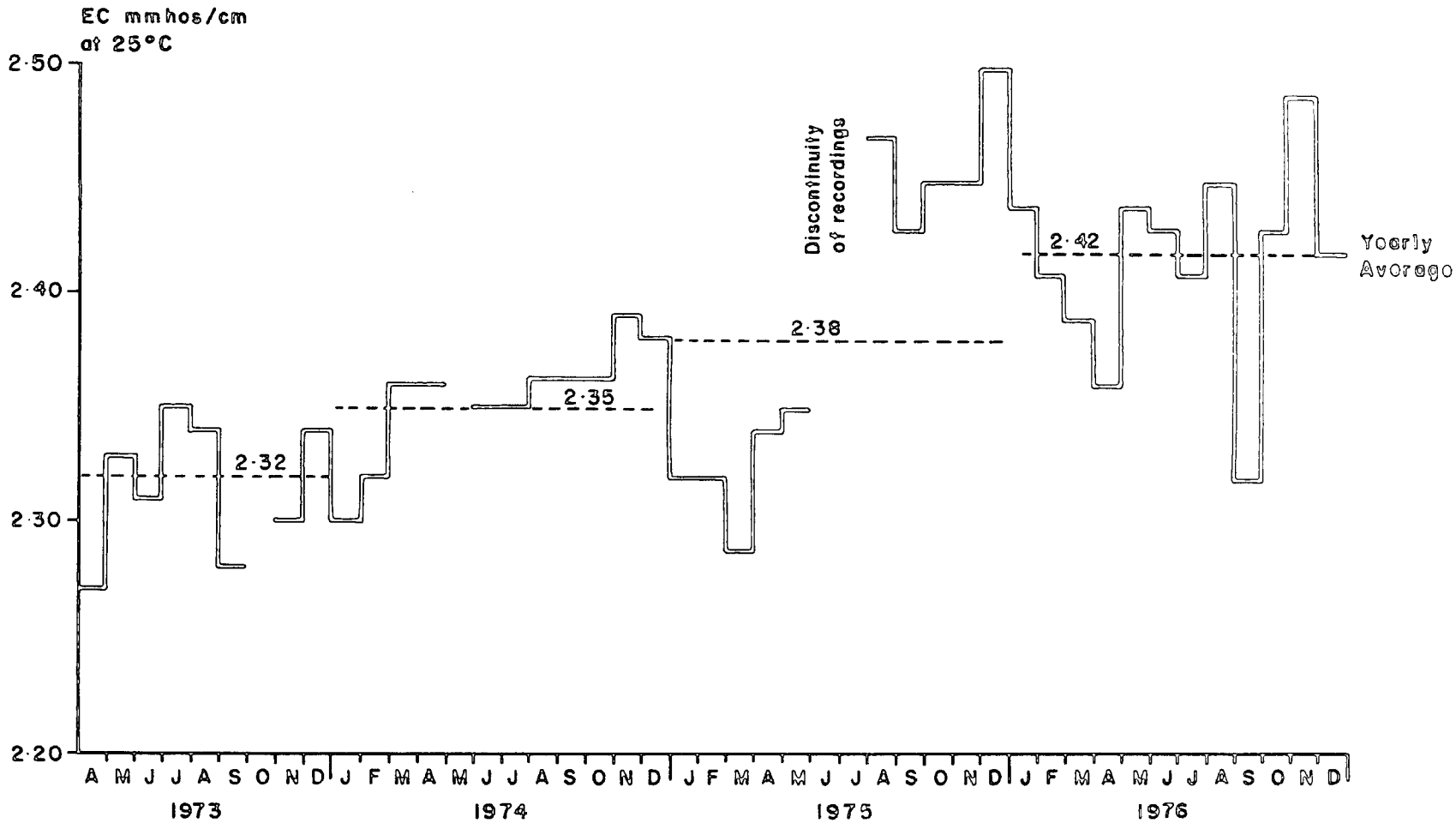
In Sections 2.2 and 2.4 the old systems of irrigation were examined. In the 1950's farmers began to instal motor pumps. Some of these were used in mugharraf irrigation to replace human and donkey power, while others were used to draw water from newly drilled wells of which in 1967 there were 887 in and around the oasis. This use of pumps constitutes a transitional period between the established traditional system in force which operated up to about 1950, and the

Table 3.10 Irrigation Water Analysis in 1976

	Spring	Electrical conductivity (mmhos/cm) at 25°C			Total salinity (ppm)		
		min	max	mean	min	max	mean
1	Khudud	2.1	2.2	2.2	1365	1430	1430
2	Haql	2.2	2.2	2.2	1365	1430	1430
3	Hueire	2.1	2.3	2.3	1365	1495	1495
4	Guedad	2.1	2.5	2.4	1365	1625	1560
5	Umm Save	2.1	2.3	2.2	1365	1495	1430
6	Umm Freech	2.2	2.4	2.3	1430	1560	1495
7	Aseimi	2.2	2.4	2.3	1430	1560	1495
8	Ta'adhid	2.2	2.5	2.3	1430	1625	1495
9	Amarah	2.3	2.5	2.4	1495	1625	1560
10	Rasibe	2.2	2.4	2.3	1430	1560	1495
11	Barabir	2.4	2.6	2.5	1560	1690	1625
12	Talib	2.3	2.4	2.4	1495	1560	1560
13	Umm Allif	2.4	2.7	2.6	1560	1755	1690
14	Buhadje	2.4	2.7	2.5	1560	1755	1625
15	Manah	2.4	2.6	2.4	1560	1690	1560
16	Luwaimi	2.4	2.6	2.5	1560	1690	1625
17	Umm Dalli	2.4	2.7	2.5	1560	1755	1625
18	Bsetinat	2.3	2.5	2.4	1495	1625	1560
19	Sable	2.4	2.8	2.6	1560	1820	1690
20	Mushatiyah	2.5	3.0	2.7	1625	1950	1755
21	Jaburiyah	2.4	2.8	2.6	1560	1820	1690
22	Bahlah	2.1	2.6	2.3	1365	1690	1495
23	Huweirrah	2.4	2.6	2.5	1560	1690	1625
24	Abu Nasser	2.4	2.7	2.5	1560	1755	1625
25	Hagege	2.4	2.6	2.5	1560	1690	1625
26	Jedide	2.4	2.7	2.5	1560	1755	1625
27	Sumbor	2.4	2.6	2.5	1560	1690	1625
28	Umm Sabah	2.3	2.6	2.4	1495	1690	1560
29	Nasser	2.3	2.5	2.4	1495	1625	1560
30	Jauhariyah	2.2	2.4	2.3	1430	1560	1495
31	Mansur	2.3	2.5	2.4	1495	1625	1560
32	Harrah	2.3	2.6	2.4	1495	1690	1560
	Average	2.29	2.55	2.42	1490	1655	1570

Source: H.A.R.C, 1978, p.43.

Fig 3·19 Average Monthly Electrical Conductivity of the Water of the 32 Main Springs of the Al-Hassa Oasis, 1973-76



Source : after H.A.R.C

new irrigation and drainage project which came into full operation in 1972.

The same period from the early 1950's to the early 1970's saw dramatic changes in the whole socio-economic structure (see Chapter 4). During the two decades before 1970 agriculture declined in competition with other sectors. However, from about 1960 the M.A.W. took steps to try to reverse this decline, based on regional studies which resulted in the construction of a completely new irrigation and drainage project, which also alleviated the problem of soil salinity as well as providing a scientifically designed drainage system and efficient distribution of water.

As mentioned above (section 3.5.3), the project designers overestimated the amount of water available,with the result that only 7,000 ha out of the intended 16,000 ha are under year round irrigation. There are still the problems of monitoring water use and ensuring that land use is made compatible with the most efficient use of water.

In general, there is sufficient water available to irrigate additional land which has a potential for cultivation, if only the water were more efficiently used. As Humaidan (1980) observed, "the inadequacy of guidance and restraints in the proper use and conservation of this vital resource has confined the total cropped area to a magnitude much less than the anticipated potential of the project. More land could undoubtedly be brought under cultivation if available water were more efficiently utilized." In Chapter 5, land use and water distribution, extension services and agricultural research in al-Hassa will be examined.

CHAPTER THREE

REFERENCES

Al-Abdulwahed, Y.A., (1978), Al-Hassa Sand Stabilisation Project, M.A.W., Saudi Arabia, (in Arabic).

Al-Jazeera, Daily Newspaper (17/6/1404), Riyadh, Saudi Arabia, (in Arabic).

Al-Sayari, S., and Zött, J.G., (1978), (Edited), Quaternary Period In Saudi Arabia, Springer-Verlag Wien, New York.

Al-Sharef, A.S., (1977), Geography of Saudi Arabia, Part I, Riyadh, (in Arabic).

Al-Shuaiby, A.M., (1976), The Development of the Eastern Province with Particular Reference to Urban Settlement and Evolution in Eastern Saudi Arabia, (unpublished Ph.D. thesis), University of Durham.

ARAMCO, (1968), Aramco Handbook, Arabian American Oil Company, Dhahran, Saudi Arabia.

Beaumont, P. (1981), Water Resources and their Management in the Middle East (ed) J. Clarke and H.Bowen-Jones, Methuen, London.

Bowen-Jones, H., (1979), Land Use in al-Hassa Oasis, Report to the M.A.W. of Saudi Arabia, Unpublished.

El-Khatib, A., (1980), Seven Green Spikes, M.A.W., Saudi Arabia, Second Edition, Dar al-Asfahani, Jeddah, Saudi Arabia.

Fisher, W.B., (1978), The Middle East, A Physical Social and Regional Geography, Methuen and Co. Ltd.

Hajraha, H.H., (1970), The potential of Agricultural Development in Saudi Arabia, M.A.W., Saudi Arabia (in Arabic).

Humaiden, S.H., (1980), Policies and Management Guidelines For Optimum Resource Utilization at al-Hassa Irrigation and Drainage Project, Saudi Arabia, (unpublished Ph.D. Dissertation), State University, Oklahoma.

Ied, S.Y., (1979), Agricultural Geography of al-Hassa Oases, Saudi Arabia (unpublished Ph.D. thesis), University of Cairo, Egypt (in Arabic).

Labban, S.A., (1974), Agriculture in the Main Oases of The Eastern Province of Saudi Arabia, Arabian American Oil Company, Dhahran.

Ministry of Agriculture and Water, (1973), Hofuf Agricultural Research Centre, publication No.7, Agrometeorological Data of the al-Hassa Oasis.

____ (1976), Hofuf Agricultural Research Centre, Publication No.15, Hydrogeology of al-Hassa Oasis.

____ (1977), Hofuf Agricultural Research Centre, publication No.16, Water Resources of al-Hassa Oasis.

____ (1978), Hofuf Agricultural Research Centre, publication No.22, Water Resources of the al-Hassa Oasis.

____ (1978), Hofuf Agricultural Research Centre, publication No.23, Investigations on the Hydrogeography and Water Resources of the al-Hassa Oasis.

____ (1978), Hofuf Agricultural Research Centre, publication No.26, Agrometeorology of the al-Hassa Oasis (1969-1976).

____ (1978), Hofuf Agricultural Research Centre, publication No.27, Soil Investigations in al-Hassa Oasis.

____ (1979), Hofuf Agricultural Research Centre, publication No. 38, The Water Potential of the al-Hassa Oasis.

____ (1981/82), Hofuf Agricultural Research Centre, Unpublished Records Consulted by the author during fieldwork.

____ (1982/84), Hassa Irrigation and Drainage Authority, Unpublished records consulted by the author during fieldwork in 1982 and 1984.

Saxen, A., (1968), Situation of the Irrigated Agriculture in the Eastern Province of Saudi Arabia.

Twitchell, K.S., (1944), Water Resources of Saudi Arabia, Geographical Review, Vol.34.

Vidal, F.S., (1955), The oasis of al-Hassa, Arabian American Oil Company, Dhahran, Saudi Arabia.

Wakuti, (1964), Final Design for the Project of Improving Irrigation and Drainage In The Region of al-Hassa, Saudi Arabia.

Wakuti, (1969), Studies for the Project of Improving Irrigation and Drainage In the Region of al-Hassa, Saudi Arabia, Volume 3 - Soil Study, Siegen, West Germany.

CHAPTER FOUR

ECONOMIC AND SOCIAL CHANGE - NATIONAL AND REGIONAL

Introduction

As noted earlier, agriculture in al-Hassa oasis remained little altered from its traditional past until the 1950's. The changes that have taken place since must be, first, set in the context of national and regional economic and social change, and, secondly examined against the physical and historical background outlined in Chapters 2 and 3.

4.1 Statistical Indicators of National Economic Change during the last 30 years - The oil era

i. The economy of Saudi Arabia before the exploitation of oil was originally based on subsistence agriculture, pastoralism practised by nomadic tribes and funds from foreign Moslem pilgrims who visited the holy places at Makka and Medina. In addition, there were other revenues drawn partly from high import duties (although the total value of imports was low) and partly from zakat (religious tax). Statistical indicators of economic change during the last 30 years show that oil exploitation and export became the main source of income for the national economy.

Table 4.1 shows how oil revenue return has contributed markedly to sustaining the Saudi Arabian national income during the period from 1950 to 1980.

Oil production increased continuously and the price obtained for exported oil rose sharply after 1973/74.

Table 4.1 : Oil Production, Oil Revenues and Total Revenues

Year	Oil production Millions of Barrels	Oil revenue S.R.Million	Total revenue S.R. Million
1950	200	202	n.a.
1951	278	320	n.a.
1952	302	753	n.a.
1953	308	603	n.a.
1954	351	838	n.a.
1955	356	1,210	n.a.
1956	367	1,029	n.a.
1957	376	1,040	1,500
1958	386	1,058	1,400
1959	421	1,111	1,405
1960	481	1,186	2,786
1961	540	1,342	2,166
1962	600	1,455	2,452
1963	652	2,158	2,686
1964	694	1,857	3,112
1965	805	2,354	3,961
1966	950	2,804	5,025
1967	1,024	3,227	4,937
1968	1,114	3,291	5,535
1969	1,174	3,405	5,966
1970	1,387	4,310	7,940
1971	1,741	6,905	11,120
1972	2,202	9,920	15,368
1973	2,773	15,407	22,810
1974	3,095	80,136	98,247
1975	2,583	91,151	95,743
1976	3,139.3	93,873	103,384
1977	3,358	121,902	135,957
1978	3,029.9	115,412	132,241
1979	3,479.4	116,876	131,505
1980	3,623.5	191,105	211,196

Source : Cleron, J.P., Saudi Arabia 2000, 1978 (Table 2.1)
: Ministry of Planning, Saudi Arabia, Achievements of the First and Second Development Plans 1970-1980, 1982.

Consequently oil revenue also increased, from 202 million SR in 1950 to 191,105 million SR in 1980. However, this had very considerable direct and indirect impact on other economic sectors. These developments led in particular to the movement of labour from the traditional economic sectors such as agriculture to sectors such as oil utilization, industry, trade, construction, civil service etc.

In addition, these economic changes have led to rapid social change throughout Saudi Arabia, but particularly in the Eastern Province.

Prior to the discovery of oil, this province had been dependent on agricultural income, but a great number of the younger men left agriculture for non-agricultural jobs which carry higher and quicker rewards than those in agriculture.

Nowadays, farmers do not depend completely on the cash return from agriculture. Most of them have other jobs, either part or full-time, and agriculture has become a secondary source of income. Farming became the residual sector.

In order to derive the maximum benefit from the income from oil, the government instituted in 1970 a series of five year development plans, the most important objectives of which are preserving moral and religious Islamic attitudes, strengthening the country's defence, stability and security, maintaining the economic development momentum, decreasing the dependence of the country on oil production as the main national income source, developing manpower resources by education and training, and providing its citizens with basic requirements. The first development plan, completed in 1975

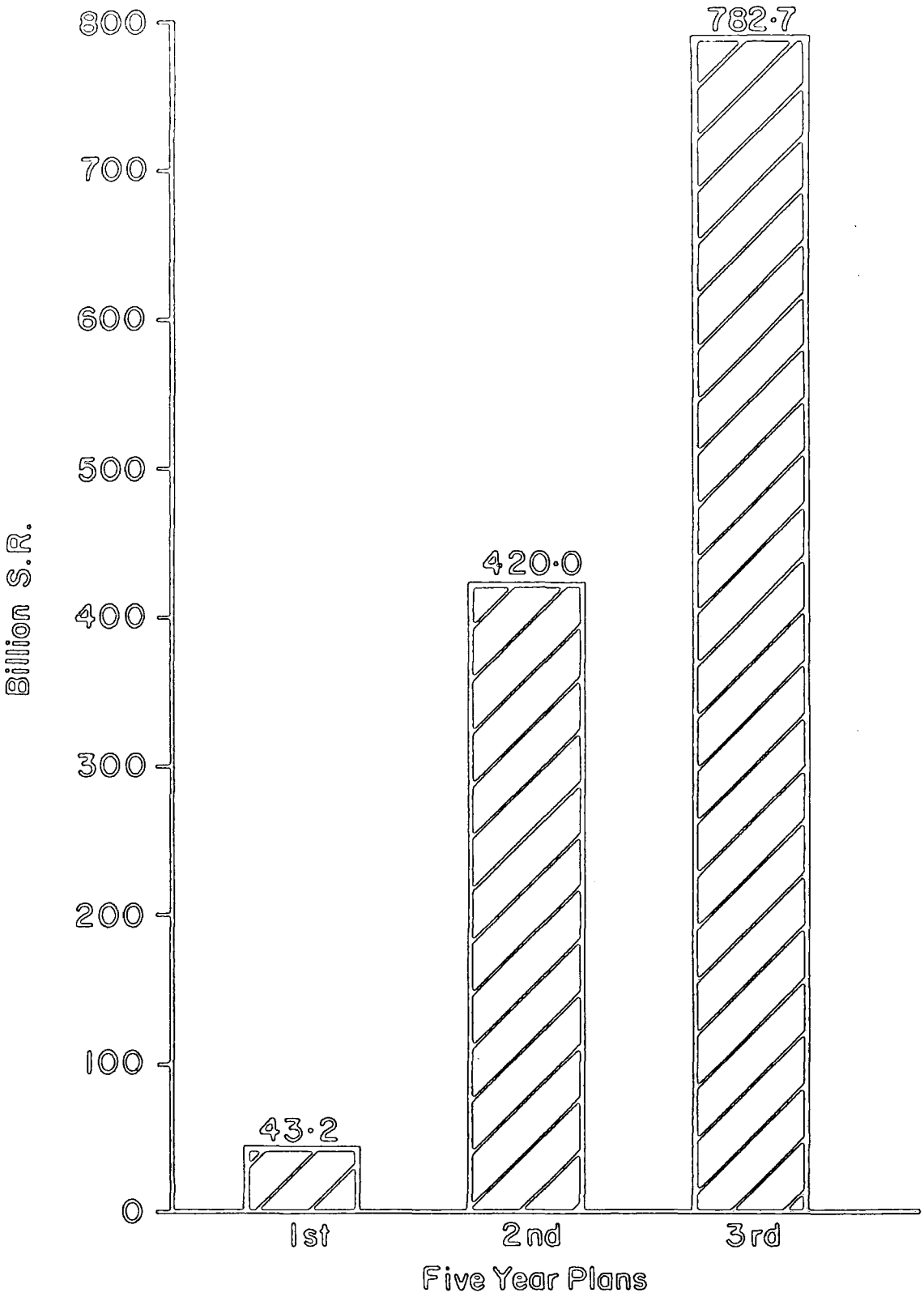
introduced major improvements in education, health, social services and construction. The second plan, completed in 1980, had a major effect on people's lives, having brought about major economic growth, greatly improved health and living conditions, ensuring that health and social services are available to all, and giving all citizens the opportunity to benefit from the country's economic welfare and obtain the basic needs of life. It has also resulted in a change in the distribution of population since large numbers have migrated to the cities.

The third development plan, running from 1980-1985 is designed to continue these developments, with particular emphasis on education, social welfare, administrative and economic efficiency, and the greatest involvement possible of the citizens in the development projects. Priorities of the third plan are to continue the objectives of the previous plans, and make heavy investment in industrial and agricultural expansion, as well as the development of rural areas. Also, the third plan aims to solve the problem of the distribution and marketing of the manufactured and agricultural production which the plans have stimulated.

The total amount set aside for the first plan was SR 43.2 billion, for the second SR 420 billion, and for the third SR 782.7 billion as shown in Figure 4.1. Figure 4.2 shows how government expenditures have kept pace with the increase in revenues.

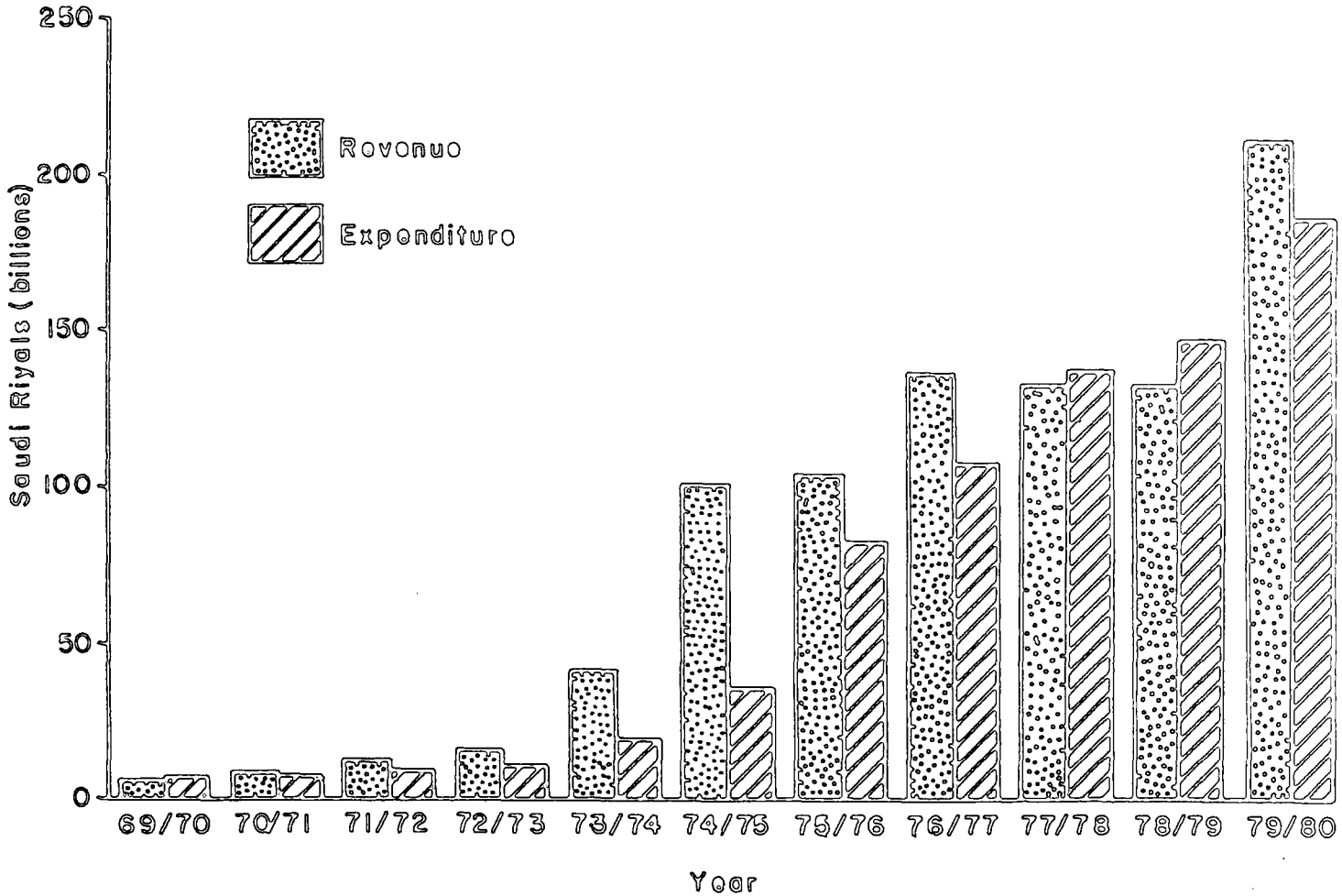
Clearly, oil wealth, through the development plans, has had a profound effect on all sectors, bringing great economic and social changes throughout the nation.

Fig.4·1 Government Expenditure on Development Plans Billion S.R.



Source: Feature from Saudi Arabia (1983). p. 17.

Fig.4-2 Government Revenues and Expenditures



Source : Achievements of the First and Second Development Plans (1402/1982), p3

Perhaps the greatest single impact on traditional rural cultures and economics has been that of progress in development of the national education. More than 10-13 per cent of Saudi Arabia's budget, particularly since 1954, and in recent years has been devoted to education, which has resulted in rapid expansion at all levels.

Table 4.2 gives statistical information about schools and student numbers, and budget size for 1954 and 1968.

Table 4.2 Statistics and Budget of Government Schools

Year	Students enrolled	Teachers	Schools	Expenditure	
1954	52,839	2,288	469	65 mill.SR	14.6 mill.US
1968	331,760	14,522	2,068	524 mill.SR	125 mill.US

Source: Abd-el Wassie, A. (1970), p.5.

The expenditure shown in Table 4.2 above of 125 million US dollars in 1968 represented 10.3% of government expenditure, 5.3% of the total national income. It can be seen that in the fourteen years to 1968 the population in schools had increased more than six fold.

Ten years later in 1978, the numbers had increased to 4,445 primary schools, and 1,400 intermediate and secondary schools. The total school population was then over 1 million pupils. At the same date there were 41,584 students attending 19 higher education colleges or universities (E.I.U. 1980). By 1982-83 there were 879.000 boys and 649,431 girls attending schools and nearly 55,000 students at national universities (Features from Saudi Arabia, Undated).

Educational levels and expansion were limited before oil exploitation but the accelerated large-scale provision of educational facilities has everywhere produced new generations who neither have to, nor want to follow their fathers as farmers.

As an indirect effect of development changes in Saudi Arabia, the process of urbanisation has also severely affected the agricultural scene. Oil exploitation itself accelerated the immigration process to the urban areas at the expense of the rural ones, and particularly in the Eastern Province. The oil industry produced direct employment opportunities in the oilfields but, more importantly, indirect employment opportunities became also more readily available in cities throughout the country.

Urbanization in Saudi Arabia has recently increased at an annual rate of over 9.0% which exceeds the world average of between 4 and 4.5% per annum (Al-Elawy 1976). This high rate of urban growth is because of the rapid increases in migration to the urban areas and the rising natural increase of their own inhabitants.

Before the oil era, the largest cities of Saudi Arabia were the holy city of Makkah, and Jeddah in al-Hijaz, Riyadh, the capital of Saudi Ababia, in the centre, and al-Hofuf in the Eastern Province.

Table 4.3 shows the rapid increase in population of the main cities of the country between 1959-1974 (the last census).

The establishment of new towns and the extension of

Table 4.3 Population of the Main Cities of the Country Between 1959-1974

Population (in thousands)

City	1959(1)		1974(2)	
Riyadh	300		667	
Jeddah	100		561	
Makkah	120		361	
Taif	-		205	
Medina	40		198	
Dammam	35		128	
Hofuf and	60	88	101	155
Mubarraz	28		54	
Tabuk	-		75	
Buraidah	-		70	
Khamis Mushayt	-		50	
Al-Khobar	15		49	
Najran	-		48	
Hail	-		41	
Jizan	-		33	
Abha	-		30	

Sources: (1) George A.Lipsky, (1959) p.25.

(2) Al-Besher, A. (1983), p.39.

economic development of old cities offered many non-agricultural jobs which pay higher wages than those in agriculture, and, as a result attracted the labour from the traditional agricultural sector. Both towns and villages have benefited from government assistance in housing although the majority of large new housing schemes have been built in large cities. Government departments had built 58,000 housing units for their employees, mainly urban, by 1982. 15,000 units were under construction for government and up to 1982 the Real Estate Development Fund had granted 25,000 loans totalling SR 52 bn. for private dwellings and supplied loans worth SR 3,576 mn. to build accommodation for rent (Features from S.A. Undated). These statistics are further indications of the social and economic transformation of the kingdom. In spite of the rapid development in other sectors, agriculture has remained the primary occupation of the Kingdom's population. In 1974 AD, (1394-1395 A.H) it is estimated that about 695,000 persons (i.e. 40% of the civil labour force) were engaged in agriculture. By 1979 AD, (1399-1400 A.H) although agricultural employment had declined sharply, by about 96,000 persons (Third Development Plan 1400), the sector still remained the largest employer with about a quarter of the kingdom's civil labour force.

ii. Gross Domestic product contribution by Agriculture in S.R. million

Table 4.4 shows that the actual value of national agricultural production has increased continuously. In 1962/63 A.D (1382/83 A.H.) it was 879.9 million S.R. increasing to 1640.0 million S.R. in 1978-79 (1399-1400).

Table 4.4 Gross Domestic Product Value of Agriculture

Year	SR Millions	
1962-63 (1382-83 A.H)	879.2	
1967-68 (1387-88 A.H)	897.4	At 1966-67 (1386-87 A.H) prices
1970-71 (1390-91 A.H)	986.6	(1)
1970-71 (1390-91 A.H)	1018.0	
1975-76 (1395-96 A.H)	1221.0	At constant prices of
1978-79 (1399-1400 A.H)	1640.0	1969-70(1389-90 A.H) (2)

Source (1) Report of the Central Planning Organization, 1394 A.H Kingdom of Saudi Arabia, p.123.

(2) Saudi Arabia, Achievements of the First and Second Development Plans 1390-1400 (1970-1980) Ministry of Planning, p.76.

Table 4.5 shows that the proportional agricultural contribution to the national income of Saudi Arabia has decreased continuously. In 1962-63 A.D. (1382-83 A.H) the agricultural contribution was 10.1% decreasing in 1978-79 A.D (1399-1400 A.H) to 3.3% of the total income. This decrease can be attributed to the continuous increase of the oil revenue contribution to the national income, even though agricultural production was increasing in value all the time.

Table 4.5 Gross Domestic Product Sectoral Contribution of Agriculture as % of total

Year		%	
1382/83		10.1	) At current prices
1387/88	(1)	6.2	)
1392/93		4.0	) At constant prices
1399/1400	(2)	3.3	)

Source: (1) Kingdom of Saudi Arabia, Report of the Central Planning Organization 1394 A.H. p.122.

(2) Saudi Arabia, Achievements of First and Second Development Plans 1390-1400 (1970-1980) Ministry of Planning, p.79.

iii. Rate of growth of G.D.P. of Agriculture

Figure 4.3 and Table 4.6 show that the rate of growth of agriculture has increased continuously from 101.9 in 1962 to 166.7 in 1979. This is because of the development schemes which have been planned by the government following the increase in oil revenue. The significant growth of the rate between 1972-1979 was due to modernization in agriculture, distribution of new large scale holdings and the setting up of an agricultural credit bank.

The subsidies, grants and loans available, particularly in the late 1970's are summarised below.

Sudsidies include 45% of the cost of agricultural machinery, 50% of the cost of concentrate livestock feed and of chemical fertilizer (S.A.A.B 1973). Also production is subsidised; for example the M.A.W. pays 250 S.R per ton for wheat produced, whilst wheat has guaranteed purchase price of SR 3.5 per kilo; dates also have an official purchase price

Fig. 4·3 Rate of Growth of GDP in Agriculture

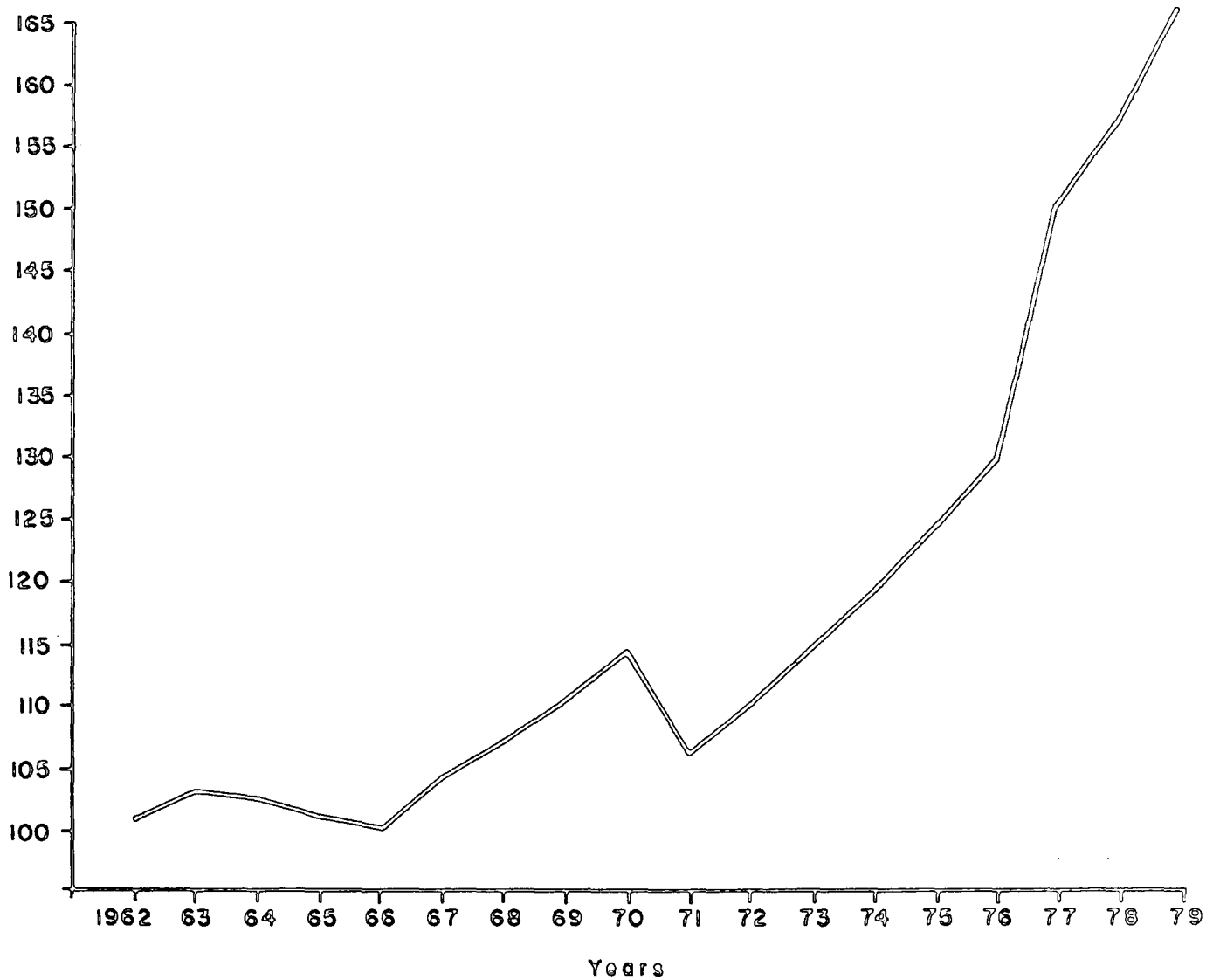


Table 4.6 Rate of growth of GDP in Agriculture

Year	Rate of growth
1962 - 63	101.9
1963 - 64	103.7
1964 - 65	102.9
1965 - 66	101.7
1966 - 67	100.0
1967 - 68	104,1
1968 - 69	107.1
1969 - 70	110.5
1970 - 71	114.4 (1)
1971 - 72	106.7
1972 - 73	110.7
1973 - 74	114.8
1974 - 75	119.3
1975 - 76	124.1
1976 - 77	130.3
1977 - 78	150.7
1978 - 79	157.5
1979 - 80	166.7 (2)

Source: (1) Kingdom of Saudi Arabia, Report of the Central Planning Organization 1394 A.H.p. 124.

(2) Saudi Arabia, Achievements of First and Second Development Plans 1390-1400 (1970-1980) Ministry of Planning, p.78.

of 3.5 S.R per kilogram. In addition the M.A.W. has a programme of land distribution under which free grants of 50-100 donums are made to any individual citizen willing and able to farm them, while organizations may be granted up to 400 donums. This latter figure can routinely be increased to 4,000 donums where particular products are to be produced (Al-Besher 1983).

The Agricultural Credit Bank (S.A.A.B) makes loans on various terms for a number of purposes including the purchase of machinery, irrigation equipment, vehicles, livestock, seeds and fertilizer. The rapid increase in numbers and value of loans made by the S.A.A.B. is shown in Table 4.7.

Table 4.7 Growth of Loans by the Agricultural Bank for 19 years up to 1402/3

Year	Total of Loan	
	Number	Value in S.R
1384/5	625	4,389,598
1385/6	1,922	8,927,425
1386/7	3,146	13,182,600
1387/8	3,732	12,019,800
1388/9	3,674	13,877,095
1389/90	4,356	16,136,127
1390/1	4,381	16,627,628
1391/2	3,865	16,558,107
1392/3	4,477	19,593,526
1393/4	5,414	36,303,805
1394/5	16,251	145,505,438
1395/6	19,702	269,433,166
1396/7	21,377	489,838,361
1397/8	20,298	585,668,268
1398/9	23,758	709,071,962
1399/00	19,782	1,128,686,107
1400/1	45,128	2,530,866,481
1401/2	37,446	2,932,902,061
1402/3	38,886	4,166,027,937
Total	278,220	13,115,615,492

Source : SAAB 1983, Annual Report p.19.

Table 4.8 Value of Imported Agricultural Products 1961-1980

Year	Value (000,000)	S.R.
1961	357	
1962	396	
1963	422	
1964	488	
1965	600	(1)
1966	603	
1967	664	
1968	796	
1969	925	
1970	1,009	
1971	n.a.	
1972	1,221.3	
1973	1,686.0	
1974	2,022.0	
1975	2,301.0	
1976	3,536.0	(2)
1977	5,385.0	
1978	7,802.0	
1979	10,432.0	
1980	14,136.0	

Source : (1) Kingdom of Saudi Arabia, Report of the Central Planning Organization 1394 A.H. p.186.

(2) A.A. Al-Besher, 1983 Agriculture and Manpower in Saudi Arabia, p.55.

(iv) Imports of Agricultural Products

Table 4.8 shows how the value of imported foodstuffs has increased continuously even though domestic agricultural production has also increased. This is due to national population growth as well as to the rise in the general standard of living and consumption. For example the value of agricultural imports in 1961 was 357 million S.R. increasing in 1970 to 1,009 million S.R. By 1980 the value of agricultural imports had further jumped to 14,136 million S.R.

Nationally, therefore, there have been two contradictory statistical trends, a growth in agricultural production but an even faster growth in the imports of agricultural commodities. Behind these lie specific social and economic changes, national and regional, which are reviewed below.

4.2 Transport and Communications Development

Among the most important factors transforming agriculture and rural society during the second half of the twentieth century, in al-Hassa as elsewhere, were developments in transport and communication. Before the oil era the only means of transport between al-Hassa oasis and the outside world was the camel caravan; within the oasis itself pack animals - donkeys and horses - and walking on foot were the only means of communication between the different parts of the oasis, for the sedentary population of the area did not use camels.

The tracks were rough, sandy and usually difficult

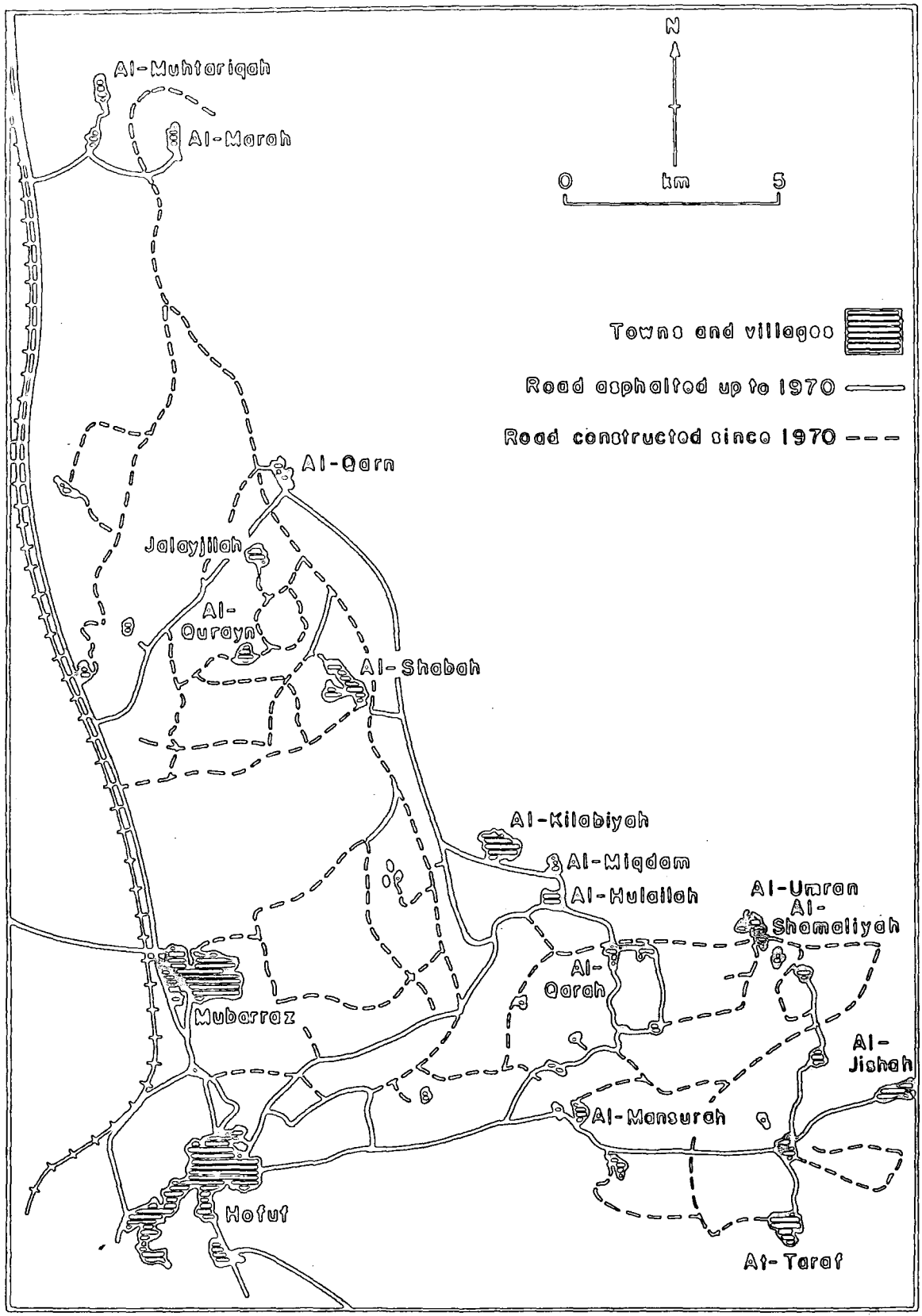
to trace. Within al-Hassa oasis itself there were two main routes. The first led north from al-Hofuf through al-Mubarraz and al-Mutairifi to al-Uyun, the second, east from al-Hofuf to al-Fudal via al-Jafar to al-Jishshah leading eventually to al-Uqair port. A side road from the former went to al-Shabah and al-Julajilah, while a branch of the latter led to the villages around the al-Qarah hills, and to the al-Umran settlements. These two branches met at al-Qarah village. See Figure 4.4.

The main tracks out of the oasis were, eastwards from Hofuf to al-Uqair port which was then the main port of al-Hassa. The second main route led to the west from Hofuf to central and western Arabia. The third main route led north-east from Hofuf to al-Qatif oasis and then on to other countries such as Kuwait, Iraq, Syria etc. See Fig. 4.5A.

In the early 1950's there were only 200 km. (ARAMCO 1968) of asphalted roads, mainly the oilfield areas of the Eastern Province. In 1951 the railway connecting Dammam and Riyadh through al-Hassa was completed, but it was not until the early 1960's that the construction of major roads started. First, the Saudi capital, Riyadh, was linked by a 500 km. road through al-Hassa to the Arabian Gulf ports and the Eastern Province oilfields, and several years later to the Red Sea port of Jeddah in the West by a 1,000 km. highway. Figures 4.5, 4.6 and 4.7 show the rapid expansion of the road network in Saudi Arabia between 1938 and 1968.

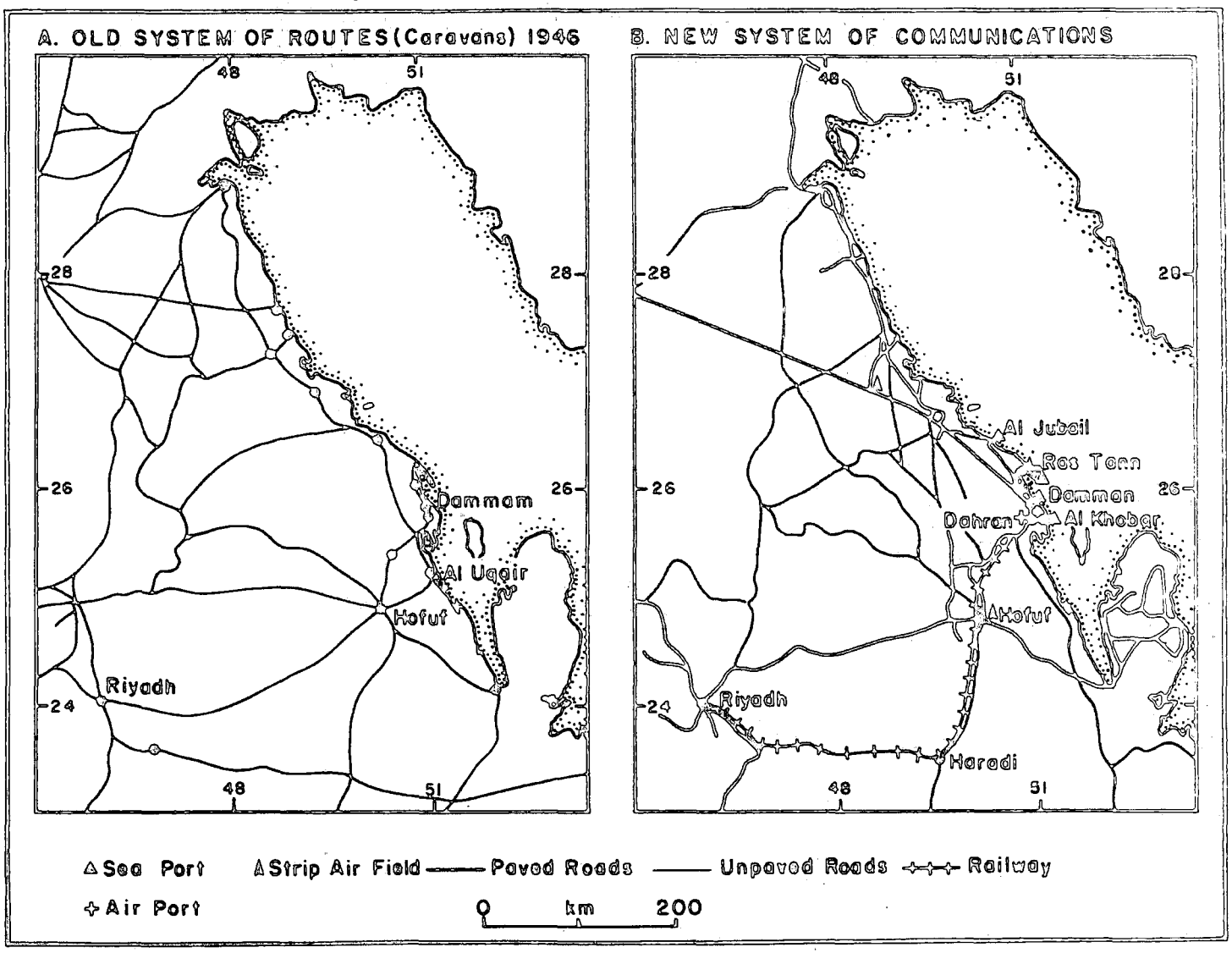
Regionally the most important new links were the roads from Dammam to Kuwait and the Tapline road to Jordan, and the road from Hofuf through Salwa to Qatar, United Arab

Fig. 4.4 Transport Network in Al-Hasa Oasis



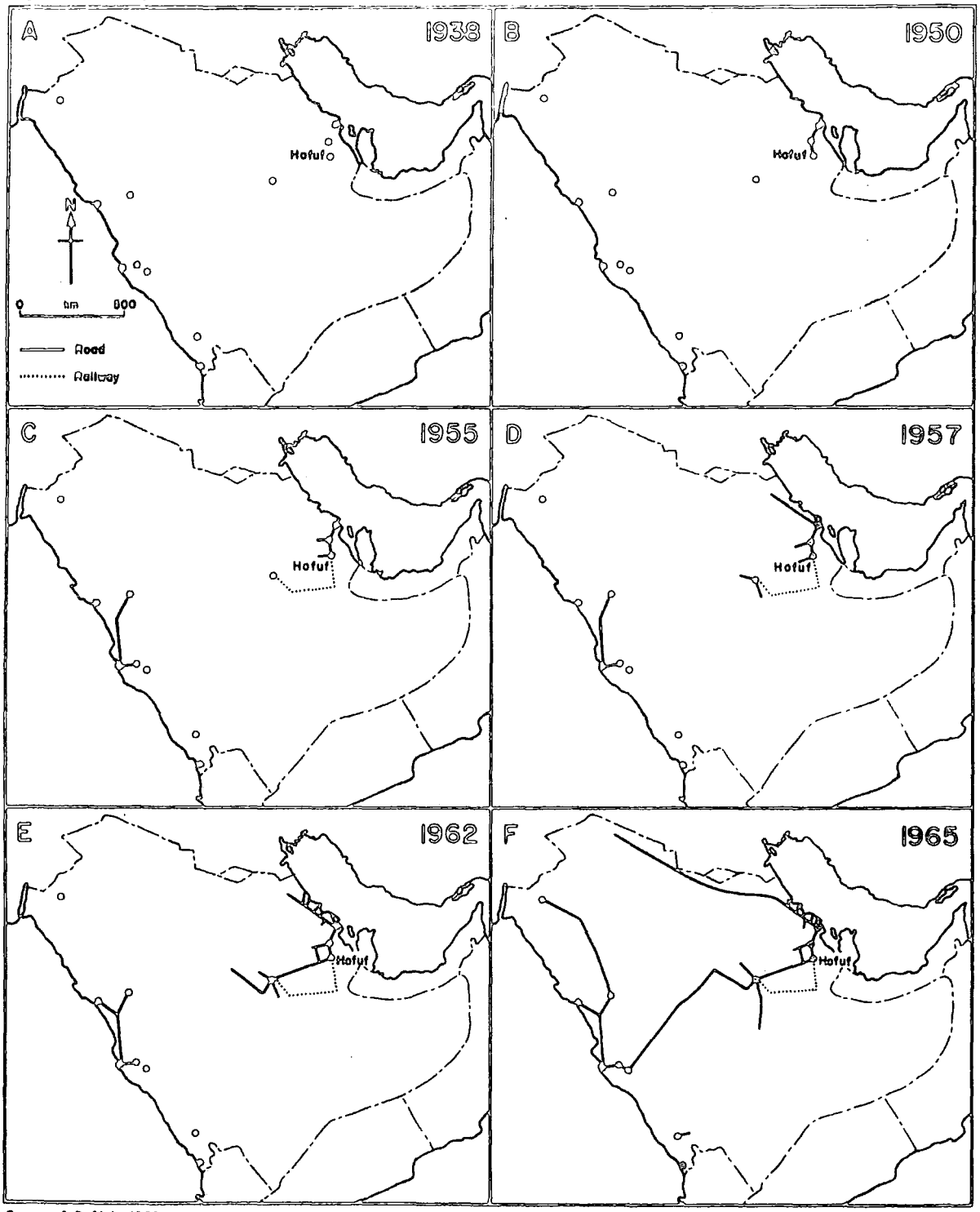
Source: Al-Elawy, 1976

Fig. 4.5 Old and New System of Transport in the Eastern Province



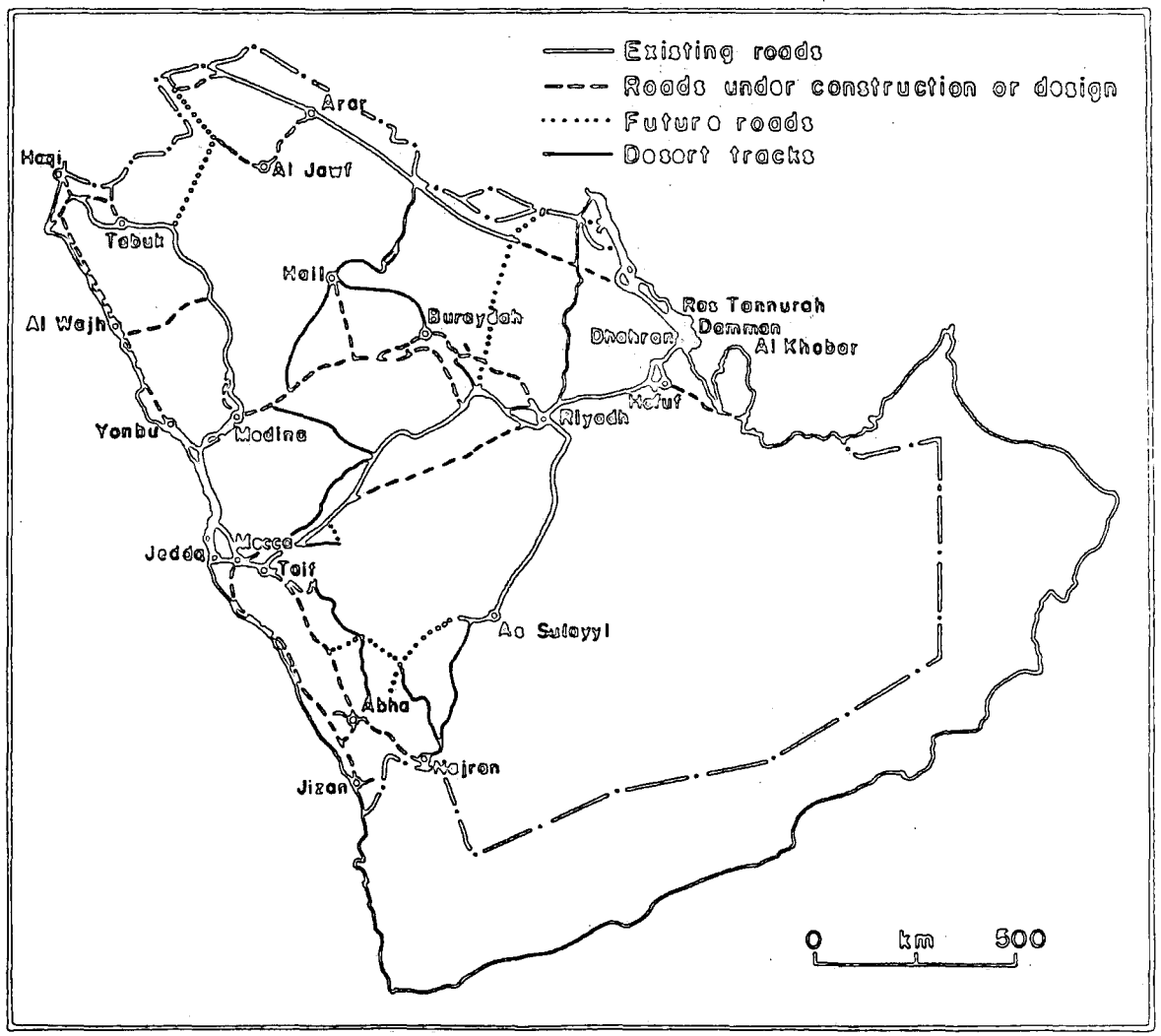
Source: A.M. Al-Shuaiby, 1976

Fig 4-6 The Expansion of the Modern Road Network in Saudi Arabia 1938 – 1965



Source: A. S. Abdo, 1969

Fig. 4.7 The Modern Road Network of Saudi Arabia



Source: A.S. Abdo, 1969

Emirates and leading eventually to Oman. See Fig.4.5B.

Nationally, expenditure on road building reached a peak in the five year road development plan costing S.R.14,000 million and completed in 1980 (Fig.4.8).

Table 4.9 Plan Allocations for Road Transport in S.R.Millions

	1976	1977	1978	1979	1980	Plan Total
Recurrent expenditure	425.5	492.7	628.8	774.1	908.8	3,229.9
Project Finance	2,516.7	2,599.0	2,291.1	1,923.0	1,522.3	10,852.1
Total	2,942.2	3,091.7	2,919.9	2,697.1	2,431.1	14,082.0

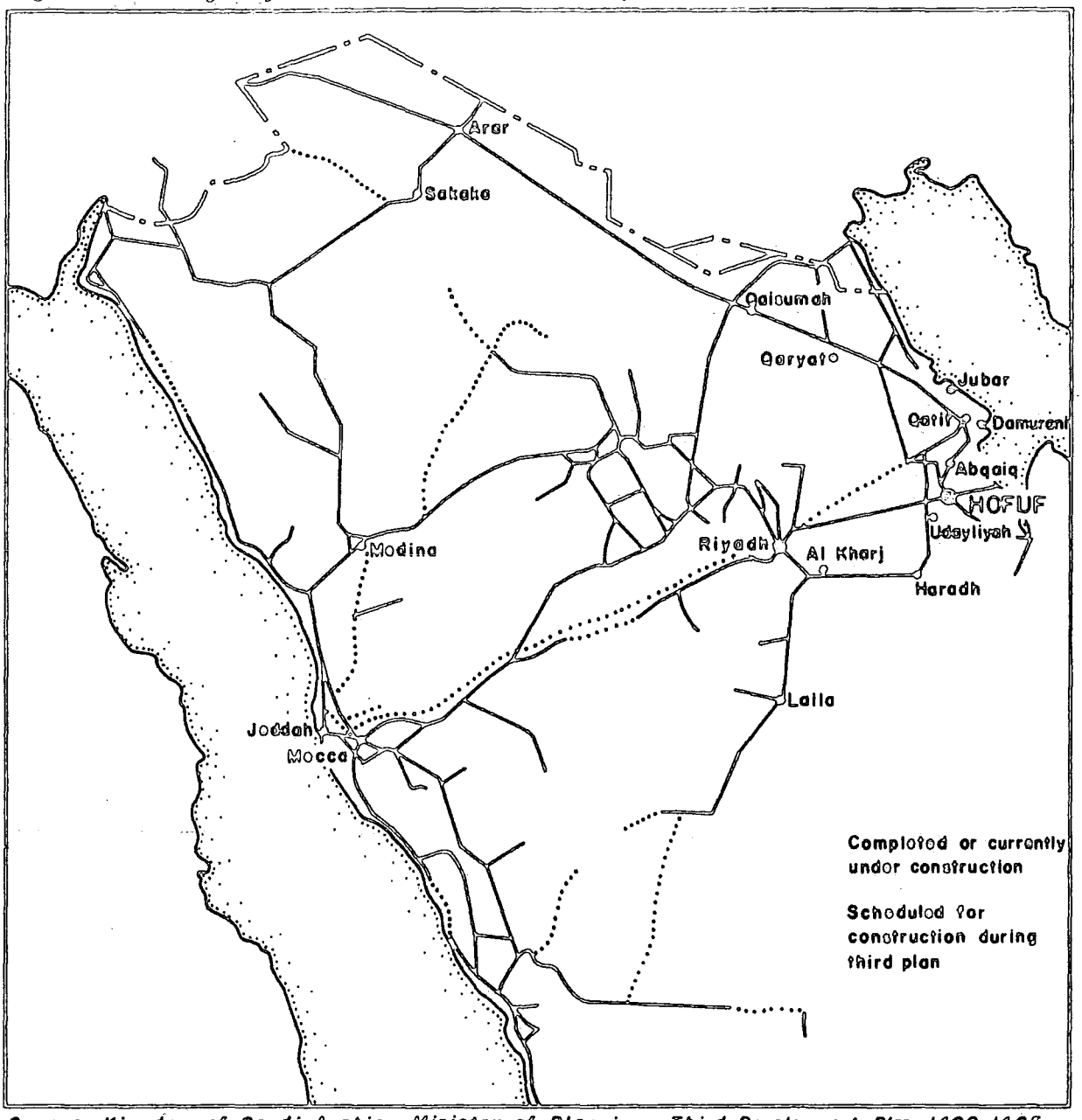
Source: Saudi Arabia: Developmental Aspects, Undated. Beirut, Lebanon.

Over this period, 13,066 km. of asphalted main, secondary and feeder roads and 10,250 km. of unpaved rural roads were completed (Developmental Aspects undated).

Figure 4.9 shows the rapid increase in the total length of the road network up to 1980, together with the projected construction during the third development plan to 1985.

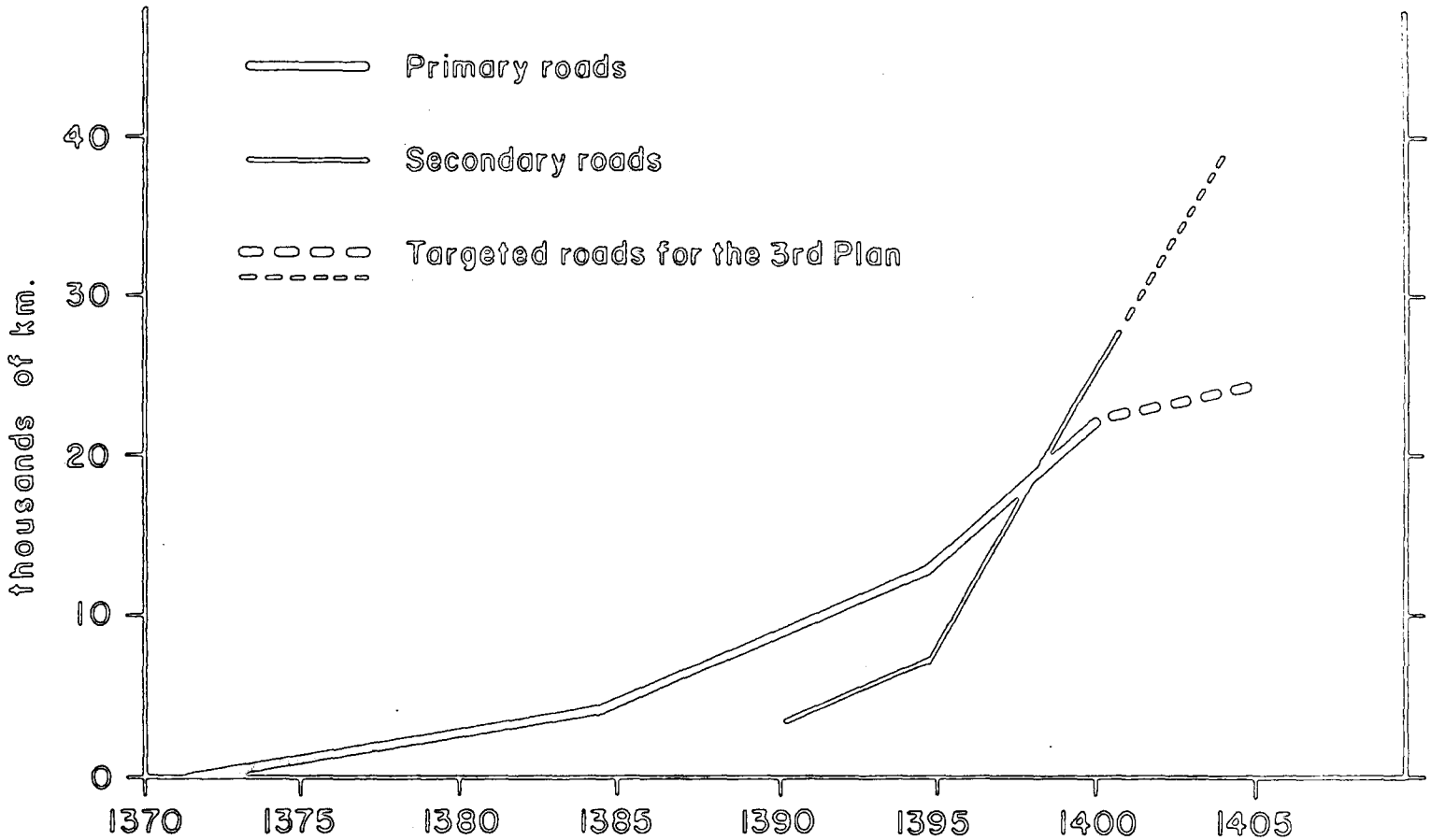
Parallel to the programme of highway construction the government has constructed and improved its national and international airports. At present a new airport costing S.R.156 million is being constructed in al-Hassa to replace the old one (Features from S.A Undated). The 50 square kilometre airport is expected to be in operation towards the end of 1404 A.H. (1984).

Fig. 4.8 The Highway Network of Saudi Arabia, 1980



Source : Kingdom of Saudi Arabia, Ministry of Planning, Third Development Plan, 1400-1405

Fig. 4·9 Total Distance of Network Road Constructed



Source : Feature from Saudi Arabia (1983) p. 30

The Effects of Improved Communications on Social Structure and on Agriculture

i) The Effect of improved communications on social structure

The improvements in transport noted above have broken the relative isolation of agricultural settlements in the whole of the country and particularly in the Eastern Province. They resulted in closer contact between the settlements themselves, and between the settlements and the major towns and cities, both in the Province and in the rest of the Country. This close contact has resulted in severe changes to the social structure of the rural settlements because of (a) migration to the cities and (b) the economic influence of the cities.

Migration within the Eastern Province has been examined, so far as is possible given the great deficiencies of data, in several previous studies (Al-Shuaiby 1977, Al-Elawy 1976). The general causes for migration from the rural areas are well-established, and all spring from the growing economic and social attractiveness of non-agricultural activities during the oil era. Most of such activities were urban centred, and the topic of urbanization in the context of this study is considered in the following section.

The social effects of migration from rural communities were and are important and can be summarised as follows:-

1) When individuals (and almost all migration here was at first by individual men) from traditional farming communities move to urban areas they are exposed to social and economic environments quite different from their traditional culture. An individual must adapt to a diversified and

individualised society, which means that his social life is no longer oriented towards and closely linked with his local community. His traditional social status is now subordinated to his role within the framework of the organisation which employs him. He is now an independent economic unit reliant only upon his own ability, whereas in the rural community he was part of his family and group which was economically interdependent. This theme has been developed recently in relation to bedouin movement to towns by Birks (1981) and Bey-Heard (1983) and the arguments are equally relevant to movement by villagers away from their traditional communities.

Al-Akkad (1974) illustrates the gradual adaptation to these tensions with statistics (see Table 4.10) showing at first very high rates of and later the progressive reduction in the turnover of Aramco employees.

Table 4.10 Reduction in Turnover of Aramco Employees

Year	Av.man-power	Number Leaving	Leaving Rate	Number joining	Joining rate	Turnover rate
1945	8,469	7,820	90.0	8,099	95.0	91.0
1950	9,973	4,769	47.8	4,486	45.0	45.0
1955	13,708	1,706	12.4	893	6.5	6.5
1959	11,838	744	6.3	259	3.0	3.0

Source: A.A.Al-Akkad (1974)p.45.

Al-Akkad suggests that -

"the decline in the proportion leaving each year between 1945 and 1959 (90% to 6%) could indicate the degree of adjustment to the organisations set up, and the

> assimilation of the new patterns of life by Saudi employees. But one may also suppose that the organisation gained experience in how to orient new employees, and take better account of some cultural aspects of the people. Of those who left their job some no doubt returned home, but it is likely that the majority shifted to other jobs in the same area."

What is certain is that the al-Hassa rural communities were severely damaged, as far as their socio-economic structures were concerned by these departures.

2) With increasing exposure to new social structures and to the availability of hitherto unknown commodities people adapt to them more quickly. When a man returns from the town to his native settlement or village, even for a short visit, he will demand such commodities as convenience foods e.g. canned fruit juices, soft drinks, jam.. etc. The rural standard of living rose, as growing national income was dispersed through a great variety of government expenditures and with the wealth of income due to the availability of new jobs, within rural areas. At the same time worker migrants remitted money back to their families and on the temporary or sometimes permanent return to their home communities brought with them a large amount of cash wealth, as well as more sophisticated consumer demands.

New consumer commodities then appeared in the old communities, and became increasingly demanded even by the residual population which would have been unable previously to afford them or even be aware of their existence. This demand eventually led to the influx of retail shops which in turn created, through exposure, a demand for further traditionally alien commodities. Supplying these demands became physically

easier and cheaper with the improvements in transport referred to in the previous section and the resulting availability of imported produce has had a marked effect on local agriculture, which is discussed below.

ii. The Effects of Improved Communications on Agriculture

Before the discovery of oil, the people of al-Hassa lived mainly on locally grown dates, vegetables and fruit. With the rapid development of transport and the increasing demand for foodstuffs which could not be produced locally, there was an increasing shortfall in supply which was made up by imported produce. This rapidly became a flood due to the introduction of refrigerated container-lorries bringing all kinds of foodstuffs e.g. vegetables, fruit and dairy produce, by road from surrounding countries such as Syria, Lebanon and Turkey, and via Dammam port from India, Pakistan and elsewhere in Asia. By the late 1960's the arrival in Hofuf of such container transported foodstuffs was a common sight.

The value of imported agricultural produce into Saudi Arabia as a whole had already reached 664 S.R million in 1967, an increase of 36% over the figure for 1961. By 1980 the value of imported foodstuffs had jumped to 14,136 S.R million. See Table 4.8.

This trend towards reliance upon imported produce was repeated in al-Hassa oasis itself as is demonstrated by the decline in local agriculture.

It proved impossible to market the agricultural produce of al-Hassa, not only within the oasis itself but also elsewhere in the Eastern Province and in the whole country.

This was as a result of the following factors:

1. All year round availability of relatively cheap and good quality imports in al-Hassa and in any possible markets.

2. The change in diet due to outside influences and increased wealth which resulted in a high effective demand for foodstuffs other than those produced in the oasis as discussed above.

3. The difficulties noted in Chapters 2 and 3 of improving traditional style local farming.

These difficulties of meeting the competition by imported produce in local and export markets are a problem to agriculturalists not only in al-Hassa area but throughout Saudi Arabia.

Table 4.8 shows the accelerating increase of agricultural product imports, from 68.07% in the four years from 1961 to 1965 to 514.34% in the five years from 1975 to 1980.

This can be compared with the growth in domestic agricultural production from 879.2 S.R. million in 1962-63 to 1640.0 S.R. million in 1978-79 (see Table 4.4 above) to show the increasing dependence of Saudi Arabia on foodstuffs from abroad.

4.3 The Growth of Urbanization in the Eastern Province

Urbanization in the Eastern Province has been very closely linked with migration from traditional rural areas, as noted in the previous Section 4.2. Its effects on al-Hassa have been considerable and wide-ranging. In 1934 the Eastern Province had only one principal city, Hofuf, while Dammam was a small fishing village on the south side of Tarut Bay and al-Khobar City did not exist (Al-Elawy 1976 & Aramco Handbook 1968). There was no indication that any change would take place in this region in the near future; but oil was discovered in the region, and this resulted in a spectacular change in the whole country, particularly in the Eastern Province.

The oil operations in the Eastern Province have resulted in the establishment and rapid growth of several new settlements such as Dhahran, al-Khobar, Abqaiq, and Ras Tanura, as well as the rapid expansion of existing settlements such as Dammam. All of these were based on non-agricultural functions and had very little functional linkage with their agricultural and pastoral hinterlands.

Dammam replaced al-Hofuf in 1953 as the capital city of the Eastern Province. This led at first to a decrease in the available jobs in al-Hofuf City or at least to a lack of growth in job opportunities, as a result of which the economic status of the town declined. This had an adverse effect on agricultural development, particularly during the period from the 1950's to the late 1960's. However, since 1970 agricultural activity has begun to revive as noted in Chapter 5, whilst at the same time a movement south of the centre of gravity in the oilfields, as the Ghawar field

was developed, together with other factors considered later in this chapter, have resulted in a recent phase of rapid urban expansion in al-Hassa.

Al-Hassa Oasis

Al-Hassa oasis, an ancient settled area, contains two cities, Hofuf and Mubarraz, now merged into one through expansion during the late 1970's. There are also four sizeable towns: al-Uyoun in the north, al-Taraf in the east, al-Jishshah in the north-east, and al-Omran beside Jabal al-Qara, as well as about 50 villages.

Table 4.11 shows the population of al-Hassa oasis in 1962-63, based partly on the population census and partly on unpublished survey which covered settlements and sub-regions of the Eastern Province. However, the latest year for which census details are available is 1974 when there were 244,307 inhabitants in al-Hassa oasis of whom 101,213 lived in Hofuf (Population Census 1977).

Table 4.11 Population of al-Hassa oasis in 1962/63

Cities/towns	Population
Oasis area	106,677
Hofuf	51,387
Mubarraz	25,395
Al-Uyoun	3,848
Al-Taraf	3,352
Al-Jishshah	2,602

Source: Al-Shuaiby (1976), pp.80, 87.

Many estimates have been made of the population of al-Hofuf at various times, as shown in Table 4.12.

Table 4.12 Estimated Population of Hofuf for Selected Year

Year	Population	Reference
1862	23,000 (OR)	Palgrave, W.
	24,000	
1905	20,000	Holgarth, D.G.
1908	25,000	Lorimer
1924	30,000	Mackie
1949	25,000 (OR)	
	30,000	Dickson
1952	60,000	Vidal
1962	80,000	Albert N.Abdo
1971	60,000	M.E.E.D,"Saudi Arabian consumer market has great potential" Weekly Report, Vol.15:16 April 1971.

Source: Al-Shuaiby (1976), p. 222.

Al-Shuaiby (1976) attempted to provide an estimate of growth trends in the population of al-Hofuf by aerial photograph house-counts. An estimated average of residents per housing unit, on the basis of preliminary sampling, was taken at five persons per house, with further estimates for buildings containing flats of three storeys per building, and four flats per floor.

The population of Hofuf as thus estimated was 50,000 in 1935, 55,000 in 1951; 63,000 in 1960 and 78,000 in 1970 (see Table 4.13).

Table 4.13 Estimated From Aerial Photographs of Hofuf

Year	Population	% increase
1935	50,000	-
1951	55,000	10.0
1960	63,000	14.5
1970	78,000	23.8

Source: Al-Shuaiby (1976), p. 223.

During the sixteen years from 1935 to 1951 the population of al-Hofuf increased very little (10.0%) because in the first stage of the development of the oil industry many people moved to work in the new activities in other parts of the province. However, during the nine years from 1951 to 1960, which might be called the second stage of the growth of the oil industry, the increase was about 14.5% because during this period the size of businesses increased in the town, partly associated with the growth of government administration up to 1953 and of continuing private sector activity. The largest increase was during the period from 1960 to 1970, about 23.8,due to the many changes taking place such as the widespread effects of regional growth, the centralization at Hofuf of offices and employees attached to new projects such as the sand stabilisation and al-Hassa irrigation and drainage scheme and other nationally financed projects for agriculture, urban and industrial development.

During the 1950's and 1960's the indications are that

whilst the new and growing cities of Dammam, al-Khobar etc. were growing most rapidly, the settlements of al-Hassa were still growing although more slowly than those further north. Al-Hassa's decline in status was only relative and not absolute. Indeed, the only areas of absolute decline were the rural districts since Hofuf and Mubarraz urban centres themselves grew at the expense of the farming areas.

In general, the indications are that the population of al-Hassa oasis is now growing fairly rapidly. An estimation of current population may be made based on the number of schools in al-Hassa oasis. There are in excess of 200 schools of all levels for boys with 43 under construction (Al-Riyadh Daily Newspaper 24/3/1984). The average numbers of pupils per school is 500, which gives a male school population of 100,000. Assuming that male school students form about 20% of the population as a whole, this gives a total population for al-Hassa oasis of 500,000 inhabitants. The Ministry of Information estimate the population of al-Hassa oasis at about 600,000 (Features from S.A. undated but not before 1982). These estimated totals may be compared with the census figures of 106.677 in 1962/63 (Al-Shuaiby 1976) and 244,307 in 1974 (Population Census 1977), together with the estimates of 160,000 in 1952 by Vidal (1955) and 200,000 in 1969 by Wakuti (1969).

It is noteworthy that the population of the oasis and of its towns has continued to grow in spite of migration to the oilfields.

In 1954, 3,827 of Aramco's employees came from al-Hassa oasis (Al-Elawy 1976). This represented about 2% of Vidal's

estimate of total population of al-Hassa in 1952. Aramco's employment has had comparatively little direct effect, because of its need for skilled labour - not to be found in al-Hassa - as well as its need for few unskilled workers.

Further, neither Abu Ela, nor Vidal (who is in many respects the most trustworthy of the writers on al-Hassa, being both interested in the people and an employee of Aramco), single out as significant the direct impact of oil on the settlements of al-Hassa. However, we do know that the indirect effect was considerable because of the numbers attracted to the non-oil industrial and other activities that were established in the northern cities as a result of spin-off effects of the oil industry.

Al-Shuaiby's (1976) Sample Survey of the origins of the populations of Dammam and al-Khobar, carried out in 1970 suggests that 24.1% of the former and 17% of the latter's population originated in al-Hassa. This migration within the Eastern Province was, no doubt, also parallelled with some movement to other cities. The loss to al-Hassa was especially severe because it consisted mainly of active people of working age.

4.4 The Effects of Educational Progress on Agriculture in al-Hassa

In Section 3.4.1.1 of the Third Saudi Arabian Five Year Plan attention is drawn to the fact that the emphasis placed on educating and training the Saudi population will produce a decrease in employment participation, i.e. younger people will take up productive jobs at a much later age than they used to. This quantitative loss to the labour force,

together with the effect of the superior attractions, especially to educated people, of non-agricultural employment has adversely affected farming in al-Hassa for many years.

In 1936 the new educational system was introduced in al-Hassa with the opening of a new elementary school for 160 pupils (Al-Shuaiby 1976). By 1952, the enrolment in the primary schools of al-Hofuf and al-Mubarraz was about six hundred; the number of students in the secondary school at Hofuf was about forty (Vidal 1955). The whole picture of al-Hassa education changed very rapidly, because the official efforts to widen the educational base of the people resulted in a considerable increase in the school population. Many of the young people left farming to go to school in order to seek better jobs.

Tables 4.14,4.15,4.16,4.17 and 4.18 show the development of education in al-Hassa oasis.

Table 4.14 Elementary Schools in al-Hassa oasis

Year	Number of schools	Number of students	
1937	1	180	(1)
1946	3	454	(1)
1956	19	3,913	(1)
1966	46	13,619	(1)
1971	63	19,531	(1)
1978	103	28,104	(2)

Sources: (1) Al-Elawy (1976)

(2) Al-Othman (1399)

Table 4.15 Intermediate Schools in al-Hassa oasis

Year	Number of schools	Number of students	
1947	1	5	)
1957	1	125	)
1967	7	1,330	) (1)
1971	17	2,927	)
1978	37	6,065	) (2)

Sources: (1) I.S. Al-Elawy
(2) A.A. Al Othman, p.150.

Table 4.16 Secondary schools in al-Hassa oasis

Year	Number of schools	Number of students	
1957	1	7	)
1967	1	167	) (1)
1971	1	473	)
1978	11	1,817	) (2)

Sources: (1) I.S. Al-Elawy
(2) A.A.Al-Othman, p.164.

Table 4.17 Other Educational Institutions in al-Hassa oasis in 1978

Institutions	Number of schools	Number of students
Secondary school (Industrial)	1	121
Secondary schools (Commerce)	2	421
Special Institutes	4	166
Night schools	84	4,949

Source: A.A. Al-Othman, p.192.

An example of the rapid increase of enrolment numbers can be found in the school at Al-Jishshah village, built in 1948 whose pupil numbers are shown in Table 4.18.

Table 4.18: The rapid increase of pupils in Al-Jishshah's School

Year	Pupils
1949	43
1950	75
1951	120
1952	150

Source: F.S. Vidal 1955.

Al-Akkad's study of the socio-economic impact of development schemes on a rural community traces the spread of enrolment at an increasing number of village elementary schools and also at intermediate, secondary and technical schools. Al-Akkad in particular drew attention to "The social community of the schools which, at least as much as the formal curriculum, will tend to draw the child away from traditional social patterns and perhaps from the traditional adult occupation of agriculture." (Al-Akkad 1974)

From family experience the candidate knows that forty years ago the Khuwiyah (collectively the Amir's armed escort) were sent to houses and farms in the oases to persuade parents to send their children to school. For the last twenty-five years education has become attractive as a way of ensuring a career away from farming.

A movement out of farming and the migration loss from the oasis does not necessarily mean a decline in agricultural production. In many cases, a loss of farm labour can be more than made good by the injection of capital and the introduction of higher technology into farming. In the case of al-Hassa, however, as will be considered in Chapter 6 , these physical movements were accompanied by a loss of motivation to farm in improved ways. The new mobility of people was not accompanied by any significant increase in land sales and purchases for the sake of building up commercially viable farms until the late 1976's. Holdings remained small and fragmented and little spontaneous investment of the new sources of income was made in farms. The net result of economic change was negative. The availability of water remained a limiting factor, marketing - even to the rapidly growing new cities - remained difficult, and manpower became even more difficult to maintain on the land.

Very little recent data is available or can be obtained of the details of the socio-economic changes occurring in the oasis itself. What is clear however is that the national and regional context within which al-Hassa agriculture is set has been very rapidly and fundamentally changing. It is against this background of change that the development of agriculture, as examined in the next chapters,has to be evaluated.

CHAPTER FOUR

REFERENCES

Abd-el Wassie, A., (1970) Education In Saudi Arabia, Macmillan.

Abu-Ela, T.M., (1959), A Geographical Study of Man and His Environment in al-Hassa Province, Saudi Arabia, (Unpublished Ph.D. thesis), Trinity College, Dublin.

Al-Akkad, A.A., (1974), Socio-Economic Impact of Development Schemes on A Rural Community, al-Hassa Oasis, Saudi Arabia, (unpublished M.A. thesis), University College of North Wales, Bangor.

Al-Besher, A.A., (1983), Agriculture and Manpower In Saudi Arabia, (Unpublished Ph.D. thesis), University of Durham.

Al-Elawy, I.S., (1976), The Influence of Oil upon Settlement In al-Hassa Oasis, Saudi Arabia, (unpublished Ph.D. thesis), University of Durham.

Al-Othman, A.A., (1979), Education In Saudi Arabia, 1975-1980. Al-Asfahani, Jeddah, Saudi Arabia. (in Arabic).

Al-Riyadh Daily Newspaper, (24/3/1984), Riyadh, Saudi Arabia, (in Arabic).

Al-Shuaiby, A.M., (1976), The Development of the Eastern Province with particular reference to Urban Settlement and Evolution In Eastern Saudi Arabia, (unpublished Ph.D. thesis), University of Durham.

ARAMCO, (1968) Aramco Handbook, Arabian American Oil Company, Dhahran, Saudi Arabia.

Bey-Heard, F. (1983), From Trucial States to United Arab Emirates, Longman.

Birks, J.S., (1981), The Impact of Economic Development on Pastoral Nomadism In the Middle East : An Inevitable Eclipse? Change and Development In the Middle East Edited by John I. Clarke, and Howard Bowen-Jones, Methuen.

Central Planning Organization, (1394 H.A.), Report of the Central Planning Organization, Saudi Arabia, Jeddah.

Cleron, J.P. (1978), Saudi Arabia 2000 : A Strategy For Growth, London, Croom Helm.

Economic Intelligence Unit, (1980), Quarterly Economic Review of Saudi Arabia, Annual Supplement.

Lipsky, G.A. (1959), Saudi Arabia, Its People, Its Society, Its Culture, Harf Press, New Haven.

Ministry of Finance and National Economy, (1977), Population Census, 1974 (1394 A.H.), Detailed Data for Eastern Province, Dammam, Saudi Arabia.

Ministry of Information (undated), Features From Saudi Arabia, Dar al Watan, Saudi Arabia.

Ministry of Planning, (1980), Third Development Plan 1400/1405 A.H., (1980/1985 A.D), Riyadh, Saudi Arabia.

____ (1982), Saudi Arabia, Achievements Of the First and Second Development Plans 1390-1400 A.H., (1970-1980 A.D.), Tihama, Jeddah, Saudi Arabia.

Saudi Arabia, (undated), Developmental Aspects, Beirut, Lebanon.

Saudi Arabian Agricultural Bank, (1973), Ninth Annual Report, 1392-1393 A.H.

____ (1983), Nineteenth Annual Report, 1402/1403 A.H. Riyadh, Saudi Arabia.

Vidal, F.S., (1955) The oasis of al-Hassa, Arabian American Oil Company, Dhahran, Saudi Arabia.

Wakuti, (1969), Final Completion Report For Supervision of Execution of al-Hassa Irrigation and Drainage Project.

CHAPTER FIVE

THE AL-HASSA IRRIGATION AND DRAINAGE PROJECT

Introduction

It is against the background of traditional farming in the oasis as examined in Chapter 2, of the physical resources available for agriculture - Chapter 3, and of the socio-economic changes that, since the late 1940's, affected the country, the Eastern Province, and al-Hassa Oasis (Chapter 4), that we must examine the major development project which was designed to modernise agriculture in the oasis.

Before the exploitation of oil resources the people of al-Hassa oasis, as the rest of the Kingdom, were engaged in a predominantly pastoral-agricultural economy which was still largely on a subsistence basis, raising crops and livestock to meet their own needs for food and to some extent for clothing and shelter. The principal crops grown were dates, wheat, barley, millet, rice, various fruits and vegetables and alfalfa and the most important livestock raised were camels, sheep, goats, cattle and donkeys. In addition to this subsistence economy there was income from the sale of agricultural surpluses, particularly of dates and rice.

From the early 1950's onward the significant growth of national revenue from oil, together with the evolution of governmental administrative agencies resulted in the capability to undertake major development projects throughout the country e.g. improvements of education, communication, industry, agricultural health etc.

Al-Hassa itself had a typical single-dominant-crop economy, based on date or rice. Alfalfa was grown under the palm trees as fodder for livestock, particularly cows and for the donkeys which provided transport, and fertilizer, as well as power for raising water for irrigation. A few other vegetables and fruits were also grown. There was also some small local industry and trade which helped give the people of al-Hassa a viable peasant economy.

During the 1950's the social and economic system which, for many centuries, had operated, became destabilised because as well as the replacement of Hofuf as capital of the Eastern Province by Dammam, symptomatic of the effect of oil development on the movement of population and employment from al-Hassa to the new cities, there were two serious local problems. These threatened the ecological survival of the oasis itself. The first was the continued but now critical encroachment of windblown sand into their fields and gardens and villages (see Chapter 3.2). The second was the increasing salinisation of the soil in the remaining cultivated areas due to inefficient use of water in combination with inadequate drainage.

The first development surveys of Saudi Arabian agriculture began in 1937, then in 1942 a mission from the United States of America arrived at the request of the Saudi Government to carry out further surveys and advise on the development of irrigated agriculture (Twitchell 1944). In addition, some particular development interest in the oasis was itself the product of oil exploitation and the associated non-oil involvement in the Eastern Province by Aramco, in

order to develop agricultural production, to meet the needs of Aramco's workforce for fresh fruit and vegetables.

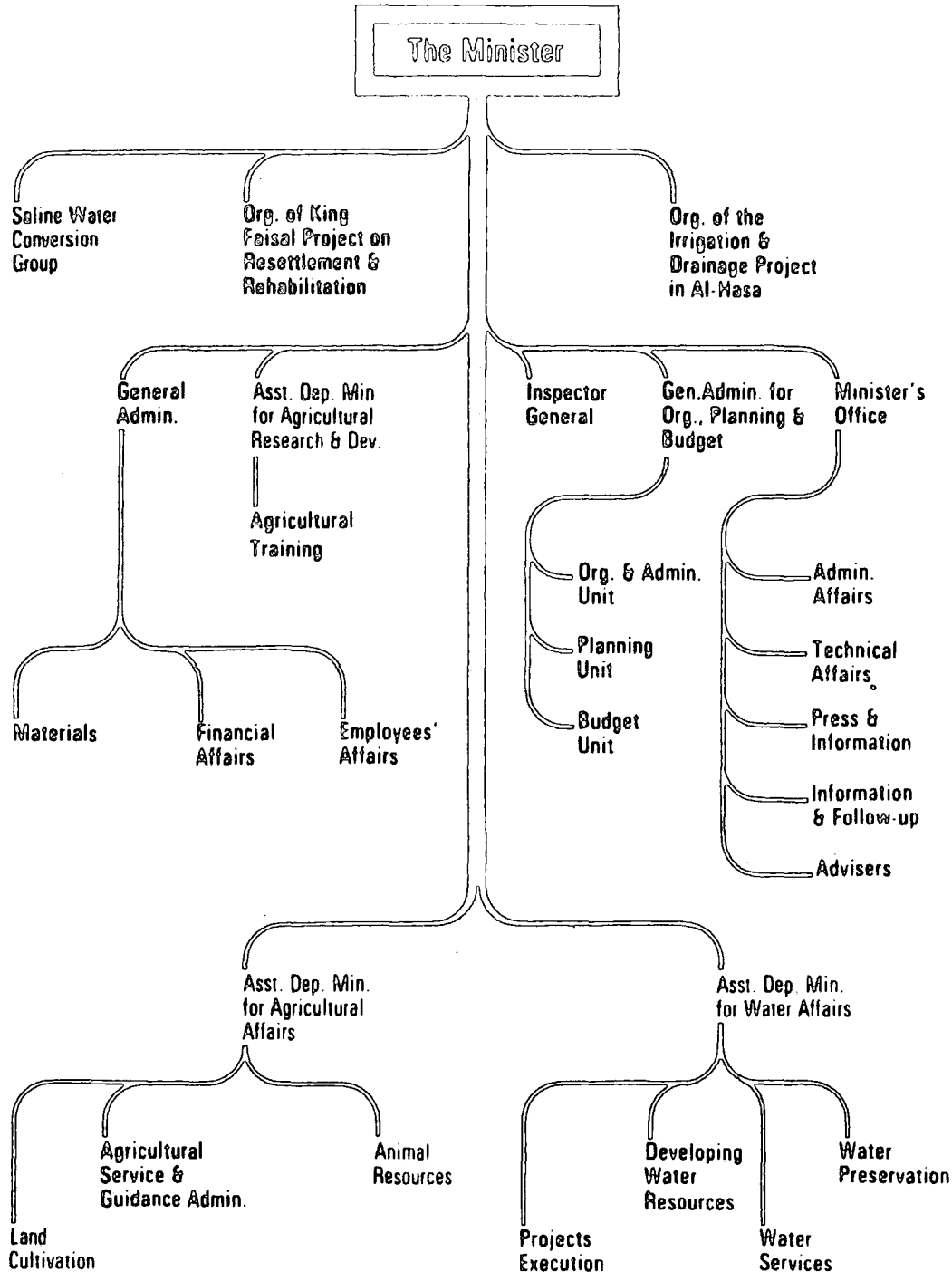
In 1948 a General Directorate for Agriculture was attached to the Ministry of Finance and National Economy and in 1953 (1373 A.H) a Ministry of Agriculture was established. Later the ministry was renamed the Ministry of Agriculture and Water and became responsible for preparing and implementing plans and programmes for agriculture and water development. Special status was given to two particular irrigation agricultural projects, the al-Hassa Irrigation and Drainage Project and the King Faisal Resettlement Project at Haradh and to Water Desalination. The Ministry (M.A.W) was given general responsibility for the conservation and use of the scarce water resource for agricultural development(see Fig.5.1).

In 1960 the International Bank for Reconstruction and Development prepared a report for the Ministry of Agriculture entitled Approach to the Economic Development of Saudi Arabia. This report included recommendations that the stabilisation of the sand dunes and the improvement of irrigation and drainage at al-Hassa be undertaken "at the very earliest possible opportunity". (I.B.R.D 1960).

As a result of these recommendations the Ministry of Agriculture and Water commissioned the consultant firm Wakuti to survey the oasis in order to obtain data on which to base a development project.

The timing of these first studies in the late 1940's and 1950's and the commissioning in 1961 by The Ministry of Agriculture and Water of a project design is important

Fig. 5·1 Ministry of Agriculture and Water



Source :Al-Farsy. F. 1978

because the al-Hassa project must be set in its correct time context.

The decision in principle to develop al-Hassa was taken against the background of the 1950's when there was only limited appreciation of what the economic and social impact of oil would be. Even by 1972 when construction was completed it was not possible to predict the even greater impact of oil revenue which resulted from later rises in oil price and an increase in oil production almost continuously up to 1981/82 (see Chapter 4.1).

As a result it was assumed that technical improvements in irrigation and drainage systems would be followed by an increased interest in farming by the local rural population and by increased production. As examined in Chapter 4 these assumptions were not wholly to be justified. The reasons for this include the competition for water for non-agricultural purposes, the movement of labour from the agricultural sector to better paid sectors, encouraged by better education, the expansion of urbanization, as well as the inefficient land use due to the small holdings and the dominance of palm-trees (see Chapter 2).

Here we examine the basic characteristics of the al-Hassa development project as they emerged by the early 1970's.

5.1 Project Design and Construction

(a) In 1960-64 Wakuti Consulting Engineers carried out surveys to provide data on which to base development and improvement of agricultural productivity (Wakuti 1970). This survey covered the following:

i. Water resources

ii. Soil classification

iii. Land use

iv. Irrigation methods

v. Agri-meteorology

(b) The main findings of the survey were as follows:

1. Water wasted by the tendency of the local farmers to over-irrigate was very considerable.

2. Salinization and waterlogging largely due to over-irrigation and absence of drainage were reducing land productivity and the area available for cultivation. Because of the salinization heavy leaching was required which increased the demand for fresh water by about 25 to 30% more than needed for consumptive use.

3. High water losses resulted from the high evapotranspiration rates (see Chapter 3) together with leakage losses from unlined canals.

4. High rates of water application were associated with factors 1 - 3 above, making it necessary to introduce an integrated and efficient distribution and drainage system.

5. If such a system were provided then a large expansion of the area under cultivation would be possible.

6. Expansion of the sand stabilisation project would be essential to protect the investment (see Chapter 3).

Water Distribution

As a result of these findings the Ministry of Agriculture and Water decided on:

i. Immediate strengthening of their sand stabilisation

measures, among which were the levelling of the sand-dunes, covering the levelled area with a layer of soil 15 to 20 cm. thick and planting suitable trees such as Tamarix, Accacia, Eucalyptus, etc. (Yousuf al-Abdulwahed 1979).

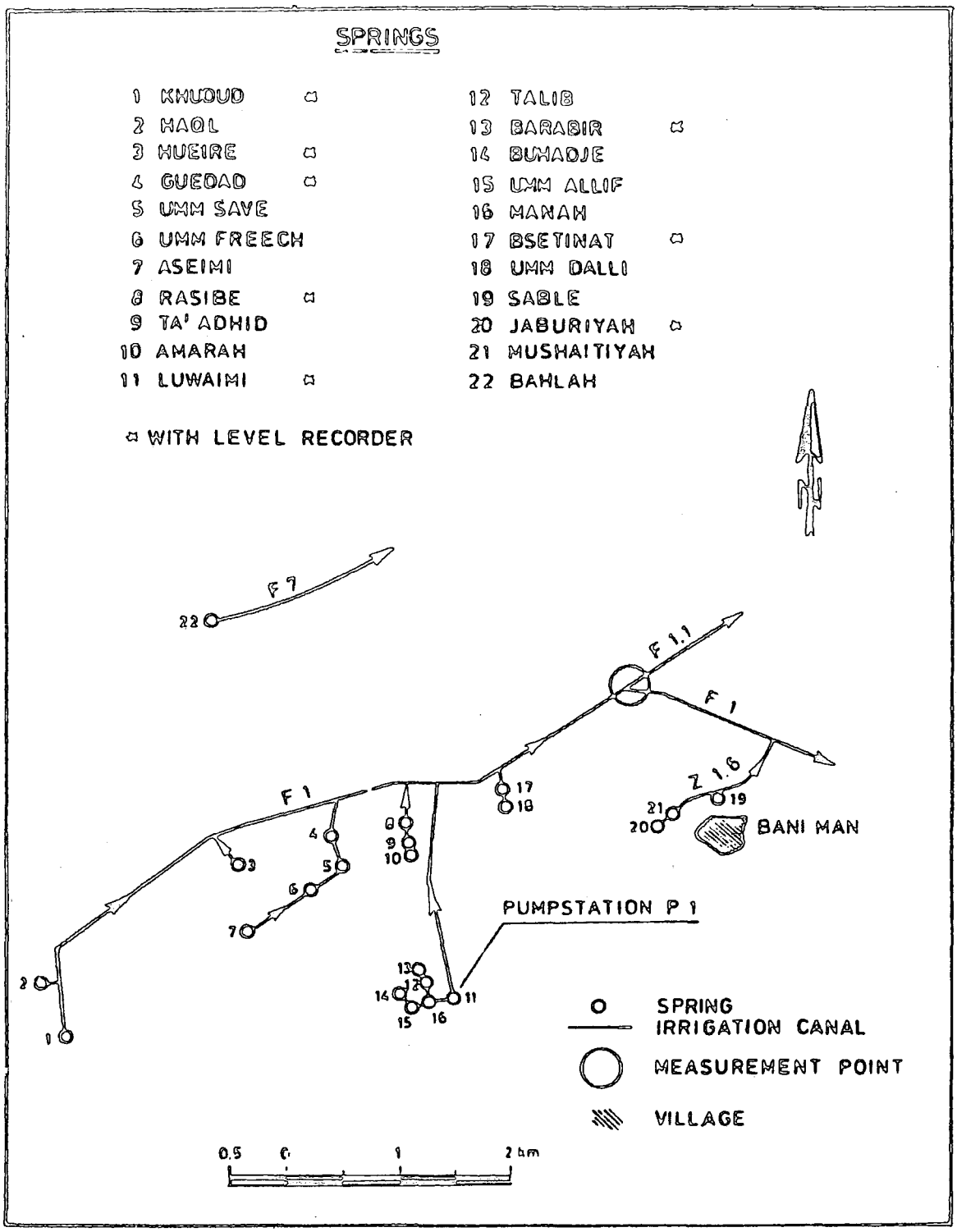
ii. Commissioning a design for an irrigation and drainage system by Wakuti.

iii. The award at the end of 1966 of the construction contract to Phillip Holzmann, the work to be supervised by Wakuti. Construction was to start in 1967 and be completed in five years.

Between 1967-1971 the construction phase of new distribution and drainage systems were completed.

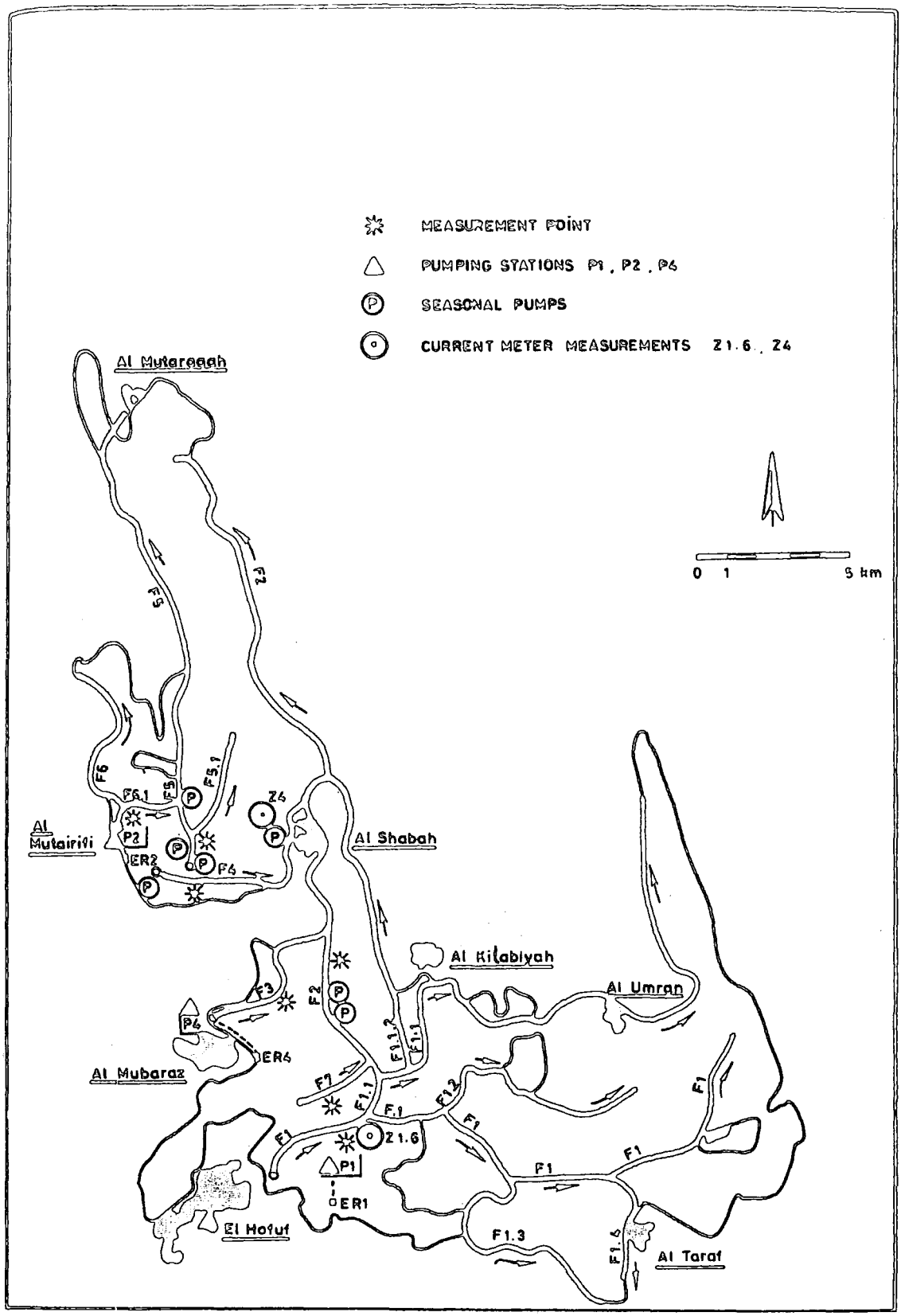
At the completion of the project al-Hassa oasis was supplied mainly through a new integrated water distribution net, drawing on 32 springs and managed by the al-Hassa Irrigation and Drainage Authority (see Figs. 5.2 to 5.4). Additional irrigation water was and is taken from private wells. The 32 springs can be divided into two groups and three single springs. Generally, the springs are located along the axis Hofuf, Mubaraz and al-Mutairifi village. The main springs lie very close to the 145 m. contour line which runs in a SSW-NNE direction (see Fig. 3.16). A group of 22 springs lies between Hofuf and Bani-Man village, al-Mutairifi village group having 7 springs. The single springs are Ain al-Harrah located near al-Mubaraz, Ain al-Jauhariyah located near al-Battaliyah village and Ain Nasser located near al-Shabah village. Also a number of less important springs and wells are scattered all over the oasis.

Fig. 5.2 Springs East of Hofuf (Detail from Fig. 3.15)



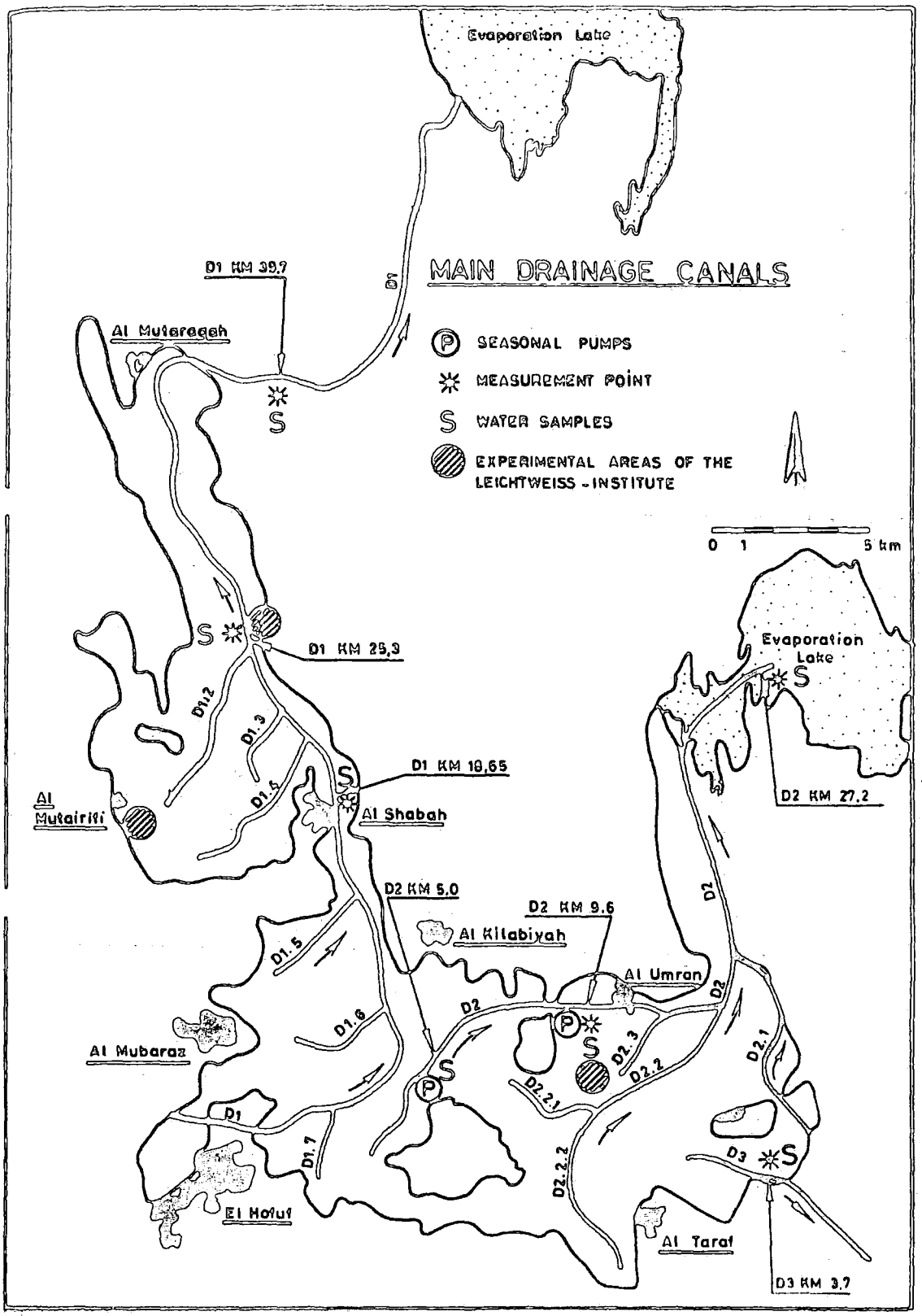
Source: H.A.R.C., Saudi Arabia Publication, No. 38, 1979

Fig. 5.3 Main Irrigation Canals



Source : H.A.R.C., Publication No. 16, Hofuf, 1977, M.A.W., Saudi Arabia

Fig. 5.4 Main Drainage Canals



Source: H.A.R.C., Publication No. 16, Hofuf, 1977, M.A.W., Saudi Arabia

Under the new system of irrigation, there are two main distribution systems, one by gravity to lower oasis levels designed to supply 16,000 hectares. The other one by lifting to higher levels, requiring three reservoirs, to supply 3,650 hectares (Hans Karl Barth 1976).

In the former system there are two main distribution canals each with sub-main and lateral canals. In the latter there are no main canals, the laterals being fed from sub-main canals supplied directly from the reservoirs. In both cases these are laid out to maximise hypothetical hydraulic efficiency with no reference to existing landholdings (see Chapters 2.4 and 2.5). All final distribution is by gravity flow (see Fig. 5.3), the only pumps required being those supplying the three reservoirs mentioned above.

The total lengths of constructed irrigation canals are:

Main canals	155 km.
Sub-main canals	265 km.
Lateral canals	1,100 km.

The main canals run along the contour lines in the irrigation area, while the sub-main canals cover the area between the main canals. They follow the incline of the terrain in general as determined by topography and they in turn feed the lateral canals which carry the water to the plots.

The lengths of the main and sub-main canals are as follows - Tables 5.1 and 5.2.

Table 5.1 The Lengths of the Main Canals

Main Irrigation Canal	Length in km.
F1	19,715
F1.1	23,346
F1.1.1	4,782
F1.1.2	11,300
F1.2	8,500
F1.3	8,360
F1.4	4,374
F1.5	3,072
F2	21,477
F3	6,255
F4	7,480
F5	17,315
F5.1	3,830
F6	6,250
F6.1	2,060
F7	2,901
Total	151,027

Source: Wakuti (1969) Final Completion Report for Supervision of Execution of the al-Hassa Irrigation and Drainage Project, Zug, 1969.

Table 5.2 The Lengths of sub-main canals

Sub-main Irrigation Canal	Number of canals	Lengths in km
F1aa + F1bc	28	28,829
F1.1aa + F1.1.bf	31	26,526
F1.1.1aa + F1.1.1ae	5	5,146
F1.1.2aa + F1.1.2am	13	7,808
F1.2aa + F1.2am	13	22,464
F1.4aa + F1.4ag	7	9,622
F1.5aa + F1.5ag	7	7,260
F2aa + F2ay	24	18,918
F3aa + F3ac	3	2,250
F4aa + F4ag	7	12,854
F5aa + F5ay	24	30,636
F5.1.aa + F5.1ak	10	8,046
F6aa + F6.ah	8	5,911
F6.1aa + F6.1ac	3	3,108
F7aa + F7ad	4	7,770
P1a + P1h	8	21,640
P2a + P2m	10	14,230
P3a + P3c1	3	4,613
P4a + P4m	12	23,846
Total	233	722,722

Source: Wakuti (1969).

The main and the sub-main canals cannot be tapped directly for irrigation, all water being distributed through the sub-main canals to the laterals. They are at intervals of 150 m. and their lengths vary between 600 and 1000 m. The total length of the lateral canals is 1,100 km. Figure 5.3 shows the main irrigation canals.

5.2 The Drainage System

As noted in Chapter 3.2 natural drainage is generally aligned to the east and north-east, see Fig. 5.4. The main directionsof the new drainage system follow the natural slopes within the oasis (to the east in the eastern oasis and to the north in the northern oasis). The drainage water discharges into two evaporation lakes located north and east of the oasis. See Fig. 5.4.

As one of the main aims of the New Irrigation and Drainage project was to provide for permanent leaching of the soil to reduce salinity which was one of the biggest problems facing agriculture in the oasis, a drainage system as efficient as the irrigation system was essential.

The new project includes two main drainage systems to parallel the distribution systems. There are two main canals for drainage, each with sub and lateral canals which run alongside the irrigation canals. The main drainage canal, D1, runs from Hofuf in a northerly direction and drains the whole north oasis. The second main drainage canal D2 starts east of Hofuf and runs east draining the entire eastern oasis before turning north to the evaporation lake.

The total lengths of the drainage canals are as follows:

Main drainage canals	140 km.
Sub drainage canals	180 km.
Lateral drainage canals	1,100 km.
Total	1,320 km.

All these canals are of earthen construction except for the connections between the upper and lower levels which are built of cement, and the places where the drains cross the sand dunes which are enclosed concrete canals.

The lateral drainage canals were constructed at intervals of about 150 m. parallel to the irrigation canals. These flow into sub-drainage canals which in turn flow into the main drainage canals.

The main drainage canals have the following lengths.

Table 5.3 The Lengths of Main Drainage Canals

Main Drainage Canal	Length in km.
D1	51,298
D1.1	7,556
D1.2	5,892
D1.3	2,946
D1.4	6,370
D1.5	3,362
D1.6	2,582
D1.7	2,194
D2	26,500
D2.1	12,260
D2.2	14.150
D2.2.1	3,270
D2.2.2	2,340
D2.3	.978
Total	141.698 km.

Source: Wakuti, Final, Zug (1969).

The sub main drainage canals have the following lengths:

Table 5.4 The Lengths of Submain Drainage Canals

Sub main Drainage Canal	Single Canal	Total Length in km.
D1.aa + D1.ca	51	46.153
D1.1aa + D1.1ah	8	10.128
D1.2aa + D1.2am	12	10.360
D1.3aa + D1.3ae	5	3.647
D1.4aa + D1.4ai	9	9,450
D1.5aa + D1.5ad	4	6.778
D1.6aa + D1.6af	6	5.852
D1.7aa + D1.7ac	3	3.449
D2.aa + D2.bd	29	30.287
D2.1aa + D2.21ap	15	15.337
D2.2aa + D2.2ap	15	20.061
D2.2.1aa + D2.2.1ac	3	4.502
D2.2.2aa + D2.2.2ah	8	6.954
D2.3aa + D2.3ac	3	5.754
Total	171	179.252 km

Source: Wakuti (1969) Final Completion Report for Supervision of Execution of al-Hassa Irrigation and Drainage Project, Zug, 1969.

5.3 Communications

The whole irrigation area of 202.50 sq.km (Wakuti 1969) was linked up by a road system adapted to the canal system. Several existing asphalt roads, especially in the eastern oasis, connected some villages. More roads were necessary for transportation between the villages and future settlements as well as for approaches to farms, canals and installations for reasons of operation and maintenance.

Generally, the roads run parallel to the drainage canals. Around 2,000 km. of agricultural roads were built through the project in order to link up all parts of the project together; at the same time they facilitate the transport by farmers of agricultural products more easily from their farms to the markets.

After the project was completed all the villages in al-Hassa oasis were connected to the new road system by asphalt feeder roads see Fig.4.4. Also the main street in each village has an asphalt surface and adequate street lighting and pavements.

The total cost of the construction of the new irrigation and drainage system was about S.R. 245 million (about 60 million U.S dollars). This amount included the establishment of the factory to produce 100,000 m^3 of prefabricated concrete elements per year, the employment of 200 Germans and more than 2,000 local people, and the import of 15,000 tons of steel (Wakuti 1970). Also 55 bridges, 800 weirs and gates and 3 pump stations and their elevated reservoirs had to be constructed.

5.4 The al-Hassa Irrigation and Drainage Authority

It was clear that, following the completion of construction, it was necessary to have a team of highly qualified personnel to manage and operate the project to ensure that its ultimate objectives were attained.

(a) On 12,1311/1392 A.H. (1972 A.D) the Council of Ministers issued decree No. 28, which announced the creation of the al-Hassa Irrigation and Drainage Authority (HIDA un-dated).

An independent Board of Directors, headed by H.E. the Minister of Agriculture and Water, became responsible for setting the general policy and plan of the Authority.

The day-to-day work is managed by a Director General, assisted by the personnel of two technical and administrative divisions.

Independent financial and managerial systems were set out to manage and operate the daily works of the project. High flexibility was considered when these systems were set out to allow quick and efficient action in the daily work. In order to attain the best relations with the farmers, the Director General cooperates with a consultative committee which consisted of the leading farmers in the province, and well experienced in farming.

In order to upgrade the level of its employees, and keep them up-to-date with modern technology, the authority immediately established a training section, to set up and implement needed training programmes for the employees, and conduct training programmes that would help in the development of agriculture as a whole.

Since the oasis is divided into two parts, a team was assigned to be in charge of water distribution for each part. Each team consists of the following personnel:-

1. Irrigation engineer for general supervision.

2. General foreman to assist the engineer.

3. A certain number of foremen in charge of water distribution; each one is responsible for a main area and supervising the water operators, and

4. A team of water operators; each one is responsible for operating one of the sub-main canals, i.e. in charge of many lateral canals.

Also, an extension service was established within the cadre of the authority to instruct the farmers and demonstrate modern methods and techniques in agriculture. This section started its work in 1394 A.H (1974 A.D). In addition to the services offered in the extension field, the section performs surveying works and collects statistical data on farms within the area of the project.

It is worth mentioning that farmers in the project area do not pay for the services that the project offers.

These developments followed the taking over by the Ministry of Agriculture and Water of the Survey and Research Centre in al-Hassa in 1970. This was totally separate from the Hofuf Agricultural Research Centre established by the Leichtweiss-Institute in 1967-68.

In summary, al-Hassa Irrigation and Drainage Authority is concerned with the management of the project while the Hofuf Agricultural Research Centre is concerned with agricultural research.

(b) Water distribution and drainage technical control

i) The al-Hassa Irrigation and Drainage Authority is responsible for the distribution of water to lateral canals from which farmers syphon their requirements, and for controlling the quantity of water supplied. This is managed by the operation of weirs and sluice-gates supervised by the team mentioned above.

The most important elements in the supply and control of water are the following (see Fig. 5.5).

1. Springs

There are 32 springs which supply the project, the most famous and biggest of which is Al-Khudud which supplies about 1/3 of the total input to the project. Its maximum discharge reaches 5m^3 per second(Wakuti 1970).

2. Irrigation canals

The reinforced concrete canals were designed in different shapes and sizes in accordance with the areas that they supply water to. According to their capacities, the canals are divided into three main groups:-

a) Main canals are 16 canals in number, and their total length reaches 160 km.

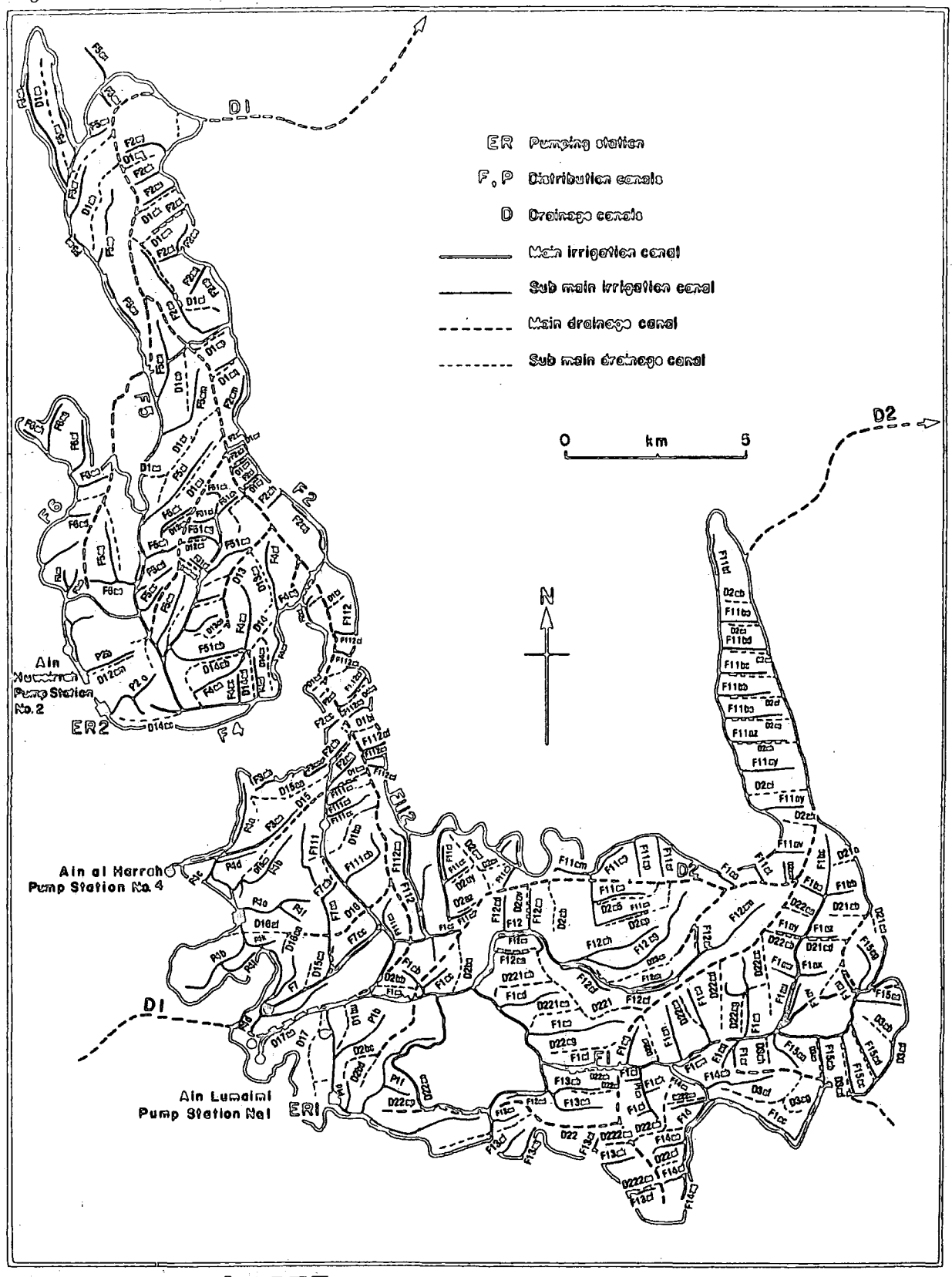
b) The sub-main canals are 233 in number with a total length is 265 km.

c) The lateral canals are distributed into the farms with a total length of 1,100 km. See Fig. 5.5.

3. The Main Irrigation Gates

In order to control the flow through the main canals, and be able to build up a suitable head of water steel gates

Fig 5-5 AL HASSA OASIS



Source: HIDA, 1975.

were installed on these canals. Closing these gates causes the water level in the springs and in the canals to be raised and thus the needed water head is built up and water is discharged into the sub-main canals and laterals. High water discharge rates allow greater areas to be irrigated in a shorter time. The main canals were specially designed in a rectangular cross section shape, giving high volume capacities, in order to act as a water reservoir when the gates were closed.

4. The main connections

The eastern part of the oasis is supplied from a group of springs located between Hofuf and Bani-man village of which al-Khudud and al-Haql springs are the main ones. The northern part is supplied from another group of springs which is located between al-Mutairifi and al-Shabah villages (see Fig.3.16).

In order to have quick control of the quantities of water supplied to both parts of the oasis, it was necessary to construct two connection canals to permit the flow of excess water flowing from the Eastern to the Northern part. Also there were a group of smaller canals which was built to connect all the main canals.

5. The pumping stations and water reservoirs

The areas which are higher than the water level of the springs amount to about 3,650 hectares of the total area of the project. For it to reach these areas, the water must be lifted by pump. This area was divided into three sections, and pumping stations were built in each part. Four turbine pumps were installed in each station.

Each pumping station delivers the pumped water into high elevated water reservoirs by two underground pipes. The elevated reservoirs have the following storage capacities: (see Fig.5.5).

ER1	15,150 cu.m.	P1 (Ain Al-Luwaimi)
ER2	8,000 cu.m.	P2 (Ain Al-Huweirrah)
ER3	8,000 cu.m.	P3 (Ain Al-Buhairiyah)
ER4	15,000 cu.m.	P4 (Ain Al-Harrah)

These storage capacities require a surface of 55 x 55m and 40 x 40 m respectively for a maximum water level of 5.0m above the bottom of the reservoir (Wakuti 1969).

ii) As well as being responsible for the distribution of water as detailed above, the Authority is in charge of the 32 springs supplying the system and controls the amount of water extracted in order to conserve the availability of fresh water.

iii) The Authority is responsible for maintaining the material structure of the canals and drainage systems. The Authority controls the factory established by Phillip Holzmann for manufacturing the pre-cast concrete elements used in building the canals, and so has a supply of sections to replace those broken by accident. In addition, the Authority is responsible for cleaning the irrigation and drainage canal systems to prevent blockage by the accumulation of sand, silt or vegetation.

iv) Water flow and quality monitoring

The Authority is responsible for monitoring the discharge of the springs as well as controlling the pump stations. This is carried out by the Department of Hydrology which also

monitors the quality of the water in both the irrigation and drainage systems. In addition, it monitors and advises the farmers how best to use the available water.

The introduction of modern agricultural practices and urban development bring further problems of water quality. Professor H.Bowen-Jones in his report of February 1979 to the Ministry of Agriculture and Water states "the monitoring of water quality will remain permanently of great importance." The new urban sewage scheme mentioned by Professor Bowen-Jones in his report has now been partially completed : Hofuf and Mubarraz area has been connected to it, and other towns and villages are currently being connected. However, although this will remove any danger of water pollution by urban effluent some 20 springs are already affected by it and the potential problems of the increasing use of pesticides and artificial fertilizers, the effluent from livestock and industrial waste remain to be considered.

Leaving aside industrial waste, the development of agriculture will demand a close watch on the connection between land use and water quality, especially if drainage water is to be re-used. Many high yield varieties of grains, seeds and vegetables require relatively high applications of artificial (particularly nitrogenous) fertilizers. HIDA will have to ensure that such application is not carried to such excess that drainage water which might be re-used is contaminated by the chemicals, and that fresh irrigation water is not polluted which would affect specific crop response and therefore land use, e.g. through excessive nitrates, boron and phosphate imbalances etc.

Further, the future growth of zero-grazing, stall-fed livestock production, a development otherwise to be welcomed, would be det rimental to water quality in areas of high concentration of livestock, unless the farmers are given good advice and information on proper management.

5.5 Water Utilisation Control and Irrigation Farming Improvements

The main problem facing agriculture in the oasis for centuries is the shortage of water, particularly during the summer season. After the completion of the new project the al-Hassa Irrigation and Drainage Authority has sole responsibility for management and distribution of water supplies. Included in this is a responsibility for ensuring the efficient use of the water supplied which involves surveys and advice on land use.

i) The expansion of the al-Hassa Irrigation and Drainage Authority from 1972 to 1980 was remarkable. In 1972 there were 568 employees and an annual budget of S.R 21 million, while in 1980 there were 1,150 employees and a budget of S.R 86 million. There were similar increases in vehicles and machinery. The number of cars increased from 92 in 1972 to 339 in 1980, heavy trucks from 7 in 1972 to 49 in 1980, pumps from 17 in 1972 to 137 in 1980, and agricultural machines from 2 in 1972 to 98 in 1980.

In the same period 32 km of farm canals and 378 bridges were constructed by the Authority. In addition the Authority completed 64 km. of feeder canals connecting individual farms to the new drainage system. (HIDA undated).

Also as mentioned above in 1974 the extension services section was established within the Authority with 18 employees,

increasing to 103 in 1980, this including technical specialists (ibid).

During this period the section assisted 2,000 farmers with advice, and free supplies of seeds, chemical fertilisers, pesticides, and the loan of farm machinery. In addition the Authority established 205 pilot farms to demonstrate modern agricultural practices, particularly the efficient use of irrigation water . Also, the Authority has recently established a veterinary training Institute.

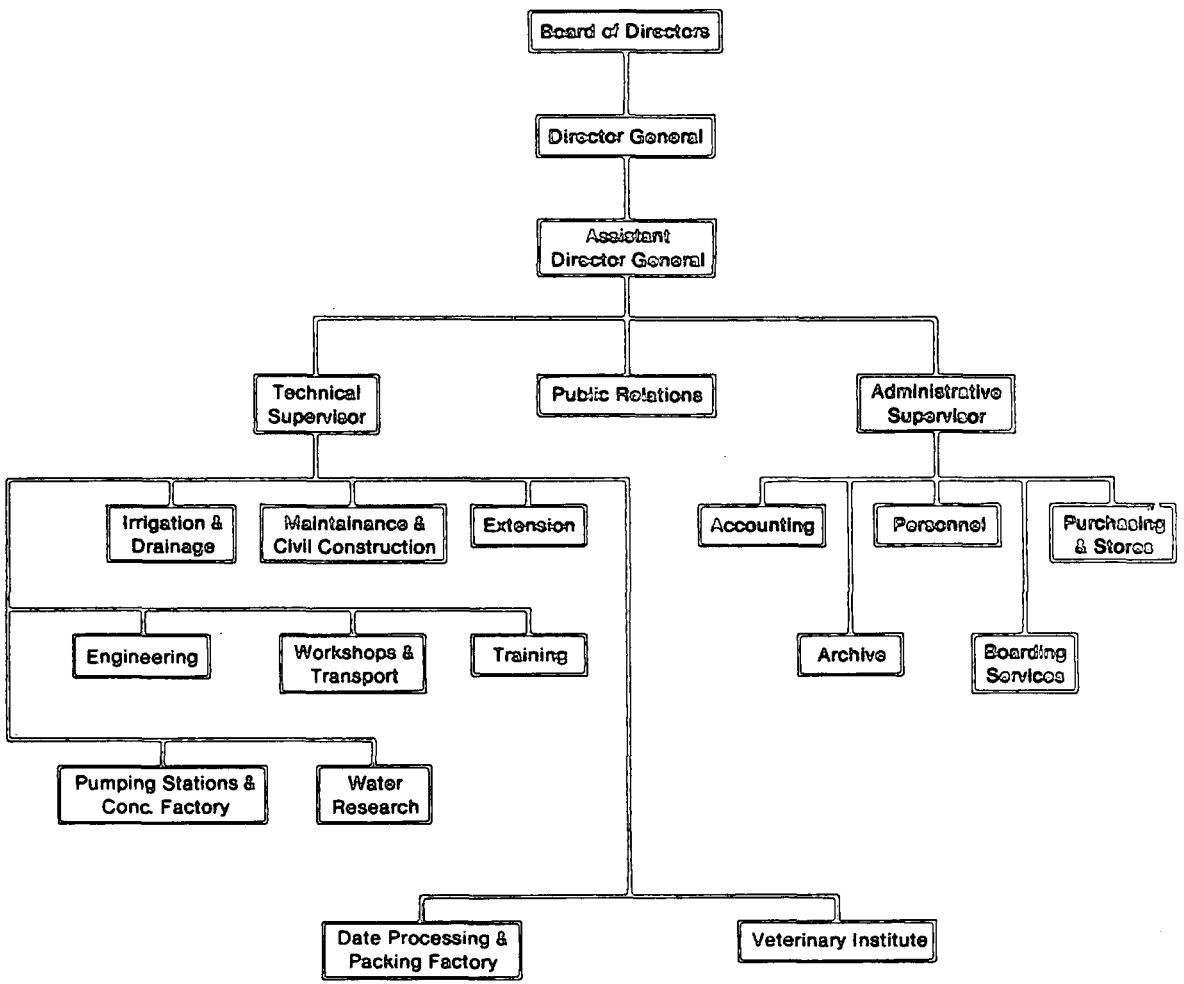
Figure 5. 6 shows the administrative structure of the al-Hassa Irrigation and Drainage Authority. In addition to its responsibility in al-Hassa oasis the al-Hassa Irrigation and Drainage Authority manages irrigation and drainage schemes in al-Kharj, al-Aflaj, al-Qatif, Wadi al-Miyah, Jabrin and Haradh, as well as in the whole Eastern Province.

Recently, the Minister of Agriculture and Water has set up a liaison committee with members drawn from the al-Hassa Irrigation and Drainage Authority and the King Faisal University at Hofuf to develop cooperation and interchange of information between the two Institutions. In addition, University staff have given lectures and advice to the Veterinary Institute of HIDA, as well as communicating the results of their researches into soil, water, water re-use, plants, livestock etc. (HIDA and King Faisal Univ. 1983).

Communication and co-operation is also developing between HIDA and all the institutions concerned with agricultural research e.g. the H.A.R.C. and the General Directorate of the Ministry of Agriculture and Water.

This cooperation between these institutions concerned

Fig. 5.6 The Administrative Structure of the Al - Hassa Irrigation and Drainage Authority



Source : Al - Hassa Irrigation and Drainage Authority,Summary Report, undated, Kingdom of Saudi Arabia

with agricultural development is intended to alleviate the problem of a new physical structure imposed upon a traditional farming system. Traditionally farming in Saudi Arabia and in al-Hassa in particular has been the cultivation of small holdings producing predominantly dates, with alfalfa and some livestock. The main constraint upon expansion of production has been the limited availability of water.

In al-Hassa today there is now a system allowing the most scientific distribution of water together with adequate drainage. However, the traditional farming practices, land-use and relatively small plot size remain largely unchanged.

In order both to extend the area that can be brought under cultivation and to increase the productivity of the land at present cultivated, as well as of the water available, agricultural practices should be made as modern as the irrigation and drainage project itself. Here lies the problem: the agricultural practices and the concentration on one dominant crop, the date palm, have grown up over centuries, and like most such well established traditional systems will take much effort and many years to change. More factors which complicate the problem include the physical and climatological conditions described in Chapter 3, and the socio-economic impact of the oil development examined in Chapter 4 which has dramatically changed the expectations of the population in al-Hassa, as elsewhere. The oil industry has attracted, both directly and indirectly, many young able-bodied men away from the farms and wages are, therefore, high.

As mentioned in Chapter 4, the policy of the government is to encourage people to stay or move into farming whether

full or part time. This is done by encouraging investment, providing water and the advice and information from the responsible institutions free of charge, provision of credit, subsidies and grants. The philosophy of this policy is not one of imposing direct controls on what farmers do but, rather, encourages the choice of superior systems through the incentives described above. This can of course slow-down farming change but is more likely to lead to permanent and diverse improvements. One reason for this policy is the desire of the government to make the country less reliant on imports of food.

CHAPTER FIVE

REFERENCES

Al-Abdulwahed, Y.A., (1979), Al-Hassa Sand Stabilisation Project, M.A.W., Saudi Arabia, (in Arabic).

Barth, H.K., (1976), Al-Hassa Oasis in the Eastern Province of Saudi Arabia, Franz Steiner Verlag GMBH, Wiesbarden, (in Germany).

Bowen-Jones, H., (1979), Land Use in al-Hassa Oasis, Report to the M.A.W. of Saudi Arabia, Unpublished.

Hassa Irrigation and Drainage Authority and King Faisal University (1983), Personal Communication.

International Bank, (1960), For Reconstruction and Development. Approach To the Economic Development of Saudi Arabia, Report No. AS-82a.

Ministry of Agriculture and Water, (undated), Hassa Irrigation and Drainage Authority. Hofuf, Saudi Arabia.

Twitchell, K.S., (1944), Water Resources of Saudi Arabia, Geographical Review, Vol.34.

Wakuti, (1969) Final Completion Report for Supervision of Execution of al-Hassa Irrigation and Drainage Project, Saudi Arabia, Zug.

___ (1970) The al-Hassa Irrigation and Drainage Scheme, Report, Hofuf, Saudi Arabia.

___ (1971) Al-Hassa Irrigation and Drainage Project, Saudi Arabia.

CHAPTER SIX

TRENDS IN AGRICULTURAL DEVELOPMENT AT AL-HASSA

6.1 The main elements in the development of the irrigation and drainage project considered in Chapter 5 can then be summarised as follows:

a) The construction of the new integrated irrigation and drainage systems, the main aims of which were to increase the cultivable land area from 4,000 to 20,000 hectares, (Bowen-Jones 1979) the reduction of soil salinity, and the removal of the malarial drainage swamps. The MAW had already begun a project to stabilize the sand-dunes to prevent the encroachment of sand into cultivated land and villages, and the waterlogging of the soil owing to the blocking of the drainage channels by drifting sand.

b) The recognition of the need for co-ordinated water distribution and monitoring and maintenance led to the establishment of HIDA to supervise the construction and management of the project.

c) To establish an efficient extension service in order to change old agricultural methods and introduce new suitable crops, also to advise farmers on the efficient use of irrigation water.

d) Improvements in village settlements, particularly proper sewage disposal, pipe water and electricity.

e) To construct a wide network of roads in order to connect all the different parts of the project together, and facilitate the transport of agricultural products and the movement of the farmers.

Figures 5.3, 5.4 and 5.5 show the results of the projects, the new irrigation and drainage systems and the new network of roads. This can be compared with the situation before the projects, shown in Figures 6.1 and 4.4

There are four government agencies in addition to H.I.D.A. which are concerned with farming activities, which have been established in al-Hassa oasis. These are the General Directorate of the MAW, SAAB, HARC and King Faisal University, the last of which is too recently established to have much effect as yet on al-Hassa agriculture. Together these institutions carry out all the agricultural research in al-Hassa, as well as providing extension services such as credit, technical advice and veterinary services as mentioned earlier. They also have a responsibility for agricultural research and development in the country as a whole. The first section of this chapter is devoted to an overview of the operations of these agencies.

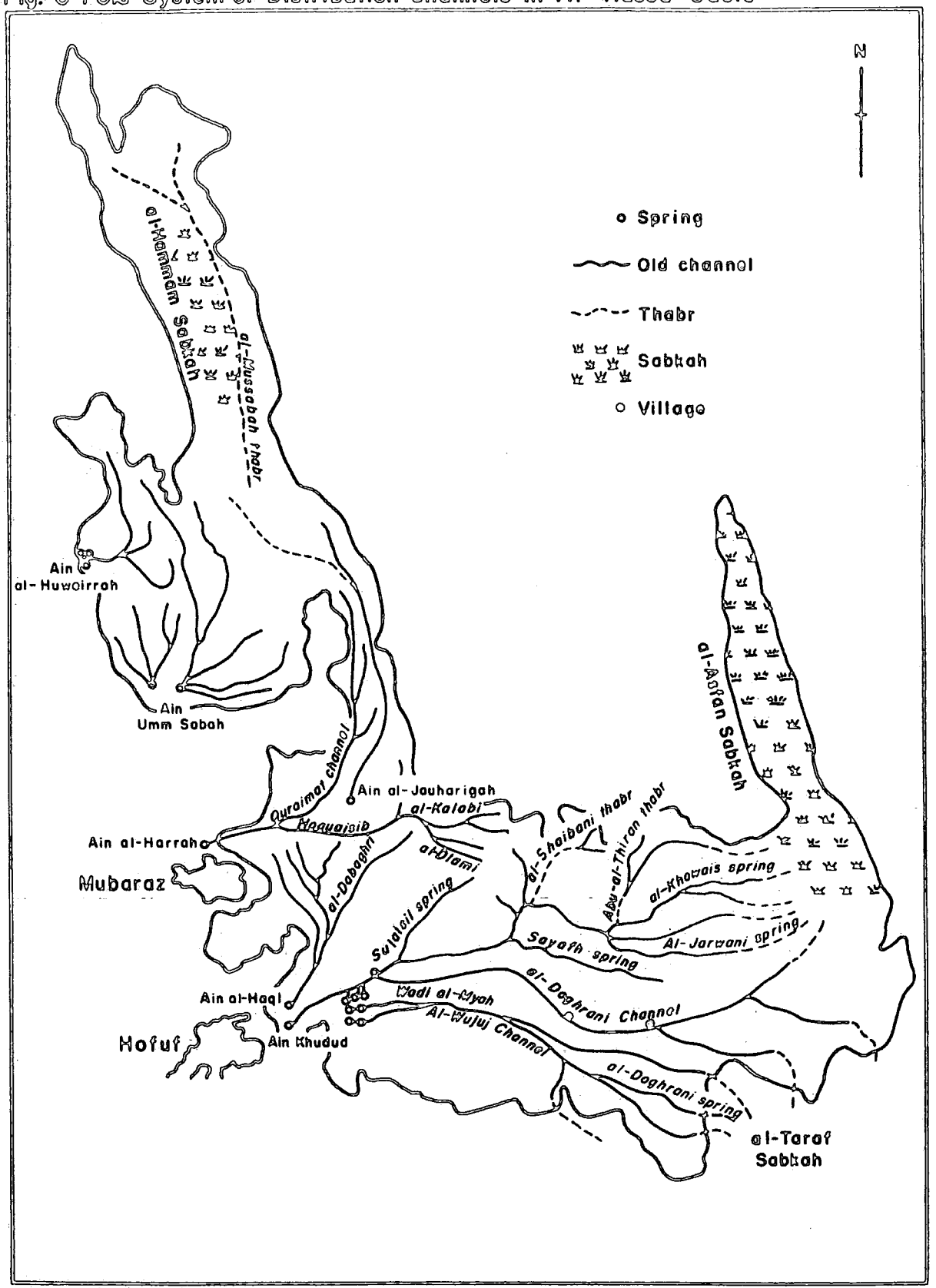
A. Development Agencies

6.2 The General Directorate of the MAW at Al-Hofuf

This regional branch of the MAW at Al-Hofuf which has six branches in the Eastern Province, at Dammam, Qatif, al-Sarrar, Qaryat al-Ulya, Mlayjah, Hafr al-Batin, as well as supervising the Saud Stabilization Project, and the Centre for Rural Social development at al-Jafar village, provides limited extension services to farmers, mainly along the lines of plant protection, poultry production and bee-keeping.

In addition, the General Directorate is responsible for the distribution of new land and for issuing permits for drilling and monitoring new wells (see Chapter 3.5). It is

Fig. 6·1 Old System of Distribution Channels in Al-Hassa Oasis



Source: Ibid (1979)

also responsible for monitoring and issuing permits for the import and export of agricultural products, including livestock.

The Directorate also subsidises the production of certain crops e.g. rice at S.R 0.30 per kg and dates at S.R 0.25 per kg. A subsidy of S.R 50 per offshoot is also paid for planting datepalm offshoots on condition that they are at intervals of 10 m. in each direction (MAW, Annual Report, Hofuf 1401/1981). This is to ensure sufficient space to use machinery between the trees when they are fully grown. This programme of subsidies is intended to reduce the cost of food production and encourage the farmers to stay in farming and produce more, in order to reduce the country's dependence on imports.

The question of production subsidies leads on to the complex and larger matter of governmental financial incentives to agriculture.

Table 6.1 illustrates the range of loans, grants and subsidies which are available to motivate agricultural producers. They range from free land and direct production subsidies to the guaranteed purchase of wheat and dates at high support prices. The agencies involved, as well as MAW, are the GSFMO (Grain Silos and Flour Mills Organization) and SAAB (Saudi Arabian Agricultural Bank). The main relevance to al-Hassa of the GSFMO lies in its high price purchasing of dates and this will be examined in context later in this chapter.

Table 6.1 Incentives for Agricultural Production

Type	Amount	Source [a]
Production input		
Fertilizer	50% of cost	MAW
Animal feed	50% of cost	SAAB
Potato seed	5 tons free, SR 1,000/ton thereafter up to 15 tons	MAW
Machinery and equipment		
Poultry equip.	30% of cost	SAAB
Dairy equip.	30% of cost	SAAB
Engines and pumps	50% of cost	SAAB
Fish trawlers	variable	SAAB
Transportation		
Air transport of cows	100% of cost	SAAB
Output		
Wheat	SR 3.50/kg*	GSFMO
Rice	SR 0.30/kg	MAW
Corn	SR 0.25/kg	MAW
Millet/barley	SR 0.15/kg	MAW
Dates	SR 0.25/kg	MAW
Date palms planted	SR 50.00 tree	MAW
Dates	SR 3.50/kg*	GSFMO
Agricultural credit		
All types	variable conditions	SAAB
Agro-industrial credit		
All types	variable conditions	SIDF
Land acquisition		
Land distribution	free	MAW

Notes: a. MAW = Ministry of Agriculture and Water; SAAB = Saudi Arabian Agricultural Bank; GSFMO = Grain Silos and Flour Mills Organization; SIDF = Saudi Arabian Industrial Development Fund.
* Guaranteed purchase price.

6.3 Agricultural Credit in al-Hassa Oasis

Since the establishment of the Saudi Arabia Agricultural Bank and a branch in Hofuf in 1964, farmers in the al-Hassa oasis have had access to interest-free loans. The bank offers short, medium, and long-term loans to individuals, cooperatives and firms engaged in agricultural activities.

Short-term loans, repayable within a year, are used for meeting seasonal production costs such as seeds, fertilizer, labour for weeding and pollination and so on. Medium term loans, repayable within five years, are intended to meet such fixed costs as well-drilling, the purchase of machinery or vehicles, and construction of such things as poultry houses, byres and dairy farms. Long-term loans, repayable in 25 years, are intended for large-scale land development projects.

Table 6.2 shows the number and value of short and medium term loans supplied by the Hofuf Branch of the S.A.A.B. between 1964 and 1984. It may be noted that as well as the increase in the numbers of loans, the average size of the loans has increased sharply over the period.

The activities of the bank, together with the other agencies provide encouragement to the farmers to remain in agriculture and develop their farms. They also provide an incentive to people to engage in agriculture.

There is an increasing tendency of farmers to grow vegetables as cash crops away from the summer months because of the seasonal shortage of water. This has also involved some change in crop varieties and a greater degree of commercial

Table 6.2 Number and Value of Loans Supplied by the Hofuf Branch of the Saudi Arabian Agricultural Bank 1384/85 A.H. to 1403/1404 A.H.

Loans / Years	Short-term loans		Medium-term loans		Total loans	
	No.	Amount S.R.	No.	Amount S.R.	No.	Amount S.R.
84/85	6	35,654	41	272,121	47	307,775
85/86	1	42,750	67	438,877	68	481,627
86/87	68	326,900	118	826,000	186	1,152,900
87/88	94	372,300	85	451,100	179	823,400
88/89	130	505,078	100	485,810	230	990,888
89/90	167	6,378,857	116	520,520	283	1,158,377
90/91	164	432,814	142	1,064,053	306	1,496,867
91/92	193	458,355	174	1,273,566	367	1,731,921
92/93	154	451,044	155	1,383,343	309	1,834.387
93/94	209	659,633	270	3,999,108	479	4,658,741
94/95	496	1,445,969	1361	17,304,157	1857	18,750,126
95/96	428	2,488,004	917	22,960,708	1345	25,448,712
96/97	377	2,347,870	1236	55,331,056	1613	57,678,926
97/98	371	3,204,546	764	46,888,323	1135	50,092,869
98/99	283	2,308,138	605	30,166,484	888	32,474,622
99/400	305	1,970,121	672	43,713,235	977	45,683,356
1400/1401	494	4,365,471	1062	164,318,130	1556	168,683,601
1401/1402	468	2,945,415	979	147,822,598	1447	150,768,013
1402/1403	442	2,535,177	812	185,058,046	1254	187,593,223
1403/1404	200	4,058,664	601	167,785,316	801	169,843,980
Total	5050	29,591,760	10277	892,062,551	15327	921,654,311

Source : Saudi Arabian Agricultural Bank, Hofuf Branch, unpublished Record (Personal communication with Hofuf Branch, June 1984).

risk taking (see later in Chapter 6.1). There is also a trend towards setting up poultry farms; in 1402 (1982) there were 115 poultry producers, of which 65 produced meat and 50 eggs (Al-Madina Daily 26th/3/1404).

However, there remains a proportion of small farmers who have not taken advantage of the available credit. Many of these are unwilling to get into debt and do not see the need to expand their business. The provision of free irrigation and drainage means that the expenditure of an established farmer is very low, unless he wishes to modernise or introduce new crops or livestock, as exemplified later in this chapter.

Tables 6.3, 6.4, 6.5 and 6.6 show the purposes of short and medium term loans made by the Hofuf Branch of the S.A.A.B. in 1972/73. It will be seen that the most significant short term purposes were to meet labour costs and the purchase of animals and fodder. The high labour costs emphasise the urgent need to modernise agricultural practices, while the trend towards animal husbandry is an important development. The low amount required for fuel is a result of the irrigation project integrated design which means that farmers no longer need individually to raise water mechanically by pumps.

In Tables 6.5 and 6.6 the trend towards animal husbandry is further illustrated by the very high amounts lent for the purchase of fodder and animals, while the process of modernisation is demonstrated by the loans for machinery and soil treatment. The benefit of the irrigation project is

Table 6.3 Short Term Loans by Hofuf Branch of S.A.A.B 1392-93 A.H. (1972-73 A.D.)

Purpose of loan	Value of Loans S.R.	% of Total
Chemical Fertiliser	20,803	4.6
Seeds	6,220	0.6
Fuel	1,250	0.3
Labour costs	191,012	42.4
Machinery and levelling	5,000	1.1
Animals for fattening	104,650	23.2
Other cash loans	1,119	0.2
Poultry fattening	27,200	6.0
Fodder for fatstock	81,570	18.1
Local manure & topsoil	4,580	1.0
Other materials	11,200	2.5
Total	451,044	100.0

Source: S.A.A.B. Ninth Annual Report (1392/93), p.41.

Table 6.4 Short term loans by Hofuf Branch of S.A.A.B. as a proportion of the National Totals : 1402/1403 A.H.

Purpose of Loans	Hofuf Branch	National Total	%
Chemical fert-ilizers	89,727	6,169,480	1.45
Seeds	1,189,770	9,438,921	12.6
Manure	-	182,884	0.0
Ploughing	91,880	3,399,805	2.7
Fuels	-	1,835,910	0.0
Animals	-	-	-
Labour Wages	1,157,300	4,073,641	28.41
Transport-ation and install-ation	-	8,000	0.0
Basin land	-	-	-
Others	6,500	167,200	3.89
Total	2,535,177	25,270,841	10.03

Source: S.A.A.B. (1402/1403 A.H), Nineteenth Annual Report, p.29.

Table 6.5 Medium Term Loans by Hofuf Branch of S.A.A.B. 1392/93 A.H (1972/73 A.D)

Purpose of loans	Value of loans S.R.	% of Total
Machinery	134,305	9.7
Pumps	3,326	0.2
Pipe	2,200	0.2
Drilling and well maintenance	-	-
Animals for breeding	110,700	8.0
Seeds and seedlings	75,471	5.5
Ploughing and levelling	29,785	2.2
Building construction & water towers	61,725	4.5
Chemical, soil treatment (manure, clay, sand)	209,490	15.1
Other cash loans	-	-
Spare parts	-	-
Vehicles	20,632	1.5
Tractors	-	-
Poultry for fattening	74,000	5.3
Fodder	532,120	35.5
Fisheries Equipment	24,935	1.8
Others	104,354	7.5
Total	1,383,343	100.0

Source: S.A.A.B. Ninth Annual Report (1392/93), p.49.

Table 6.6 Medium Term Loans by Hofuf Branch of S.A.A.B. as a proportion of the National Total : 1402/1403 A.H.

Purpose of loan	Hofuf Branch	National Total	%
Engines	3,340,200	221,851,930	1.5
Pumps	5,155,448	210,991,612	2.45
Machines	8,470,514	821,273,316	1.03
Buildings and tanks	14,127,844	240,304,004	5.88
Drilling machines	14,220,133	550,979,787	2.58
Ploughing and levelling	573,950	90,074,892	0.6
Offshoots	7,080,357	208,998,348	3.39
Manure	6,320,605	98,296,005	6.43
Vehicles	539,000	78,418,706	0.69
Animals	434,000	36,193,026	1.2
Animal feed	-	-	-
Spare parts	11,154,516	236,307,718	4.68
Fishing gear	3,643,273	8,548,811	42.62
Transport and installation	23,164	2,078,613	1.11
Bee-hives	6,000	8,971,950	0.07
Others	234,265	19,464,678	1.2
Projects	109,734,777	1,306,003,700	8.4
Total	185,058,046	4,140,757,096	4.47

Source: S.A.A.B. (1402/1403 A.H.), Nineteenth Annual Report, p.30.

further borne out by the low percentage of loans for pumps, pipe, drilling and well maintenance.

The continuing rate of investment in agriculture is shown by the fact that the total value of loans annually by Hofuf Branch of the S.A.A.B. had increased from just over 3,00,000 S.R. in 1964/65 to over 187 million in 1982/83, see Table 6.2.

6.4 Hofuf Agricultural Research Centre

On September 13th, 1967 the work at HARC was inaugurated by an agreement signed between the Ministry of Agriculture and Water of the Kingdom of Saudi Arabia and the Leichtweiss Institute for Water Research at the Technical University of Braunsehweig to undertake cooperative research on irrigated agriculture under the soil and climatic conditions of the al-Hassa oasis (HARC, Pub.2. 1972).

a. The Leichtweiss Institute - Technical University of Braunschweig

The research programme contains the following main items:

1. Soil and Water investigations

i) Physical and chemical analysis of the local soil types and of the irrigation water.

ii) Investigation on salinity problems of soil and water.

2. Climatic factors

i) Collection of data on all climatic factors affecting irrigation and crop growth.

ii) Analysis of correlations between climatological data and consumptive use of water.

3. Proper drainage

i) Investigation into soil properties influencing the design of drainage systems.

ii) Studies on the height of the groundwater table.

4. Leaching of excessive salts

Determination of the use of water for leaching and investigation on the leaching requirement during plant growth.

5. Studies of consumptive use of water by forage crops and date-palms, and

6. Comparative investigations on different irrigation methods.

b. The Bangor team

In 1970 a British team from the University College of North Wales at Bangor arrived to conduct research into animal production, and fodder and forage production. The aims of this team were to find the breeds of cattle and sheep best suited to the environmental conditions in al-Hassa oasis, and the forage crops best suited both to these animal breeds and to local soil and climate conditions. The experiment included 304 cattle (60% Jersey from Holland and England, and 40% Friesian from U.K.).

The research into the cattle is concerned with both dairy and beef production. In addition the experiment includes 300 sheep of which 150 are Najdi, 150 Awassi from the north of the Arabian Peninsula, both for meat production. There are also 100 Dorpen from the U.K. which are for both meat and wool production (personal communication 1983)*

* Personal communication with research team members, H.A.R.C. Summer 1983.

There are two main perennial green forage crops being researched: Alfalfa and Rhodes grass. Also there are summer and winter annual crops, maize and millet in summer and Italian rye-grass and oats in winter (Cresswell 1978).

c. The Chinese Agricultural Technical Mission (CATM)

A third team,from Taiwan,has carried out research into the production of rice, other vegetables and fruits, including new varieties to al-Hassa oasis. See Tables 6.7, 6.8, and 6.9

Recently the scope of the research has been extended to include the use of small farm machinery. The programme includes the training of local farmers in the operation and maintenance of specially designed small farm machines both in training courses and in demonstrations on farms. More than 70 power tillers, 50 planters, 40 cultivators and 30 rice threshers are available for loan to farmers for practical use in al-Hassa conditions (C.A.T.M. 1983).

Table 6.10 shows the numbers of farmers, total areas and yields, included in the vegetables, wheat and rice extension programmes in 1402-1403 A.H (1982-1983 A.D).

Finally, as more Saudi Nationals have become suitably qualified they have taken over many of the activities of the centre. Figure 6.2 shows the organization of the Hofuf Agricultural Research Centre and the responsibilities of the various teams.

Table 6.7 Yield potentiality of field crops in Saudi Arabia

Crop	Location	Yield (mt/ha)	Variety	Crop season	Remark
Maize	Al-Hassa	9.5	Corn Belt x Caribbean Comp.,UPCA Var. 1 and America Central	Fall 1977-1979	
	Gassim	8.2	Kisanga 7729 Poza Rica 7832	Fall,1979	
Mungbean	Gassim	2.1	Local variety	Spring, 1979	
		2.4	AVRDC 2010	Fall, 1979	
Oat	Gassim	6.7	NTU No.1	Winter,1978	
		68.0	NTU No.1	Winter,1978	Top fresh weight
Peanut	Gassim	4.9	Honduras	Spring,1980	Dry seed weight
Potato	Asir	53.8	Mirka	Summer,1982	In 100 days
Rice	Al-Hassa	8.2	NTU 306	Spring,1976,78	
		6.3	Hassa No.1	Summer,1979	
Soybean	Gassim	4.5	Davis	Summer,1982	
Sunflower	Al-Hassa	4.2	Kang Shan	Spring,1979	For confectionery
		4.6	Kang Shan	Fall,1980	For confectionery
	Gassim	3.2	Impesa (L1)	Spring,1979	For confectionery
		2.5	Peredovik	Spring,1979	For oil purposes
Sweet corn	Al-Hassa	10.1	Tainan No.14,15	Spring,1979	Fresh ear weight
	Gassim	9.1	Tainan No.14	Spring,1980	Fresh ear weight
Sweet potato	Gassim	103.2	AIS-0122-2	Spring,1979	Fleshy root weight
		92.5	Tainung No.62	Spring,1979	Fleshy root weight
Triticale	Gassim	5.8	Taichung Yu No.8	Winter,1979	
Wheat	Al-Hassa	7.9	Super X	Winter,1979	
	Gassim	7.3	Super X	Winter,1980	

Source: C.A.T.M. (1983) p.8.

Table 6.8 Yield potentiality of vegetable crops in Saudi Arabia

Vegetable	Location	Yield (mt/ha)	Variety	Crop season	Remark
Bean (dry seed production)	Al-Hassa	6.1	Tainung No.3	Fall, 1977	Yardlong bean
		4.6	Contendes	Fall, 1980	Bush type
		7.6	I-Li White Seed	Fall, 1980	Pole type
Broccoli	Al-Hassa	23.4	Green Comet	Fall, 1977	
	Asir(Abha)	62.1	Known You Early	Fall, 1981	
Cabbage	Al-Hassa	75.5	U.S.Hit, K-Y Cross	Fall, 1979	
		75.1	New Top	Winter,1979	
	Asir(Abha)	157.0	0-S Cross	Fall, 1981	
Cantaloupe	Al-Hassa	86.8	Farmer's Friend 57	Spring, 1980	
		69.3	43 A x Batikh	Summer, 1981	
	Gassim	46.2	Farmer's Friend 57	Spring, 1979	
Carrot	Al-Hassa	45.8	Danbers No.126	Fall, 1980	
		57.6	Scarlet Nantes (NK)	Winter, 1981	
Cauliflower	Al-Hassa	44.2	Snow Diana	Fall,1977	
		22.4	Yuan Lin Early	Summer, 1978	
		70.0	Snowball Y, Snow Flower	Winter, 1979	
Celery	Al-Hassa	90.1	Cornell 619	Fall, 1981	
Chinese cabbage	Al-Hassa	135.3	Wusuan	Fall, 1979	
		80.0	Pin Luh	Summer, 1981	
Cucumber	Al-Hassa	93.0	Flying Swallow	Summer, 1979	
Eggplant	Al-Hassa	162.0	Nile x P 760		
		152.8	Egyptian x Pingtung Long	Spring, 1981	
Garlic	Al-Hassa	13.6	Fenshan Sel.No.2	Winter, 1979	

Source: Ibid, p.9.

To be continued...

Table 6.8 (Cont.)

Vegetable	Location	Yield (mt/ha)	Variety	Crop season	Remark
Lettuce	Al-Hassa	55.9	Great Lake 659	Spring, 1978	
		71.0	Great Lake 366	Winter, 1978	
Okra	Al-Hassa	30.3	Local variety	Spring, 1979	
Onion	Al-Hassa	110.0	Texas Early,Yellow Granex,Grano 520 PR	Fall, 1981	
	Asir(Abha)	102.3	Granex 33	Fall, 1982	
Pea	Al-Hassa	20.1	Number 40	Fall, 1980	Green pea
		31.8	French Giant Pod	Fall, 1980	
Radish	Al-Hassa	111.5	Ta Mei Hwa	Fall, 1979	
		63.0	Ta Pai Chi	Summer, 1980	
	Asir(Abha)	69.4	Ta Mei Hwa	Winter, 1981	
Spinach	Al-Hassa	90.0	Benten No.2	Fall, 1981	
	Asir(Abha)	60.0	Benten No.1	Fall, 1981	
Sweet pepper	Al-Hassa	119.7	TSS No.9	Spring, 1981	
Hot pepper	Al-Hassa	70.5	Hassa,Farmers' New Wonder F_1	Spring, 1981	
Tomato	Al-Hassa	97.0	Pakmor	Spring, 1980	
		72.0	VFN 8	Fall, 1980	
Watermelon	Al-Hassa	57.1	Known Tai No.72	Spring, 1980	
	Gassim	48.2	Charleston Gray 133	Spring, 1979	

* 1 donum = 0.1 ha.

Table 6.9 Kinds and quantity of sub-tropical and tropical fruits introduced from Taiwan for observational trial

Kind of fruit	Hofuf	Gassim	Abha	Qatif	Hail	Total
Carambola	40	-	-	40	-	80
Peach	10	-	-	10	10	30
Wax apple	30	50	-	50	20	150
Sweet orange	10	25	-	-	15	50
Orange	10	30	-	-	10	50
Lemon	25	10	-	15	-	50
Mongo	20	20	-	40	20	100
Loquat	-	10	20	-	20	50
Guava	30	20	-	50	-	100
Sugar apple	15	-	-	15	-	30
Liches	5	25	-	-	-	30
Pear	-	15	10	-	25	50
Apple	-	-	200	-	-	200
Plum	-	30	-	-	-	30

Source: Ibid, p.11.

Table 6.10 Actual number of farmers and acreage participated in the Extension Programs carried out by CATM during 1402/1403 (1982-1983 A.D.)

Crop	No. of farmers partic-ipated	Total acreage (donum)*	Av. donum per farmer	Yield (kg/donum)
Wheat	50	741.5	14.83	300**
Rice	25	66.3	2.65	585
Veget-ables	160	1,638.0	10.24	-
Total	235	2,445.8	-	-

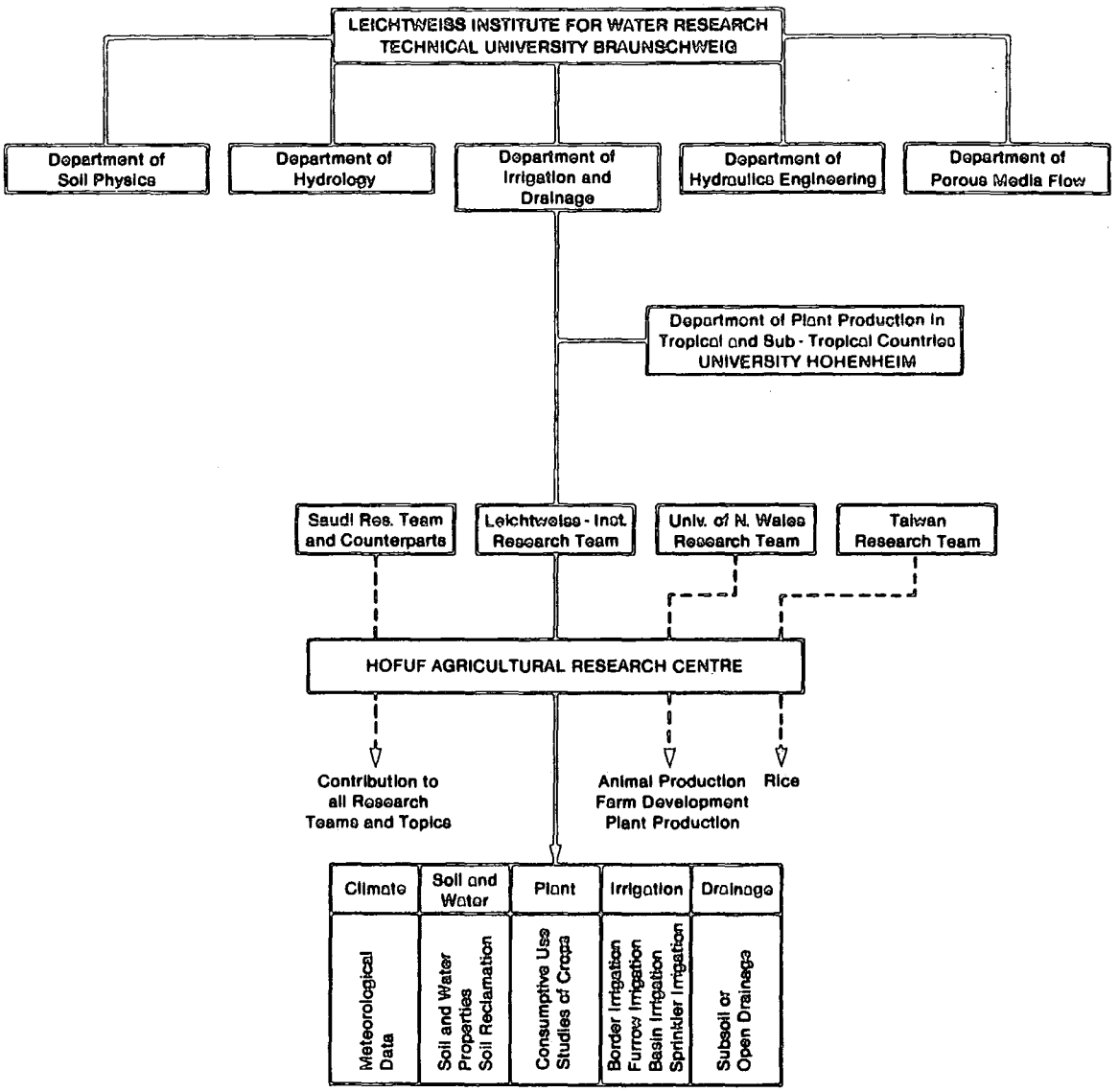
* The farmers in Al-Hassa area usually grow wheat and rice once a year but may grow vegetables 2-3 times a year. The acreage indicates the crop cultivated area in the whole year.

** Estimated yield

1 Donum = 1,000 m^2.

Source : Ibid, p.12.

Fig. 6.2 The Research Team of the Leichtweiss Institute for Water Research (Technical University Braunschweig) within the Framework of the Hofuf Agricultural Research Centre



Source: H.A.R.C., Publication No. 9, Hofuf 1974, M.A.W. Saudi Arabia

6.5 Marketing of Agricultural Products

The al-Hassa oasis is already a leading agricultural production area in Saudi Arabia, and the Irrigation and Drainage and Dune Stabilization Projects completed there have greatly expanded its output potential, both in terms of land area and in yields. Equally important to modern production methods are efficient marketing methods that can supply this output to consumers throughout the country, while at the same time rewarding the farmers with improved net returns for their production efforts. Some research has been carried out in this area but none of the major agencies involved in al-Hassa has yet carried out research into the best ways of developing facilities for processing and marketing agricultural products. At present there is no government or private body with overall authority for distribution and marketing. Even the al-Hassa Irrigation and Drainage Authority is not directly involved in marketing. The assumption, based on earlier studies, was that extension work would lead to more production of marketable profitable agricultural commodities.

The lack of proper processing facilities and other guaranteed markets acts as a disincentive to increased production by farmers. Although the government is heavily involved in providing incentives for increased agricultural production, it seems to have so far overlooked the urgent need to re-organize and develop the marketing system. With the exception of the Hofuf egg marketing co-operative, which offers grading, cold storage, and wholesaling services to its members, there are no facilities for receiving, sorting, packing and distributing incoming farm produce.

Usually, a farmer brings his products to the Hofuf Central market and sells it by auction himself or through a middleman to the wholesalers, retailers or exporters, who pay cash on the spot, with no records made of the transactions. The produce is generally marketed unsorted and varies considerably in quality. Prices fluctuate significantly due to the irregular arrival of produce, related speculations and changes in weather. The lack of immediately available information on current prices and supply and demand, in local and other markets, also affects the stability of prices.

The produce sold to the exporters is intended for sale in Riyadh, Dammam, Dhahran, al-Khobar and other cities, or export to neighbouring Gulf States, particularly Kuwait and Qatar. Larger producers usually transport the bulk of their produce direct to markets outside the oasis.

Among the recommendations that have been made to improve marketing facilities to the standard of the project as a whole and other developments are the following:

1. The project management should lead, motivate and co-ordinate efforts by producers and buyers directed to improving the quality of the products, finding new markets, increasing the returns to the farmers, and relating the supply to demand. These aims will involve reducing costs of transport and facilitating faster and more even flow of produce into the markets, by encouraging the farmers to co-operate with one another in the collection, transport and marketing of the products. Those activities could be supervised by the al-Hassa Irrigation and Drainage Authority, at least initially.

2. To improve and maintain an even quality of produce, a grading and standards programme should be developed aiming primarily at the use of standardised containers with a grading system that can be easily understood by the consumers.

3. To encourage the demand for dates, the marketing system should be modernised: they should be packed in hygienic, attractive, and reasonably priced containers in convenient sizes so as to suit the requirements of the consumers. This means that HIDA, should bring the production at al-Hassa date packing factory to full capacity.

4. Consideration should be given to new products using the available agricultural produce e.g. animal feed pellets containing alfalfa and other green roughage, as well as low quality dates, and hardboard made from palm fibres and wood.

5. The al-Hassa Irrigation and Drainage Authority should establish a marketing unit to collect and disseminate market information, conduct market research, plan and implement crop budgets and enforce grades and standards.

See also Humaidan 1980 for other suggestions.

B. Changes in Agriculture

6.6 Land Use In Al-Hassa

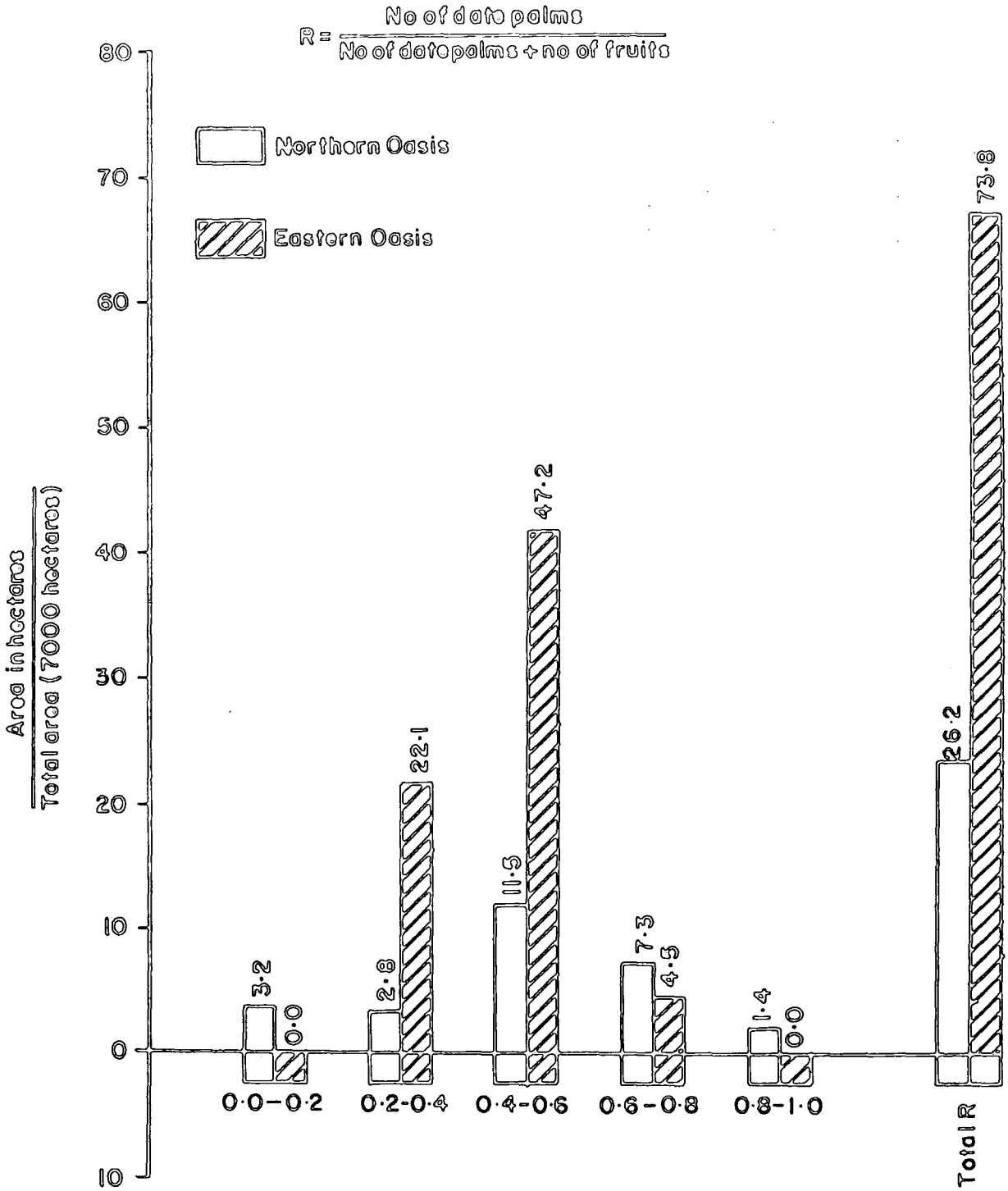
The effects on agriculture of the HIDA project and of the work of the various agencies considered above might be expected to have been illustrated in changing patterns of land use in the oasis. In this section are examined what data is available.

As mentioned in Chapter 5, HIDA was established in 1392 (1972). HIDA started its surveys of Land-Use in al-Hassa in 1974, completing them in 1979. The results were computer analysed and published in the first symposium on the data palm (El-Prince et.al. 1982). As mentioned earlier (see Chapter 4), agriculture in the oasis was declining in the period prior to the Irrigation and Drainage Project to the point where as little as 4,000 hectares was under cultivation. By 1979 there were 7,096 hectares under cultivation with year-round irrigation: this was one of the first achievements of the Irrigation and Drainage Project. There is good reason to think the expansion of the area under cultivation has continued since 1979, and an increase of 2,000 hectares up to date is not unlikely.

The aforementioned computer analysis shows that 92% of the cultivated area was under date palms. However, there is considerable interplanting with other fruit trees, with a ratio of 4 date palms to 5 fruit trees in the eastern oasis, and 4:4 in the northern. Figure 6.3 shows the relative proportions of data palms to the total number of fruit trees including date palms.

The analysis took as samples of interplanted crops , rice, apricot trees, and vegetables, and showed that all areas of the oasis have some production of all these crops. However, there is some degree of concentration by density, e.g. of apricots near Jabal al-Qara (ibid), which shows a continuity since the traditional agricultural period for which the reasons are unknown, and of rice north of al-Mutairifi (ibid), which

Fig. 6·3 Planting Ratios between Date Palms and other Fruit Trees (1974 -1979)



shows continuity of production from the pre-project phase of farming due to good water availability and good soil conditions, and of vegetables which are concentrated in areas bordering the oasis (ibid).

In general the best quality products are strongly associated with the areas of highest density of productions, and these in turn have not changed since traditional farming days. For instance, the al-Seefah area (see Fig. 3.4) is famous for the quality of its Khalas dates, while the nuclear area is famous for its Reziz dates as well as for pomegranates, figs, rough lemons, peaches and the apricots from Jabal al-Qara. The northern area is famous for rice (mentioned above), and limes (for which the northern part of the Nuclear area is also well known). Whilst there is no scientific data on the fine detail of soil variability and variations in micro-climate, local farmers regard these as established reasons for the superiority of production in particular areas. The analysis of HIDA land use data shows that the date palm remains the dominant crop-plant in al-Hassa and this remarkable absence of change needs particular consideration.

Saudi Arabia is estimated to be the fourth greatest date producing country in the world after Iraq, Iran and Algeria. The number of date palms is assumed to be about eight million with a capital value of 1,200,000,000 S.R. Assuming total production of dates of about 240,000 tonnes (Marei, H.M, 1971) per year at an average price of 3.5 S.R. per kg. the annual crop could be worth around 840,000,000 S.R.

Although the demand for dates for human consumption has

undoubtedly gone down to a relatively low level, nevertheless for strong sociological and agricultural reasons the date palm continues and will continue as an important factor in Saudi Arabian agriculture.

In al-Hassa oasis the total number of palm trees is still estimated to be about two million. In total, 7,478 Mann Weight [1 Mann = 240 kg.] of dates were paid in tax (zakat) in 1964. Based on a tax rate of one fortieth of total production, it can be estimated that 71,788.8 tonnes of dates were produced in 1964. From Table 6.11 it can be seen that the total production of dates in al-Hassa oasis has varied from year to year, for instance from 75,196.8 tonnes in 1966, it declined to 52,156.8 tonnes in 1978, whereas in 1983, the total production increased to 69,110.4 tonnes. In fact, personal observation suggests that the production figures used for Zakat estimation are far lower than the actual.

The two dominant varieties, Reziz and Khalas, form the majority of dates processed, and are also the only two assessed for Zakat and included in the above estimate of total crop value. In addition there are some twenty other varieties, some of which are only marketable or consumable fresh, and are therefore restricted to local consumers and those to whom they can be delivered quickly. These constitute about 15% over and above the production figures given in Chapter 2. This underestimation is in addition to the fact stated above, that the production figures for the two main varieties used for Zakat estimation are lower than that actually harvested. It is therefore the Reziz and Khalas varieties which are mainly reserved for processing. Further, there is

Table 6.11 Total estimated date production in Al-Hassa oasis for the years 1964 to 1983

Year		Zakat in mann mann = 240 kgs	Total Production by ton
A.H.	A.D.		
1384	1964	7478	71788.8
85	65	7705	73968.0
86	66	7833	75196.8
87	67	7489	71894.4
88	68	n.a	n.a
89	69	6940	66654.0
90	70	5660	54336.0
91	71	5865	56304.0
92	72	6007	57667.2
93	73	6146	59001.6
94	74	6233	59836.8
95	75	6315	60624.0
96	76	6197	59491.2
97	77	6203	59548.8
98	78	5433	52156.8
99	79	5691	54633.6
1400	1980	6102	58579.2
1401	1981	6244	59942.2
1402	1982	6788	65164.8
1403	1983	7199	69110.4

Source: Saudi Arabia, Ministry of Finance, Al-Hassa Office (personal communication 1983)

about another 10% of production which is lost through wind-falls and substandard fruits, which, until about 15 years ago when it became uneconomic to collect them, were used for animal fodder.

The total value of the 1983 date crop if based on an average price of 3.5 S.R. per kg (the price paid by the government for Reziz variety dates) was about 241,885,000 S.R. This means that the dates produced in al-Hassa oasis represent the most important single source of agricultural income for the farmers in al-Hassa, and in the Kingdom as a whole. Moreover, date prices are rising rather than falling. Table 6.12 shows the increase of prices of Khalas and Reziz date varieties from 1979 to 1983.

Table 6.12 Increase in Prices of Khalas and Reziz Dates

Year	Price per 1 mann = 240 kg. in S.R. Khalas	Reziz
1979	1,200	120
1980	1,300	160
1981	1,500	200
1982	1,800	840
1983	4,000	1,000

Source: Personal contact with date sellers in al-Hassa oasis in 1983.

If one then adds to farmers' incomes the return from dates sold and consumed fresh, as noted above, together with the underestimated yield element and the potential represented by at least part of the present losses then one realises that in absolute terms, revenue from dates can be quite high. What

then matters, as in all farming is the relative rate of return compared with other farming or non-farming ventures, together with the non-economic factors which keep families linked to the land.

6.7 Date Processing and Packing Factories In Al-Hassa

In al-Hassa the first packing plant was established in 1962 to hygienically pack and market dates. This plant with a capacity of around 1,000 tonnes per year was shut down in 1977 (Al-Ghazal, A.A. 1981). In 1398 A.H. (1978 A.D) the Ministry of Agriculture and Water started a modern factory for processing and packing of dates in al-Hassa oasis, with a capacity of 5,500 tonnes per year (H.I.D.A. undated report). The aim is to produce good quality dates packed in a manner attractive and convenient to the consumers in order to encourage increased demand for dates, and thereby an increased income for the farmers. The government wishes to foster the continued cultivation of date palms because of their ecological as well as psychological appropriateness to the physical and social environment.

Recently the government has begun to purchase a proportion of the total data production (5,500 tonnes in 1981, 12,500 tonnes in 1982 and 17,500 tonnes in 1983 (H.I.D.A. personal communication, 1983))which is shipped as part of Saudi Arabia's contribution to the World Food Programme instead of cash payments, as Saudi Arabia's contribution to international famine relief, and also used for institutions such as hospitals, schools and Saudi Airlines.

As the capacity of the first factory proved inadequate,

Table 6.13 Amount and destination of dates supplied by S.A for famine relief in tonnes

Country	1981/82 A.D 1401/ 2 A.H.	1982/83 1402/3	1983/84 1403/4
Pakistan	3,263	3,000	3,050
Somalia	2,215	2,050	1,050
Republic of China	777	168	2,000
Phillipines	181	-	-
Syria	140	726	900.16
Jordan	140	305	350
South Yemen	1,192	1,300	1,369.2
Mauritius	174.3	-	-
Sudan	80	150	250
Sri Lanka	100	245	250
Morocco	140	400	1,741.6
Lesotho	140	800	750
Djibouti	116	55	20.16
Mozambique	50	-	-
Uganda	-	124	50
Zambia	-	50	44
North Yemen	-	917.8	150.08
Turkey	-	-	120
Tanzania	-	-	48.96
Other countries	-	-	3,467.84
Total	8,708.3	11,802.8	15,611.28

Source : Al-Jazeera Daily Newspaper 22.6.1404 A.D. (24.3.1984) p.11.

the government ordered the Ministry of Agriculture and Water to establish a new factory in al-Hassa with a capacity of 20,000 tonnes, to be constructed and managed by al-Hassa Irrigation and Drainage Authority. This factory was completed in 1402 A.H (1982 A.D) and has now handled two harvests, those of 1982 and 1983. The smaller factory is now managed by N.A.D.I.C., The National Agricultural Development Industries Company, and supplies national markets only (personal communication with H.I.D.A. 1982).

Table 6.13 shows amounts and destinations of dates supplied by Saudi Arabia for World famine relief. These dates were packed by Hofuf Date-Packing Plant and form Saudi Arabia's first regular foreign aid commitment.

We therefore find that whilst date palms were relatively neglected during the mid 1970's, they were hardly ever removed, and since 1978/79 there has been a revival of interest in date production. The consequences of this remarkable lack of change for other aspects of land use will be considered below.

6.8 Land Use Evidence of Agricultural Improvement

In 1978 HIDA commenced a programme of land surveys in al-Hassa oasis in order to determine not only the utilisation of land but the size and shape of plots and the distribution by ownership of holdings. By 1981 this programme was completed and a great deal of data became available for analysis. The following section is based on this HIDA Survey combined with the author's own observations.

Holdings are relatively small (in relation to modern agricultural systems) but they are suitable under the circumstances

of limited availability of water and other physical and human conditions in al-Hassa oasis (e.g. evapotranspiration rates) (see Chapter 3), and the dominance of date palms which are well suited to these conditions i.e. they are not permanently damaged by drought or short-term lack of attention (although productivity is temporarily affected). Although small holdings would seem less economical than large, they are in fact much more manageable, particularly when farming is not the owner's main occupation, and when the dense planting of date palm trees requires that fertilizing etc. is carried out entirely by hand with no mechanical aid (the pollination of the trees must in any case be done manually).

As noted earlier in this chapter, the various agricultural development measures implemented in al-Hassa for almost 20 years, have not destroyed the dominance of the date palms. There are many reasons which can be listed as justifying the continued attention paid to the date palms. First, the date is nutritious and of high calorific value. Although unproductive for the first five years of its life, for the rest of its life-span of approximately 80 years it rewards careful husbandry. In addition to that the palm tree produces offshoots between the third and fifteenth year of its life. The more care over fertilization, cleaning, irrigation, pollination etc. is taken, the more productive it is (see Chapter 2.4).

Shortage of water or lack of attention will not do permanent damage to the palm trees, although these things will affect production: this means that the investment in the trees is not lost through adverse conditions or temporary neglect.

The date palm is also less affected than most other plants by diseases prevalent in the area and can stand poor water and poor soil conditions. All in all the date palm is a very dependable source of income even though price fluctuations are normal. Moreover, the market has now been assured of a high guaranteed price level through government intervention.

However, the survival of the date palm has had consequences which were not foreseen in planning the HIDA project and which have affected the objective of increasing general productivity and efficiency. The land use data shows that the main obstacles to the achievement of this objective include (a) the survival of traditional land use patterns, characterised by the dominance of the date palm, and (b) the survival of the traditional pattern of land holdings characterised by the relatively small size of farmers' holdings, at least by modern standards and by the fragmentation of holdings into several plots.

In order to illustrate the situation the data presented in one of HIDA's Land Use Survey Reports are analysed. As we see from Table 6.14, the total sample controlled area served by the 4 particular sub-principal irrigation canals was 7,221,441 sq. metres but of this 2,468,988 sq.metres were uncultivated i.e. 34.2 per cent. Secondly, it will be noted that of the 6 sub-sections of land, three have the whole of their cultivated area under fruit trees, implying that any other crops grown are grown as under-crops. Table 6.15 gives a breakdown of the area under what are classified as field crops and here it is notable that about 85% of the area is devoted to alfalfa, a crop which can easily be grown as an undercrop to trees. Rice

Table 6.14

Land Use in sample area

No.of Sub-District	Sub-principal irrigation canals	Distribution of controlled area			Area of field crops	Area of vegetables	Area cultivated with Fruit trees
		Total sq.m.	Cultivated area sq.m.	Uncultivated area sq.m.	sq.m.	sq.m	sq.m
1	F12 af	1,109,062	710,442	398,620	211,318	27,997	710,442
2	F1.2 ag	2,531,719	1,538,155	993,564	390,695	20,449	1,538,155
3	F1.2 ah	1,503,733	1,026,551	477,182	203,189	6,459	1,016,581
4	F1.2 an	225,173	147,208	77,965	72,995	-	147,208
5	F1.3 aa	1,235,904	853,868	382,036	96,580	2,755	852,068
6	F1.3 ab	615,850	476,229	139,621	83,587	4,400	464,133
	Total	7,221,441	4,752,453	2,468,988	1,058,364	62,060	4,728,587

Table 6.15

Sample area - Main Crops by area

No.of Sub-District	Sub-principal irrigation canal	Field crops Area sq.m.						Total
		Alfalfa sq.m.	Rice sq.m.	Onion sq.m.	Wheat sq.m.	Sesame sq.m.	Maize sq.m.	
1	Fl.2 af	131,098	79,970	-	-	250	-	211,318
2	Fl.2 ag	324,240	40,045	22,410	-	3,000	1,000	390,695
3	Fl.2 ah	198,579	-	4,610	-	-	-	203,189
4	Fl.2 an	59,283	-	13,712	-	-	-	72,995
5	Fl.3 aa	91,532	-	5,048	-	-	-	96,580
6	Fl.3 ab	71,491	-	3,500	8,596	-	-	83,587
		876,223	120,015	49,280	8,596	3,250	1,000	1,058,364

is the second most important crop by area but in this sample is confined to two sub-districts. Onions, the third crop, are grown almost everywhere.

Table 6.15 also indicates the statistical difficulties which arise in measuring land use in al-Hassa. It is clear from a comparison of Tables 6.14 and 6.15 that whilst in sub-district 1, the whole of the cultivated area is stated to be under fruit trees (of which about 73% are date palms - see Table 6.15), 79,970 sq. metres are also given over to rice which is not grown under date palms. The reason for this discrepancy appears to arise from a recording of those plots which have date palms grown on their borders (dwahi), but with other crops in the central parts of the plots, as being completely given over to dates.

Table 6.16 shows the considerable variety of vegetables grown and many of these are now grown mainly for sale, not for domestic consumption, e.g. honeydew melons and cucumbers. Potatoes are an example of an introduced crop but all the vegetables noted here represent a development of market-orientated "truck-farming", even before the HIDA project started. Table 6.17, fruit-trees ,indicate a similar trend even though it is obscured by the dominance of date palms. The pomegranate has been particularly strongly encouraged by HIDA agencies.

It can be seen from Table 6.18 that 40% of the holders in district F.1.2. of hold less than 10% of the land, having less than 4 donums each, while over 81% of holders hold only 40% of the land, with less than one hectare each.

Table 6.16

Sample area - Main vegetables by type

No.of Sub-District	Sub-principal irrigation canal	Area and Type of cultivated vegetables sq.m.												Total
		Okra	Honey dew	Egg-plant	Toma-toe	Turn-ip	Cabb-age	Cucu-mber	Gar-lic	Beans	Pump-kin	Lett-uce & car-rot	Pota-toes	
1	Fl.2 af	26,997	-	-	-	-	-	-	-	1,000	-	-	-	27,997
2	Fl.2 ag	9,149	-	4,250	300	2,350	2,230	-	1,250	-	-	750	170	20,449
3	Fl.2 ah	-	5,560	-	899	-	-	-	-	-	-	-	-	6,459
4	Fl.2 an	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Fl.2 aa	-	-	955	-	-	-	1,800	-	-	-	-	-	2,755
6	Fl.3 ab	-	-	-	3,440	-	-	-	200	-	760	-	-	4,400
	Total	36,146	5,560	5,205	4,639	2,350	2,230	1,800	1,450	1,000	760	750	170	62,060

Table 6.17

Sample area - Tree Crops by type

No.of Sub-District	Sub-principal irrigation canal	Number of fruit trees*										
		Date palm-trees	Pome-granate	Citrus	Peach	Figs	Grapes	Mul-berry	Other fruit trees	Woody trees	Total No. of trees except date palmtrees	Total
1	Fl.2 af	18,940	3,548	-	1,545	770	778	92	293	-	7,026	25,966
2	Fl.2 ag	41,758	15,688	2,263	4,425	2,355	2,542	546	1,226	488	29,533	71,291
3	Fl.2 ah	29,651	13,248	2,548	7,560	1,173	1,833	275	-	214	26,851	56,502
4	Fl.2 an	4,324	1,856	132	1,171	109	624	88	-	201	4,181	8,505
5	Fl.2 aa	29,505	11,228	4,114	4,709	1,557	1,226	574	878	71	24,375	53,862
6	Fl.3 ab	15,348	4,751	2,608	2,108	691	581	334	436	3	11,512	22,860

* Productive and not productive fruit trees

Similarly, in district F.1.2 ag (see Table 6.19) over 51% of holders own only 12% of the land with less than 4 donums each, while 79% own less than one hectare each, totalling 40% between them. Tables 6.20 to 6.23 show a similar distribution of holdings in four other irrigation districts.

Table 6.24 shows the accumulative frequency of holders and holdings for the six sub-principal irrigation canal districts detailed in Tables 6.18 to 6.23 from which it can be seen that in general one per cent of holders own about 10% of the total area, while 60% of holders own less than 20% of the area, with less than 4 donums each.

Figure 6.4 gives an example of the fragmentation of holdings, their small size and irregular shape. Each number denotes an individual holding. It can be seen that some holdings, e.g. number 2 and 4, have been split by the project design, which has thus worsened the fragmentation of holdings. Also, for instance, owner number 16 has three separated plots in district F.12 a.b.9, two of about half a donum, and the third of 1.7 donums, as well as a fourth plot of just over half a donum in district F.12 a.b-8. For further details of the variation in the size of holdings, see Table 6.25, which shows a range of sizes in irrigation district F.12 a.b-8 and F.12 a.b-9 from 15 donums to less than half a donum.

A further instance is mentioned by Professor Bowen-Jones (1979): the section watered by canals F.12 a.b-6 and F.12 a.b-7, a total area of 261,681 sq.m. is divided into 62 irregular parcels ranging from 130 sq.m. to 22,155 sq.m. in size.

Fig. 6·4 Example of Holding Fragmention (see Table 6·25)

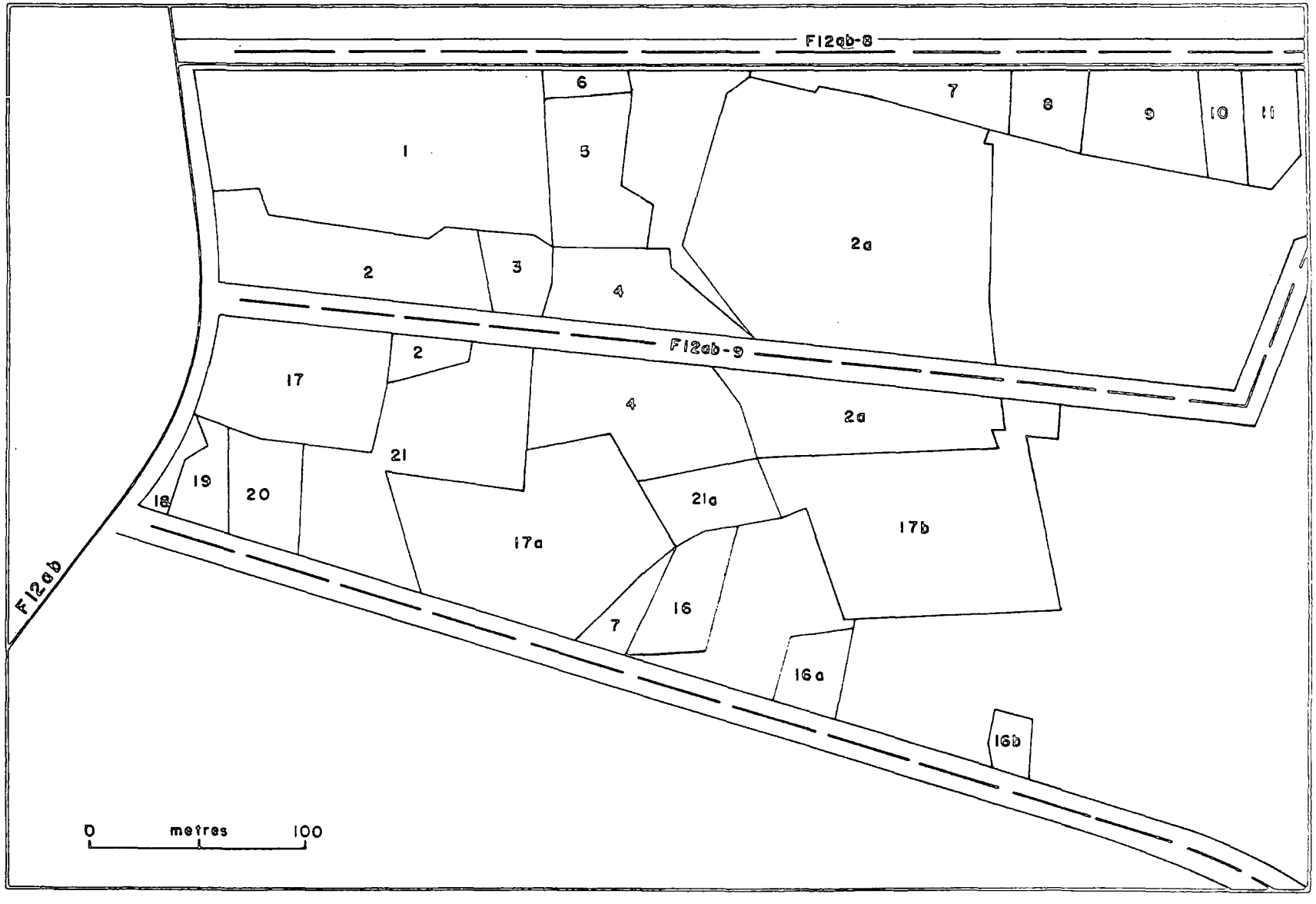


Table 6.18 Accumulative frequency distribution of the holders and holdings for the sub-principal irrigation canal (F.1.2 af)

No.	Group	No. of holders	Holding sq.m.	Accumulative Frequency Curve		% Curve of Accumulative Frequency	
				holders	holdings	holders	holdings
1	1000	7	3587	7	3587	8.05	0.49
2	2000	12	17975	19	21562	21.84	2.94
3	3000	9	22926	28	44488	32.18	6.06
4	4000	7	25211	35	69699	40.23	9.50
5	5000	7	30755	42	100454	48.28	13.69
6	6000	7	37739	49	138193	56.32	18.84
7	7000	5	32263	54	170456	62.07	23.24
8	8000	6	45083	60	215539	68.97	29.38
9	9000	4	34263	64	249802	73.56	35.16
10	10000	4	38328	68	288130	31.16	40.56
11	15000	10	119271	78	407401	89.66	57.34
12	20000	6	103843	84	511244	96.55	71.96
13	25000	2	48173	86	559417	99.85	78.74
14	30000	-	-	86	559417	99.85	78.74
15	35000	-	-	86	559417	99.85	78.74
16	35000	1	151025	87	710442	100.00	100.00

Table 6.19

Accumulative frequency distribution of the holders and holdings for the sub-principal irrigation canal (F.1.2 ag)

No.	Group	No. of holders	Holding sq.m.	Accumulative Frequency Curve		% Curve of Accumulative Frequency	
				holders	holdings	holders	holdings
1	1000	35	19367	35	19367	15.91	1.26
2	2000	40	58185	75	77552	34.09	5.04
3	3000	22	52657	97	130209	44.09	8.47
4	4000	16	55270	113	185479	51.36	12.06
5	5000	9	40715	122	226194	55.45	14.71
6	6000	13	71566	135	297760	61.36	19.36
7	7000	10	64354	145	362114	65.91	23.54
8	8000	9	67305	154	429419	70.00	27.92
9	9000	10	83354	164	512773	74.45	33.34
10	10000	11	103250	175	616023	79.45	40.05
11	15000	20	239143	195	855166	88.64	55.60
12	20000	6	96632	201	951798	91.36	61.88
13	25000	11	246710	212	1198508	96.36	77.92
14	30000	4	113747	216	1312255	98.18	85.31
15	35000	2	65873	218	1378128	99.09	99.06
16	35000	2	160027	220	1538155	100.00	100.00

Table 6.20 Accumulative frequency distribution of the holders and holdings for the sub-principal irrigation canal (F.1.2 ah)

No.	Group	No.of holders	Holding sq.m.	Accumulative Frequency Curve		%Curve of Accumulative Frequency	
				holders	holdings	holders	holdings
1	<1000	43	21666	43	21666	22.75	2.11
2	<2000	29	44213	72	65879	38.10	6.42
3	<3000	26	65155	98	131034	51.85	12.76
4	<4000	15	50559	113	181593	59.79	17.69
5	<5000	11	48557	124	230150	65.61	22.42
6	<6000	15	81465	139	311615	73.54	30.36
7	<7000	8	51304	147	362919	77.78	35.35
8	<8000	3	22455	150	385374	79.37	37.54
9	<9000	7	58824	157	441198	83.07	42.98
10	<10000	4	37490	161	481688	85.19	46.92
11	<15000	11	130794	172	612482	91.01	59.66
12	<20000	7	120756	179	733238	94.71	71.43
13	<25000	5	108153	184	841391	97.35	81.96
14	<30000	1	28320	185	869711	97.88	84.72
15	<35000	2	65100	187	934811	98.94	91.06
16	35000>	2	91740	189	1026551	100.00	100.00

Table No. 6.21

Accumulative frequency distribution of the holders and holdings for the sub-principal irrigation canal (F.1.2 an)

No.	Group	No. of holders	Holding sq.m.	Accumulati Frequency Curve		% Curve of Accumulative Frequency	
				holders	holdings	holders	holdings
1	1000	32	17536	32	17536	43.84	11.91
2	2000	17	24049	49	41585	67.12	28.25
3	3000	9	21450	58	63035 .	79.45	42.82
4	4000	5	17360	63	80395	86.30	54.61
5	5000	3	13200	66	93595	90.41	63.58
6	6000	2	10130	68	103725	93.15	70.46
7	7000	1	6730	69	110455	94.52	70.03
8	8000	-	-	-	-	-	-
9	9000	2	16190	71	126645	97.26	86.03
10	10000	-	20563	73	147208	100.00	100.00
11	15000	2	147210	73	147208	-	-

Table 6.22 Accumulative frequency distribution of the holders and holdings for the sub-principal irrigation canal (F.1.3 aa)

No.	Group	No.of holders	Holding sq.m.	Accumulative Frequency Curve		% Curve of Accumulative Frequency	
				holders	holdings	holders	holdings
1	1000	40	24776	40	24776	19.07	2.90
2	2000	44	65303	84	90079	41.38	10.55
3	3000	23	55870	107	145949	52.71	17.09
4	4000	20	71248	127	217197	62.56	25.44
5	5000	20	89712	147	306909	72.41	35.94
6	6000	17	95065	164	401974	80.79	47.08
7	7000	8	51493	172	453467	84.73	53.11
8	8000	8	60546	180	514013	88.67	60.20
9	9000	3	25660	183	539673	90.15	63.20
10	10000	1	9330	184	549003	90.64	64.30
11	15000	12	140611	196	689614	96.55	80.76
12	20000	3	54430	199	744044	98.03	87.14
13	25000	1	24531	200	768375	98.52	90.01
14	30000	2	55183	202	823758	99.51	96.47
15	35000	1	30110	203	853868	100.00	100.00
16	35000	-	-	-	-	-	-

Table 6.23 Accumulative frequency distribution of the holders and holdings for the sub-principal irrigation canal (F.1.3 ab)

No.	Group	No. of holders	Holding sq.m.	Accumulative Frequency Curve		% Curve of Accumulative Frequency	
				holders	holdings	holders	holdings
1	1000	26	14380	26	14380	22.41	3.02
2	2000	39	55347	65	69727	56.03	14.64
3	3000	19	26293	84	116020	72.41	24.36
4	4000	6	20620	90	136640	77.59	28.69
5	5000	4	18338	94	154978	81.03	32.54
6	6000	2	10998	96	165976	82.76	34.85
7	7000	4	25246	100	191222	86.21	40.15
8	8000	3	21677	103	212899	88.79	44.71
9	9000	-	-	103	212899	88.79	44.71
10	10000	2	18944	105	231843	90.52	48.68
11	15000	3	38882	108	270725	93.10	56.85
12	20000	1	19020	109	289745	93.97	60.84
13	25000	3	69650	112	359395	96.55	75.47
14	30000	3	77374	115	436769	99.14	91.71
15	35000	-	-	115	436769	99.14	91.71
16	35000	1	39460	116	476229	100.00	100.00

Table 6.24 Accumulative frequency distribution of the holders and holdings for the six sub-principal irrigation canals

No.	Group	No. of holders	Holding sq.m.	Accumulative Frequency Curve		% Curve of Accumulative Frequency	
				holders	holdings	holders	holdings
1	1000	183	101312	183	101312	29.61	2.13
2	2000	181	265072	364	366384	40.99	7.71
3	3000	108	264351	472	630735	53.15	13.27
4	4000	69	240268	541	871003	60.92	18.33
5	5000	54	241277	595	1112280	67.00	23.40
6	6000	56	306963	651	1419243	73.31	29.86
7	7000	36	231390	687	1650633	77.36	34.73
8	8000	29	217066	716	1867699	80.63	39.30
9	9000	26	218291	742	2085990	83.56	43.89
10	10000	22	207342	764	2293332	86.04	48.26
11	15000	58	689264	822	2982596	92.57	62.76
12	20000	23	394681	845	3377277	95.16	71.06
13	25000	22	497217	867	3874494	97.64	81.53
14	30000	10	274624	877	4149118	98.76	87.03
15	35000	5	161083	882	4310201	99.32	90.69
16	35000	6	442252	888	4752453	100.00	100.00

Table 6.25 Holding Distribution and size in canal districts F.12 ab-8,9.

Holder Number	Area in sq.m.		Holder Number	Area in sq.m.	
	F.12.ab-8	F.12 ab-9		F,k2.ab-8	F.12.ab-9
1	11340		18		460
2	4360	600	19		1170
2a	15200	3940	20		1709
3	1080	-	21		6570
4	2500	4500	21a		1570
5	2880		22		520
6	520		23		1240
7	1860	755	24		920
8	1240		25		1000
9	2480		26		531
10	1000		27		550
10a	4690		28		1020
11	1300		29		480
12	1400		30		2580
12a	1230		31		4000
13	2140		32		500
14	1600				
15	250				
16	640	1710			
16a		520			
16b		510			
17	4470				
17a	8060				
17b	9050				

Source: HIDA (1978), Survey and measurement of F.12.ab-8,9 Sheet No.5.

In these conditions the question arises whether it is possible to achieve efficient technical production and satisfactory total incomes for the farmers on holdings so small. As Professor Bowen-Jones (1979) pointed out, "A situation of this kind tends to be self-perpetuating; the difficulty of obtaining adequate returns today from farming such plots is such that there is little incentive for the farmer to improve water use efficiency or land utilisation and the task of ensuring appropriate water distribution by HIDA becomes well-nigh impossible."

C. Modern Trends

6.9

So far, under the heading of changes in agriculture, analysis has shown that as far as conventional farming is concerned (i.e. the cultivation of irrigated plots of land), the land use evidence does not point to any radical change. However, as in other agricultural regions, al-Hassa has also experienced some technological innovation in the field of "controlled environment" production of types normally classed in Saudi Arabia as "agricultural projects". Such projects normally have the following characteristics:

(a) They are normally undertaken by commercially motivated investors rather than by tradition based cultivators.

(b) They are highly specialised production units which rely on heavy investments of capital spent largely on imported technology and inputs.

(c) The capital investment is usually mainly obtained from S.A.A.B., through interest free loans, and many of the inputs of equipment, machinery and other items are subsidised through M.A.W. These incentive programmes shown in Table 6.1 have grown rapidly since 1978/79.

(d) They rely heavily on skilled expatriate management and technical manpower rather than on conventional field labourers.

(e) The market in some cases is guaranteed by the purchasing agencies of the Grain Silos and Feed Mills Organization (GSFMO) and M.A.W.

The best known large projects in Saudi Arabia are the large scale wheat projects (Al Besher 1983) but the group also includes dairy and meat production units, poultry and egg units, greenhouse vegetable producing units, and most recently date production. In al-Hassa, new projects of this kind have been mainly concerned with poultry, egg, vegetable and date production, of which only the last named benefits from high support prices. The reasons for this selectiveness clearly follow from the facts of physical resource endowment established in Chapter 3. Unlike, for example Hail and Qassim, al-Hassa has no great areas of virgin land associated with previously unutilised groundwater. As M.A.W. figures for public land distributed between 1966 and 1982 show, there were only 195 recipients in al-Hassa compared with 2,267 in Qassim and 1,473 in Hail. Land distributed in al-Hassa has been all in relatively small plots of up to 25 donum and almost entirely outside the oasis. Within the irrigation and drainage project area, water deficiency has made it impossible even to develop the whole planned area. In al-Hassa therefore new investment projects have almost all had to be fitted into the existing land holding structure and have not been able to call on large new water resources.

In the present highly fluid situation in which there is a considerable time-lag between the approval by M.A.W. of new projects and their implementation, and in which many new projects are only now entering a production stage all that can be done here is to illustrate by samples the range and scale of modern agricultural innovation in al-Hassa.

6.10 Samples of Modern Projects Mid 1984

a) Automatically operated weatherproof greenhouses

Apart from ARAMCO units which are partly experimental and partly for company consumption, by June 1984 there were 5 projects of this kind, two already in operation and three expected to operate by the end of 1984. One typical unit has an area of 50,000 sq. m. of which 30,000 are already utilised. With computerised artificial environment controls, this project cost S.R. 12 million, lent by S.A.A.B. Production of a large range of vegetables is about 1,000 tons round-the-year, through drip and mist irrigation.

b) Non-automatic plastic greenhouses with drip irrigation

A typical unit utilises 10,000 m^2 in 20 greenhouses each 10 x 50 m. Such units are only partially isolated from the environment being open to north and south. The objectives are to achieve higher productivity of winter vegetables by reducing the risks of low winter minimum temperatures (see Chapter 3.3), optimising solar radiation, and reducing water demand (usually from privately owned wells). A unit of this kind costs S.R. 3-4 million.

c) Non-automatic plastic greenhouses with basin irrigation

On some existing plots higher yields are obtained than on open fields by installing fairly simple plastic covered greenhouses which give some shelter from adverse weather. Vegetables are grown throughout the year.

d) Improved date production project

Following the introduction in 1982 of official support prices for dates and the work of the development agencies in

improving local techniques of date-palm growing, a modern date-farm is now being established on the eastern fringe of the oasis. On an area of new land measuring 2 x 2 km., 20,000 palms of the Khalas variety have been planted at 10 m. intervals. The remainder of the area is being prepared for wheat production using centre pivot sprinkler systems. In each interval between the date-palms in north-south aligned rows a lemon tree is being planted, the date-palms being used as windbreaks. The project pumps its water from its own wells, outside the H.I.D.A. scheme, through a pressurised buried network of distribution pipes to each individual palm tree basin. No drainage system is being installed, it being calculated that with the low total rate of water application ensured by the controlled trickle system, natural drainage will be sufficient. Consideration is being given to the mechanization of fertilising, cleaning and harvesting of the date-palms. No figures of costs are available but the land has been granted by M.A.W. which also subsidises planting, pumps and other equipment and a S.A.A.B. loan of several million S.R. has been made. Of course, a single project of this type has to be set in the context of oasis date production as a whole.

In 1983 the General Directorate of the M.A.W. carried out a survey to establish total date production in the oasis. They counted 2,278,247 date palms covering an area of 69,037.8 donums. Assuming a yield of 60 kg. per palm tree, this gives a total annual date production of 136,694 tonnes. Since there remain a significant number of neglected and unproductive trees the actual production was likely to lie

between this last figure and the 69,000 tonnes suggested by zakat returns - see Table 6.11.

If we assumed actual 1983 production to have been of the order of 100,000 tons then this single new date production project with 20,000 trees could add an extra 10 to 15 per cent to production capacity.

e) Egg and Poultry Production

One such unit was established within the oasis on an old date-garden in 1981, self-financed by an existing landowner and businessman. This original unit consisted of 12 houses holding a minimum of 120,000 laying hens and had a 300,000 egg production capacity a day. A second unit with a daily egg production capacity of 500,000 eggs a day and several million broilers a year is now being built with S.A.A.B. finance. Consideration is also being given to establishing a chick-hatchery to replace the present daily import by air of young chicks from Holland, also to the building of a feed mill and factory to make egg cartons. A British manager oversees seven senior staff (including 2 veterinarians), all expatriate, and 42 labourers (including 4 Saudis).

Not all poultry and egg production units are of this scale but as Table 6.26 shows the average size of unit has increased considerably during the period 1977-1984.

Thirty years ago there were no farms specialising in poultry meat and egg production; all households had a few hens and produced eggs for their own needs.Table 6.26

Table 6.26 Poultry farms in al-Hassa Oasis and Meat and Egg Production

Year	Total number of poultry farms		Total production of eggs	Total number of laying chickens	Total numbers of chickens for meat
	meat producing	egg producing			
1395	-	-	15,267,630	299,700	647,525
1396	-	-	21,564,780	558,934	865,160
1397	85	55	12,704,430	233,760	1,504,590
1398	60	46	47,231,262	414,910	2,121,910
1399	63	50	75,416,508	612,390	1,669,662
1400	63	50	80,576,434	440,662	1,433,969
1401	64	48	82,140,116	747,737	1,871,925
1402	65	50	103,493,911	630,725	3,004,475
1403	65	50	102,781,800	461,776	2,373,801

Source: General Directorate, Hofuf, unpublished Record (personal communication with Hofuf Branch June 1984).

shows the importance of the new poultry farms in al-Hassa oasis today and provides an example of the new type of agricultural activities being developed in the oasis.

6.11 The Implications of Modern Projects for al-Hassa

The sample projects summarily described above illustrate one particular apparent conflict of approaches to agriculture in al-Hassa in recent years. This is a conflict between planning emphasis on agricultural production and emphasis on rural development. This "apparent conflict of interests between production economics and welfare economic" (Bowen-Jones and Dutton 1984) is of course not only to be found in al-Hassa. The characteristics of the two competing approaches are however particularly significant in areas such as al-Hassa where large, long-established traditional farming communities are confronted with very rapid social, economic and technological change.

As noted in Chapter 2, traditional oasis irrigation farming, dominated by subsistence needs, over centuries strongly influenced the whole social and economic life of the local rural community. The productive base was one of small holdings worked by a heavy use of manual labour, using simple technologies. Incomes and socio-economic opportunities were necessarily restricted. In Chapter 4 the new non-rural and non-local opportunities created, nationally and regionally, by the explosion of Saudi Arabian oil wealth were outlined. It is clear that from the late 1940's onward farming in al-Hassa was in danger of becoming not the centre of all activity but a residual sector.

The irrigation and drainage project, technically implemented in the 1960's. (see Chapter 5), was seen mainly as a means of increasing farming production and productivity through the better technical management of land and water resources. It was also therefore found to have some beneficial effects on general living standards in what was still mainly a rural area. However, the irrigation and drainage project was not designed as part of a comprehensive development programme. Other aspects of development planning, in fields such as education, housing, health, industry and most communications, were dealt with in individual Ministry sectors. It was assumed that, through H.I.D.A. agencies, non-radical, evolutionary improvements in farming the established holdings would be sufficient to revive oasis agriculture and therefore rural life. In fact, as noted earlier in this chapter, land use evidence shows that whilst some productive response took place during the early and mid 1970's, there was no real revolution in established farming, a point developed further in the conclusion to this chapter.

The major change in al-Hassa agriculture is only now under way and only really involves a few tens of production units in contrast to the hundreds of farmholdings. As illustrated in Chapter 6.10, these new production units bear very little evolutionary relationship either to pre-existing traditional farms or to the improved H.I.D.A. controlled irrigated holdings. They are essentially agri-businesses, engaged in intensive and specialised production

and heavily dependent on the import of almost all inputs from managerial and technically skilled manpower to machinery, livestock and plant varieties. In the al-Hassa area few of them even utilise the H.I.D.A. controlled water and drainage systems. They are also heavily dependent on loans, grants, subsidies and in some cases support prices, supplied by national government agencies and all ultimately flowing from national oil revenue.

H.I.D.A. and H.A.R.C., as described in Chapter 5, continue to assist the numerically dominant small farmers to improve productivity in, for example, vegetable and fruit growing. But it is also clear that the same total level of production could be obtained by one-tenth of the number of producers if these were of the new specialised project types. The question which then arises is whether conventional small farms can compete effectively with the new production units.

Al-Besher (1984) has shown that in a sample area of 437 donums 74 per cent of the farms and 35 per cent of the area in 1982 was of, and in holdings of, up to 10 donums in size and 85 per cent and 48 per cent respectively of up to 20 donums. Even if these achieved the per donum yields of vegetables or fodder which the H.A.R.C. research groups have shown are theoretically possible, both production per farm and income per farmer would be insignificant compared with those obtainable from the new production units. Similarly, if more than ten new date production units of the type described above came into operation, the economic

viability of the older date-gardens would become even more dubious. As far as eggs and poultry are concerned there is the possibility of over-production even by all the existing and planned national projects, leaving no room for the small scale commercial producer.

In al-Hassa therefore it is possible that the 1980's could see those many conventional small farm enterprises, which in the late 1970's were becoming more productive and market-orientated losing in competition with a relatively few large specialised production units. The effect of this on the oasis rural community which is left could be as great as the impact of oil economy in the 1950's and 1960's. The effects on water resources if these new production units continue to grow outside the H.I.D.A. controlled extraction, distribution and drainage system could be equally great.

6.12 Conclusion

The main points to be made in conclusion can be grouped under two separate headings: the impact of development on the farmers of al-Hassa, and the impact of development on the land and water resources of al-Hassa oasis. There remains still a very considerable problem of shortage of data on which to base any analysis of changes and trends.

As noted in Chapter 4 there is no accurate time data on the population of al-Hassa or on occupation and incomes. Before the Wakuti Surveys were made in the 1960's there was practically no recorded statistical

information on farms or agricultural production and even these surveys could be no more than samples. The farm information collected by H.I.D.A. during the late 1970's was almost entirely concerned with land use. There are no recorded data on any of the elements which affect marketing in al-Hassa - prices, volumes, seasonality etc. The individual research worker cannot hope to survey either the whole area of the oasis or the whole range of farm types and enterprises. Further, changes of all kinds, economic, social and technical, have happened very rapidly during the last thirty years and are still going on. Any evolution of progress in agriculture therefore must be tentative, tending towards the subjective, and chiefly indicative of what the author regards as the most significant forces and trends.

A. The Impact of Development on the Farmers

1. The term farmer in al-Hassa itself does not mean what it did before about 1950. Until then and for centuries before, the farmers were the landholders and their families who cultivated the land themselves with the help of some local hired labour. The whole community numbering tens of thousands, including the non-farmers of the towns and larger villages, depended for its existence on traditional agricultural production systems. By the mid 1960's, even during the commissioning of the Hassa Irrigation and Drainage, the position was already changing rapidly and by the 1980's has been transformed out of recognition. Today the landholder is still the decision maker but sample survey

by the author confirm the findings of Al-Besher (1983) that family farm labour is insignificant on the 25 to 30 per cent of holdings and 65 to 70 per cent of the area in holdings of more than 10 donums. Even on the smaller farms the use of hired labour proportional to the use of family labour is in the ratio of about 2:3. Moreover, most of the non-family labour is non-Saudi.

2. This situation has arisen because of the changes described in Chapter 4. Only very rarely and only with some small farmers does family income now depend on agricultural production. The great range of other employment and wealth-making opportunities, particularly for younger people, makes agricultural work economically and socially unattractive. The landholder therefore is now predominantly either a manager, overseeing the work of labourers, or a landlord, letting his land to tenants (often non-Saudi), or a business man employing a manager to run the enterprise.

3. During the last thirty years there have been several opposing forces affecting the attitude of farmers to agriculture. First, in the 1950's, 1960's and 1970's the expansion of education, improvements in communications and heavy governmental expenditure in other sectors resulted in a drift of people from the land. Secondly, in the 1950's, 1960's and up to the mid 1970's, the great opportunities presented by the growing demand for foodstuffs by the expanding and wealthy urban populations were not sufficient to motivate strongly the interest on investment of many landholders in commercial agriculture. There was, thirdly, the paradox that for social and cultural reasons landowners

only very rarely were prepared to sell their land even though that land had become of marginal economic value to them compared with their other business activities. Lastly, since the late 1970's and as the result of government provision of financial assistance (described earlier), a small but significant number of landholders and others have realised the financial profitability of using this assistance to establish totally new types of agricultural enterprise.

4. This last trend which is reversing the previous decline in agriculture has been assisted by the same factors which in an earlier situation attracted interest away from agriculture, i.e. education, improved communications and urbanisation. Urbanisation continues to provide a growing market for a greater range of agricultural products. Improved communications have made the long and medium distance transport of produce to market easier and relatively cheaper. Education has now made it easier for those who wish to invest (and use government finance) in agriculture to use the technical and advisory services and facilities available through H.I.D.A., H.A.R.C., M.A.W., S.A.A.B. and King Faisal University.

5. It is difficult to distinguish the beneficial effects on al-Hassa agricultural producers which can now be seen as between those produced by the H.I.D.A. project and those produced by the national economic boom after 1973 (see Chapter 4) and government financial incentives.

There is hardly any quantifiable evidence but the

situation appears to be as follows. First, without the H.I.D.A. project physical conditions in the oasis would have deteriorated very seriously and farming almost crippled (see B. below). Secondly, in the H.I.D.A. controlled area many conventional farmers have been given the technical assistance to enable them at least to take advantage of new market opportunities, particularly in vegetable production. For these reasons many oasis farmers express their appreciation for the effect the H.I.D.A. project has had in raising their incomes and living standards (Al-Angary 1982).

On the other hand, it is equally clear that in some important sectors it is other factors which have been responsible for a revival in agricultural production. Conventional field production of vegetables, for instance, responded to market demand in the late 1970's when the level of demand and prices increased rapidly. Date palms remained often neglected until the government's price support and purchasing policy was announced in 1982. The new egg and poultry projects and greenhouse units are viable mainly because of heavy government subsidising of inputs and interest-free S.A.A.B. loans.

6. Al-Hassa farmers are therefore today in much the same situation as many other communities, agricultural and others, in Saudi Arabia. A great deal seems to depend on the level of government expenditure, not only on agriculture, but on all other sectors, and that ultimately depends at the moment on the level of national oil income. Although oil income in turn depends on world demand, Saudi Arabia

in the medium to long term, i.e. for between 100 and 150 years, can expect that level not to drop from below the present.

B. The Impact of Development on Land and Water Resources

1. As noted in Section 3.5 the al-Hassa Oasis is blessed with the availability of groundwater of a quality well suited to irrigation. However, natural soil drainage deteriorated as the result of centuries of irrigation of loamy sands and sandy loams underlain by impermeable layers of tertiary marl and quaternary silty-clayey sediments (see Chapter3.1). High evapotranspiration rates simultaneously encouraged the heavy use of water and encouraged the concentration of soil and water salts in the upper soil horizons. The result of all this by the 1950's was severe deterioration in soil conditions and the shrinking of the irrigable area.

2. This process of deterioration was reversed by the installation in the 1960's of a technically modern, integrated distribution and drainage system, as described in Chapter 5. Since that time the utilisable land resources of the al-Hassa have been stabilized in area and improved in quality.

3. However, the plan for the irrigation and drainage project had projected an expansion of the irrigated area to about 20,000 ha. In fact the area under year-round cultivation at present is 8,000 ha. This shortfall in execution is mainly the result of the level of permanent groundwater availability falling below the 220 million m annually expected from surveys made in the early 1960's. The reasons for this were examined in Chapter 3.

4. Another less direct reason for the lower than expected rate of the expansion of the farmed area is to be found in the lower than hoped for aggregate efficiency of water use. Several factors are involved here.

5. First, the irrigation and drainage project was planned to use gravity-flow irrigation rather than pumps and pressurised systems. This was logical given the physical conditions described in Chapter 3 and the need for imposing a coordinated central control system to reverse the process of ecological deterioration. The question that must be asked is whether the final choice of system was the most suitable.

One possibility that was considered was the use of a reuse (mixed) system in which irrigation and drainage water is contained in one canal network, i.e. involving the multiple use of water. However, since a main priority of the project was the leaching of the soil to reduce salinity, it was essential that fresh water be supplied to all areas, and the salty drainage water removed separately so as not to contaminate the fresh supply.

A system of bringing water quickly by a few main and sub-main canals to individual areas was relatively cheap to construct and ensured that a uniform and controllable distribution was hypothetically possible, with the least loss of water. The loss of water was further reduced by using concrete lining in the construction, particularly necessary in an area with such sandy soils. The concrete linings were prefabricated in a central factory to avoid the difficulties

caused by the climate of casting concrete on site.

It was decided to keep the whole system open and on the surface in order to make damage more readily observable, and repairable. It was also thought that the better and easier cultivation possible with buried, low-pressure pipes with stand-pipes at intervals (as is common in the U.S.A) did not justify the twice as high cost of construction, maintenance, and possible loss of water before leaks and other damages were identified, inspite of the fact that the open system is more vulnerable to damage from sand impurities and accident.

The possibility of a sprinkler system was also rejected because its advantages of more precise application and higher water-use efficiency were outweighed by the high cost of operation due to the fact that the total water supply would have to have been pumped, and the high cost (if not impracticability) of providing the close wind protection for each plot that would have been required.

Drip irrigation also could not be used in al-Hassa oasis because of the tendency of this method to build up salinity in the soil unless great care is taken.

All these alternatives required greater technical skill on the part of operators, and the farmers which was not available.

Consequently it can be concluded that the system installed was the most suitable for the physical and ecological conditions, technically and economically.

However, it was also decided, for socio-political reasons not to attempt to change the existing layout pattern of plots and holdings. The result has been, as shown in Chapter 6, that the old pattern of fragmented and irregularly sized and shaped plots remain and it is absolutely impossible to achieve the efficiency levels of water distribution and use hypothetically obtainable in an integrated system.

6. Secondly, as all the land use evidence indicates (Chapter 2 and 6) the crop range is still overwhelmingly dominated by one tree crop - the date palm. Given the fact that most plots described above have at least part of their area given over to dates it again becomes virtually impossible to combine water distribution efficiency with the different volume and time needs of inter-singled tree crops, short-term perennials such as alfalfa and seasonal crops such as vegetables,

7. Thirdly, the need for conservation of water is perhaps less strongly felt by farmers who receive allocations from a centralised canal system than by those many farmers who rely on their own pumped wells.

The total result is, as noted in Chapter 5, that whilst the irrigable land resources are at least 50 per cent larger today than they were in the 1950's, they have not been expanded to the planned total, largely because of water problems.

8. Considerable success has been achieved by the Sand Stabilization Programme in arresting the loss of

cultivable land to moving sand (see Chapter 3.2). As noted earlier, this is a battle that has to be fought all the time and can never finally be won.

9. In terms therefore of securing, for the future, the potentially highly productive land resources of al-Hassa the Irrigation and Drainage Project has been extremely successful. In terms of water resource conservation and use the Project has probably been as successful as could reasonably be expected. However, these resources are only valuable if they are used well by farmers and the mixed effects on farmers' attitudes to land resources of recent socio-economic changes have been noted in A. above.

10. In order for the high capital expenditure on the irrigation and drainage project to have obtained theoretical maximum economic returns, at the same time to have achieved the theoretically most efficient and stable use of water and land resources, other requirements would have had to be met and many of these have been impractical to achieve.

First, the acceptance by M.A.W. of the perpetuation of the pre-project spatial pattern of holdings and plots, retained a great majority of holdings which were not only too small to yield satisfactory incomes but are also too small and fragmented to be technically efficient. Small size and fragmentation, together with the project's use of a non-pressurised water distribution system has made it virtually impossible to use spray, trickle or drip irrigation systems on H.I.D.A. controlled areas, even though these techniques reduce water loss and use and are appropriate for

all the major crops grown in al-Hassa. Such techniques can now only be used by landholders who pump their own wells, or on a small scale by farmers who are both prepared and allowed to instal their own high-level reservoirs and use drip or trickle irrigation. The latter is only likely to happen if the holding is sufficiently large and consolidated to make such investment worthwhile. The former raises problems of lack of central control of the management of ecologically very sensitive resources.

11. Secondly, with most of the oasis committed to gravity-flow irrigation, water use efficiency is further diminished by the impossibility of reducing the base flow of water through sub-lateral canals below the peak requirement of the most water-demanding crop on any of the many plots (see B above). Under these circumstances there is no strong motivation for farmers to be conservative in their water use. For example, if the crops grown on 3 plots out of a total of 40 watered by one sub-lateral require irrigation every 4 days then the farmers on the other 37 plots will tend to use the watering opportunities more often than they might strictly need, e.g. every 7 or 10 days, and in larger volumes than necessary. The detailed regulation involved is in practice too large for H.I.D.A. to be in full control.

12. Thirdly, technically efficient use of land and water is easier to encourage if it can be shown to be profitable.

With the climatic conditions and soil conditions noted in Chapter 3, the quality of agricultural produce in

everything from dates to vegetables is also clearly improved by good soil/water management. However, this is not necessarily reflected in the prices obtained at market and, therefore, once again, motivation towards good land resources management is weakened. Neither H.I.D.A. nor M.A.W. have taken any direct steps to improve marketing systems in, for instance, inspection and grading, except in date-packing.

The best commercial and technical marketing systems are used by a relatively small number of modern private projects. These also use the most advanced irrigation techniques but the extra demand they create for water and their limited or nil use of drainage methods could have dangerous long-term effects.

13. There are also problems associated with the dominance of date-palms all over the oasis and the tendency of farmers to grow more wherever possible. This last tendency may be encouraged by the government policy of purchasing dates at high support prices. The date-palm with its long life-span and relatively long lead-time before it comes into production is a more inflexible element in the crop-range than many others such as alfalfa or vegetables. The date-palms are an obstacle to the use of modern farm machinery and are, except when planted appropriately, very demanding of manual labour. Whilst they require, biologically, less water than most other crops, they need irrigation throughout the year, once a week in summer and once a fortnight in winter. Date-palms therefore reduce the capability of H.I.D.A. to regulate the seasonal flow of water through the distribution canals.

Many of these factors not only make it impossible for the full irrigation potential of the irrigation and drainage project to be achieved but also discourage the replacement of increasingly scarce indigenous labour by capital through the greater use of mechanised technology.

14. To summarise therefore : relics of the traditional agricultural systems remain, as in most countries where a new irrigation and drainage scheme has been superimposed on an already irrigated, utilized and settled area. The al-Hassa project has succeeded technically (a) in halting ecological deterioration, and (b) in making farming modernization and improvement possible through water quality, distribution and drainage.

The full exploitation of this new potential needs a stronger response, both by the authorities and by the farmers otherwise the H.I.D.A. controlled oasis farms will become overwhelmed by the modern private projects. Research is clearly needed to discover how best to fit continuously changing agricultural needs, attitudes and trends into the framework of H.I.D.A.'s irrigation and drainage system, starting with comprehensive surveys of present land use and distribution patterns of all agricultural elements throughout the project area.

There has already been some success. A study by Al-Angary (1982) concludes "That the inhabitants of the [Al-Hassa]area will accept change and work for change if environmental, economic, and social shifts are perceived as being beneficial to them." Examples of the statements

that Al-Angary asked the 657 farmers who took part in his survey would agree with are as follows:-

1. Water is of better quality today than 10 years ago.
2. The soil is more productive today than 10 years ago.
3. It is a good situation to have more animals today.
4. I wish to remain in al-Hassa and presume that the community will prosper.
5. My wealth is greater today than before the water projects began.

Al-Angary reports that all farmers "agree to strongly agree" with all of these statements. The answers to these and other questions asked by Al-Angary give a strong impression that the farmers see the impact on them of the changes that have taken place since the beginning of the Irrigation and Drainage Project as generally favourable. Clearly work on deciding what changes will indeed be more beneficial must fully involve the farmers in order to retain the spirit of cooperation.

This is important, not only to al-Hassa, but to Saudi Arabia because al-Hassa is one of the few remaining regions in the kingdom where rural skills and experience still survive (the Tihama in the south west is another such region). These skills and experience have been considerably weakened by the flight from the land even in the oasis but it is important that they should be preserved for the long term future. Saudi Arabia, unlike the small Gulf City-states, will always need to maintain some degree of balance between

towns and countryside in its vast territory. It is important, therefore, that farmers as well as agri-businessmen in al-Hassa, as elsewhere, are enabled to be contented with a rural existence based on economically viable production and sound management of limited land and water resources.

The whole development can perhaps be divided into three stages. The first was the construction of the project itself, coming to terms with the physical environment. The second phase was the development and provision of expertise, machinery, new seeds and the other facilities of the extension services mentioned above. The third, which will take most time, is the development of farmers', outlook, which must absorb the changes in the physical structure of agriculture following the construction of the project, and the new practices and values demanded both by this change, and by the changing economic conditions in the country. A new model of agricultural practices is needed to cope with the new environment, incorporating both small conventional farms and the new specialised private projects.

CHAPTER SIX

REFERENCES

Al-Angary, A.M. (1982) Farmers' Perception of Environmental, Economic, and Social Change In al-Hassa Oasis District, Saudi Arabia, 1971-1981. (unpublished M.A. dissertation), The University of Toledo.

Al-Besher, A.A., (1983) Agriculture and Manpower In Saudi Arabia, (unpublished Ph.D.thesis) University of Durham.

Al-Ghazal, A.A. (1981), A comparison of Date Production Costs, Returns, and Marketing In al-Hassa, Saudi Arabia and Indio, California For 1979, (unpublished M.A. dissertation), State University, Freson, California.

Al-Jazeera Daily Newspaper (22/6/1404), Riyadh, Saudi Arabia, (in Arabic).

Al-Madina Daily Newspaper, (26/3/1404). Al-Madina, Saudi Arabia, (in Arabic).

Bowen-Jones, H., (1979) Land Use In al-Hassa Oasis, Report to the M.A.W. of the Kingdom of Saudi Arabia, unpublished.

Bowen-Jones, H., and Dutton, R.W., (1984) Agricultural production and/or Rural Development? Arab Gulf Journal, Vol.4, No.1, London.

Chinese Agricultural Technical Mission (CATM), (1983) A Highlight Presented to the Seventh Session of the Sino-Saudi Arabian Permanent Joint Committee on Economical and Technical Cooperation on May/1983. Hofuf, Saudi Arabia, Hofuf Agricultural Research Centre.

Cresswell, (1978), Interim Report prepared by the University College of North Wales team at H.A.R.C. To Highlight Research Finding of Immediate Application to Saudi Arabian Agriculture.

El-Prince, A.M. and others (1982), Use of Computergraphics in Developing Density maps for the Date Culture of al-Hassa oasis, Saudi Arabia, The First Symposium on Date Palm, King Faisal University, al-Hassa, Saudi Arabia.

Humaidan, S.H. (1980), Policies and Management Guidelines For Optimum Resource Utilization At al-Hassa Irrigation and Drainage Project, Saudi Arabia, (unpublished Ph.D. dissertation), State University, Oklahoma.

Marei, H.M., (1971), Date palms processing and packing in Saudi Arabia. Riyadh, Saudi Arabia, (in Arabic).

Ministry of Agriculture and Water (1972) Hofuf Agricultural Research Centre, publication No.2, General Information About the Centre.

" " (1983), Personal communication with Research Team members of H.A.E.C. during Summer 1983.

" " (undated), Hassa Irrigation and Drainage Authority, Report about Dates processing and packing factories in al-Hassa, (in Arabic).

" " (1978) Hassa Irrigation and Drainage Authority, First Land use Survey, Technical Section, H.I.D.A., Hofuf, Saudi Arabia (in Arabic).

" " (1981) General Directorate, Annual Report, 1401, Hofuf Branch, Saudi Arabia (in Arabic).

" " (1984) General Directorate, Hofuf, unpublished Records, (personal communication with Hofuf Branch June 1984).

Ministry of Finance (1983) Unpublished Records, Al-Hassa Branch (personal communication on 1983).

Ministry of Planning (1980) Third Development Plan 1400-1405 A.H. (1980-1985 A.D), Riyadh, Saudi Arabia.

BIBLIOGRAPHY

Abd-el Wassie, A., (1970) Education In Saudi Arabia, Macmillan.

Abder Rahman and Abdelhadi (1982) The Effects of Irrigation and Drainage Methods, Water and Soil Conditions on the Distribution of Date Palm Varieties, The First Symposium on Date Palm In Saudi Arabia, King Faisal University.

Abu-Ela, T.M., (1959) A Geographical Study of Man and His Environment in al-Hassa Province, Saudi Arabia, (Unpublished Ph.D. thesis), Trinity College, Dublin.

Abu Yusuf, Yaqub bin Ibrahim, (1302 AH/1884 AD), Kitab al-Kharaj, Bulaq, (in Arabic).

Al-Abdul-Qadir, M.A., (1379 AH/1960), History of al-Hassa in the past and present, Riyadh, Saudi Arabia, (in Arabic).

Al-Abdulwahed, Y.A., (1979) Al-Hassa Sand Stabilisation Project, M.A.W., Saudi Arabia, (in Arabic).

Al-Akkad, A.A., (1974) Socio-Economic Impact of Development Schemes on A Rural Community, al-Hassa Oasis, Saudi Arabia, (unpublished M.A. thesis), University College of North Wales, Bangor.

Al-Angary, A.M., (1982) Farmers' Perception of Environmental, Economic, and Social Change In al-Hassa Oasis District, Saudi Arabia, 1971-1981. (unpublished M.A. dissertation), The University of Toledo.

Al-Besher, A.A., (1983) Agriculture and Manpower In Saudi Arabia, (unpublished Ph.D. thesis) University of Durham.

Al-Elawy, I.S. (1976) The Influence of oil upon Settlement In Al-Hassa oasis, Saudi Arabia, (unpublished Ph.D.thesis), University of Durham U.K.

Al-Farsy, Fouad (1978) Saudi Arabia, A case study In Development, Stacey International, London.

Al-Ghazal, A.A. (1981) A comparison of Date Production Costs, Returns, and Marketing In al-Hassa, Saudi Arabia and Indio, California For 1979, (unpublished M.A. dissertation), State University, Freson, California.

Al-Jazeera, Daily Newspaper (1706/1404), Riyadh, Saudi Arabia, (in Arabic).

Al-Jazeera, Daily Newspaper (22/6/1404), Riyadh, Saudi Arabia, (in Arabic).

Al-Madina Daily Newspaper, (26/3/1404), Al-Madina, Saudi Arabia, (in Arabic).

Al-Mana, M., (1982) Arabia Unified, A portrait of Ibn Saud, Hutchinson Benham, London.

Al-Moqaddsi, (1967) Ahsan al-Taqsim fi Marifat al-Aqalim, Leyden (in Arabic).

Al-Othman, A.A. (1979) Education In Saudi Arabia, 1975-1980. Al-Asfahani, Jeddah, Saudi Arabia. (in Arabic).

Al-Riyadh Daily Newspaper, (24/3/1984), Riyadh, Saudi Arabia, (in Arabic).

Al-Sayari, S., and Zött, J.G. (1978) (Edited), Quaternary Period In Saudi Arabia, Springer-Verlag Wien, New York.

Al-Sharef, A.S., (1977) Geography of Saudi Arabia, Part I, Riyadh, (in Arabic).

Al-Shuaiby, A.M., (1976) The Development of the Eastern Province with Particular Reference to Urban Settlement and Evolution in Eastern Saudi Arabia, (unpublished Ph.D. thesis), University of Durham.

Al-Zaylai, A., (1978) Makkah and its relation, (unpublished M.A. thesis) University of King Saud, Riyadh, Saudi Arabia, (in Arabic).

Aramco, (1968) Aramco Handbook, Arabian American Oil Company, Dhahran, Saudi Arabia.

Barth, H.K., (1976) Al-Hassa Oasis in the Eastern Province of Saudi Arabia, Franz Steiner Verlag GMBH, Wiesbarden, (in Germany).

Beaumont, P., (1981) Water Resources and their Management in the Middle East (ed) J. Clarke and H.Bowen-Jones, Methuen, London.

Bey-Heard, F., (1983) From Trucial States to United Arab Emirates, Longman.

Birks, J.S., (1981) The Impact of Economic Development on Pastoral Nomadism In the Middle East : An Inevitable Eclipse? Change and Development In the Middle East Edited by John I. Clarke, and Howard Bowen-Jones, Methuen.

Bondok et al (1982) Tissue Culture As A Tool in Date Palm Propagation, The First Symposium on Date Palm In Saudi Arabia, King Faisal University.

Bowen-Jones, H., (1979) Land Use In Al-Hassa Oasis, Unpublished Report to the M.A.W. of the Kingdom of Saudi Arabia.

Bowen-Jones, H., (1980) Agriculture and the Use of Water Resources in the Eastern Province of Saudi Arabia, Issues In Development : In Gulf States, Ziward Daftari, M. (ed) M.D. Research and Services Ltd. London.

Bowen-Jones, H., and Dutton, R.W. (1984) Agricultural production and/or Rural Development? Arab Gulf Journal, Vol.4, No.1, London.

Central Planning Organization (1394 H.A.), Report of the Central Planning Organization, Saudi Arabia, Jeddah.

Chinese Agricultural Technical Mission (CATM), (1983) A Highlight Presented to the Seventh Session of the Sino-Saudi Arabian Permanent Joint Committee on Economical and Technical Cooperation on May/1983. Hofuf, Saudi Arabia, Hofuf Agricultural Research Centre.

Cleron, J.P., (1978) Saudi Arabia 2000 : A Strategy For Growth, London, Croom Helm.

Cornwall, P.B., (1946) Ancient Arabia : Explorations In Hassa, 1940-41, The Geographical Journal, Vol.107, The Royal Geographical Society, London.

Cresswell, (1978) Interim Report prepared by the University College of North Wales team at H.A.R.C. To Highlight Research Finding of Immediate Application to Saudi Arabian Agriculture.

Economic Intelligence Unit, (1980) Quarterly Economic Review of Saudi Arabia, Annual Supplement.

El-Khatib, A., (1980) Seven Green Spikes, M.A.W., Saudi Arabia, Second Edition, Dar al-Asfahani, Jeddah, Saudi Arabia.

El-Prince, A.M. and others (1982) Use of Computergraphics in Developing Density maps for the Date Culture of al-Hassa oasis, Saudi Arabia, The First Symposium on Date Palm, King Faisal University, al-Hassa, Saudi Arabia.

El-Prince, A.M. and others (1983) Use of Computergraphics in Developing Density maps for the Date Culture of al-Hassa oasis, Saudi Arabia, The First Symposium on Date Palm, King Faisal University, al-Hassa, Saudi Arabia.

Fisher, W.B., (1978) The Middle East, A Physical Social and Regional Geography, Methuen and Co.Ltd.,

Forster, C., (1944) The Historical Geography of Arabia, London.

H.I.D.A. (1979) Land Use Survey, published by al-Hassa Irrigation and Drainage Authority, Al-Hassa, Saudi Arabia (in Arabic).

Hajraha, H.H., (1970) The potential of Agricultural Development in Saudi Arabia, M.A.W., Saudi Arabia (in Arabic).

Hassa Irrigation and Drainage Authority and King Faisal University (1983), Personal Communication.

Houston, J.M., (1964) The Western Mediterranean World, Longman, London.

Humaidan, S.H., (1980) Policies and Management Guidelines For Optimum Resource Utilization At al-Hassa Irrigation and Drainage Project, Saudi Arabia (Unpublished Ph.D. Dissertation), State University, Oklahoma.

Ibn Al-Fakih, B., (1967) Kitab al-Boldan, Leyden, (in Arabic).

Ibn Haukal, A.H.A., (1938) Kitab Sovat al-Aardh, Leyden, (in Arabic).

Ibn Khordadbeh, A.O.A. (1967) Kitab al-Masalik Wal-Mamalik, Leyden, (in Arabic).

Ied, S.Y., (1969) Agricultural Geography of al-Hassa Oases, Saudi Arabia (unpublished Ph.D. thesis), University of Cairo, Egypt (in Arabic).

International Bank, (1960) For Reconstruction and Development. Approach To the Economic Development of Saudi Arabia, Report No. AS-82a.

Labban, S.A., (1974) Agriculture in the Main Oases of The Eastern Province of Saudi Arabia, Arabian American Oil Company, Dhahran.

Lipsky, G.A., (1959) Saudi Arabia, Its People, Its Society, Its Culture, Harf Press, New Haven.

Lorimer, J.G., (1908) Gazetteer of the Persian Gulf, Oman, and Central Arabia, Vol.II, Calcutta, India.

Marei, H.M., (1971) Date palms processing and packing in Saudi Arabia, Riyadh, Saudi Arabia, (in Arabic).

Ministry of Agriculture and Water, (undated), Hassa Irrigation and Drainage Authority. Hofuf, Saudi Arabia.

Ministry of Agriculture and Water (undated), Hassa Irrigation and Drainage Authority, Report about Dates processing and packing factories in al-Hassa, (in Arabic).

Ministry of Agriculture and Water (1972) Hofuf Agricultural Research Centre, publication No.2, General Information About the Centre.

Ministry of Agriculture and Water, (1973) Hofuf Agricultural Research Centre, publication No.7, Agrometeorological Data of the al-Hassa Oasis.

Ministry of Agriculture and Water (1976) Hofuf Agricultural Research Centre, Publication No.15, Hydrogeology of al-Hassa Oasis.

Ministry of Agriculture and Water (1977) Hofuf Agricultural Research Centre, publication No.16, Water Resources of al-Hassa Oasis.

Ministry of Agriculture and Water (1978) Hassa Irrigation and Drainage Authority, First Land use Survey, Technical Section, H.I.D.A., Hofuf, Saudi Arabia (in Arabic).

Ministry of Agriculture and Water (1978) Hofuf Agricultural Research Centre, publication No.22, Water Resources of the al-Hassa Oasis.

Ministry of Agriculture and Water (1978) Hofuf Agricultural Research Centre, publication No.23, Investigations on the Hydrogeography and Water Resources of the al-Hassa Oasis.

Ministry of Agriculture and Water (1978) Hofuf Agricultural Research Centre, publication No.26, Agrometeorology of the al-Hassa Oasis (1969-1976).

Ministry of Agriculture and Water (1978) Hofuf Agricultural Research Centre, publication No.27, Soil Investigations in al-Hassa Oasis.

Ministry of Agriculture and Water (1979) Hofuf Agricultural Research Centre, publication No.38, The Water Potential of the al-Hassa Oasis.

Ministry of Agriculture and Water (1981) General Directorate, Annual Report, 1401, Hofuf Branch, Saudi Arabia (in Arabic).

Ministry of Agriculture and Water (1981/82) Hofuf Agricultural Research Centre, Unpublished Records Consulted by the author during fieldwork.

Ministry of Agriculture and Water (1983), Personal communication with Research Team members of H.A.E.C. during Summer 1983.

Ministry of Agriculture and Water (1982/84) Hassa Irrigation and Drainage Authority, Unpublished records consulted by the author during fieldwork in 1982 and 1984.

Ministry of Agriculture and Water (1984) General Directorate, Hofuf, unpublished Records, (personal communication with Hofuf Branch June 1984).

Ministry of Finance and National Economy (1977), Population Census, 1974 (1394 A.H.), Detailed Data for Eastern Province, Dammam, Saudi Arabia.

Ministry of Finance (1983) Unpublished Records, Al-Hassa Branch (personal communication on 1983).

Ministry of Information (undated), Features From Saudi Arabia Dar al Watan, Saudi Arabia.

Ministry of Planning, (1980) Third Development Plan 1400/1405 A.H. (1980/1985 A.D), Riyadh, Saudi Arabia.

Ministry of Planning, (1982) Saudi Arabia, Achievements Of the First and Second Development Plans 1390-1400 A.H. (1970-1980 A.D.), Tihama, Jeddah, Saudi Arabia.

Qudamah bin Jafar, (1967) Nubadh Min Kitab al-Kharaj wa Sanat al-Kuttab, Leyden (in Arabic).

Saudi Arabian Agricultural Bank (1973), Ninth Annual Report, 1392-1393 A.H.

Saudi Arabian Agricultural Bank, (1983), Nineteenth Annual Report, 1402/1403 A.H. Riyadh, Saudi Arabia.

Saudi Arabia (undated) Development Aspects, Beirut, Lebanon.

Saxen, A., (1968) Situation of the Irrigated Agriculture in the Eastern Province of Saudi Arabia.

Speetzen, H., (1974) Land Settlement Project and Agricultural Development, An Analysis of Development Factors and Processes based on Four Case Studies in China, Libya and Saudi Arabia, (Unpublished Ph.D. thesis), University of Durham.

The Holy Quran, Sura XIX 25 and 26, Translation of Abdullah Yusuf Ali, Dar al-Arabia, 1968.

Twitchell, K.S. (1944) Water Resources of Saudi Arabia, Geographical Review, Vol.34.

Vidal, F.S. (1955) The oasis of al-Hassa, Dhahran, Saudi Arabia.

Vidal, F.S. (1980) Development of the Eastern Oasis : A Case Study of Al-Hassa Oasis; In King Faisal and the Modernization of Saudi Arabia, Ed. Beling, W.A., Croom Helm, London.

Wakuti, (1964) Final Design for the Project of Improving Irrigation and Drainage In The Region of al-Hassa, Saudi Arabia.

Wakuti, (1969) Final Completion Report For Supervision of Execution of al-Hassa Irrigation and Drainage Project.

Wakuti, (1969) Studies for the Project of Improving Irrigation and Drainage In the Region of al-Hassa, Saudi Arabia, Volume 3 - Soil Study, Siegen, West Germany.

Wakuti, (1969) Report, Final Design For the Project of Improving Irrigation and Drainage in the Region of al-Hassa, Saudi Arabia, Zuq, Switzerland.

Wakuti, (1970) The al-Hassa Irrigation and Drainage Scheme, Report, Hofuf, Saudi Arabia.

Wakuti, (1971) Al-Hassa Irrigation and Drainage Project, Saudi Arabia.

Wilkinson, J.C. (1977) Water and Tribal Settlement In South-East Arabia, Clarendon Press, Oxford.

Yakut al-Hamawi, I.S.A., (1955), Mu'djam al-Buldan, Vol.I, Dar Sader Dar Beirut, Beirut, (in Arabic).