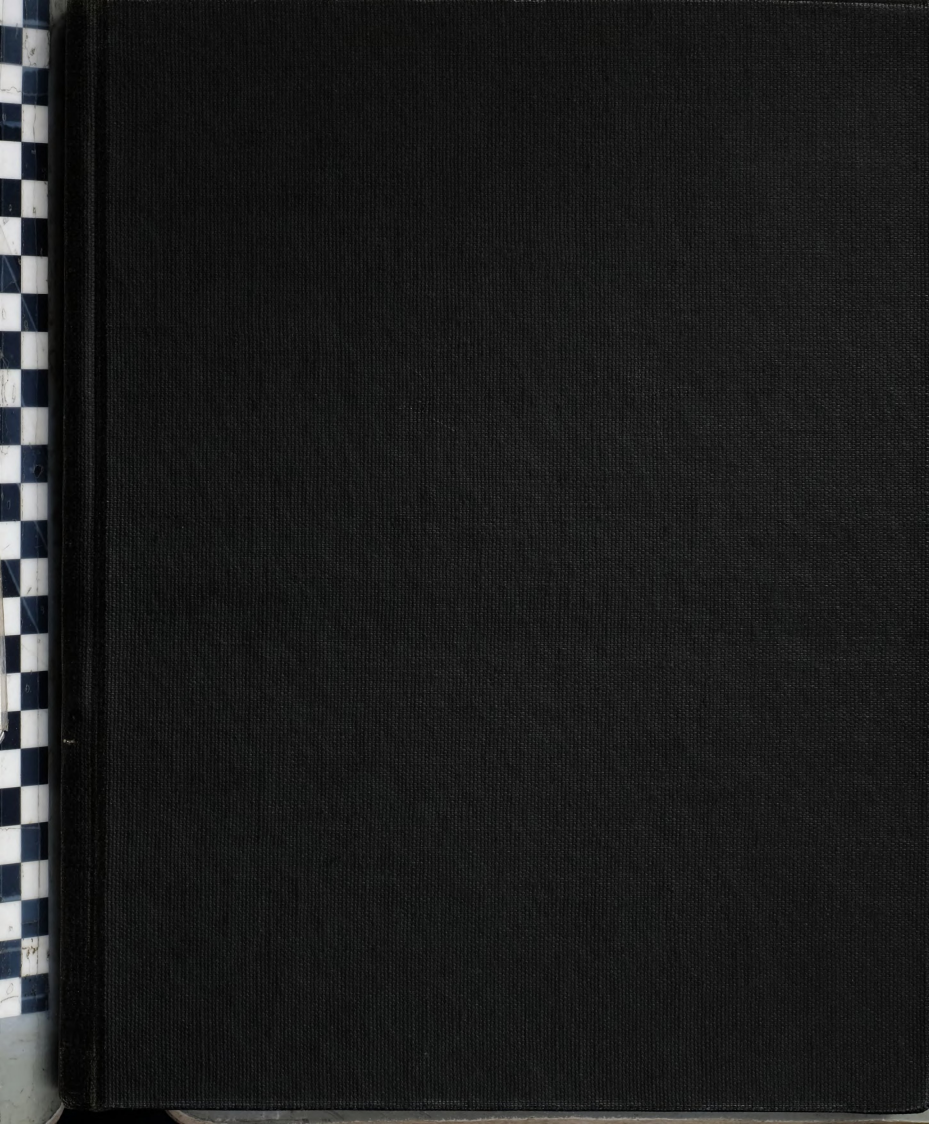






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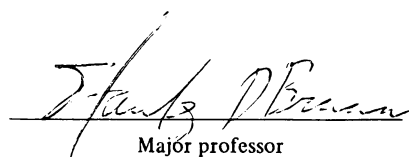
IMPACT OF THE MALAKI DAM ON THE
AGRICULTURAL SYSTEM IN THE
WADI JIZAN AREA, SAUDI ARABIA

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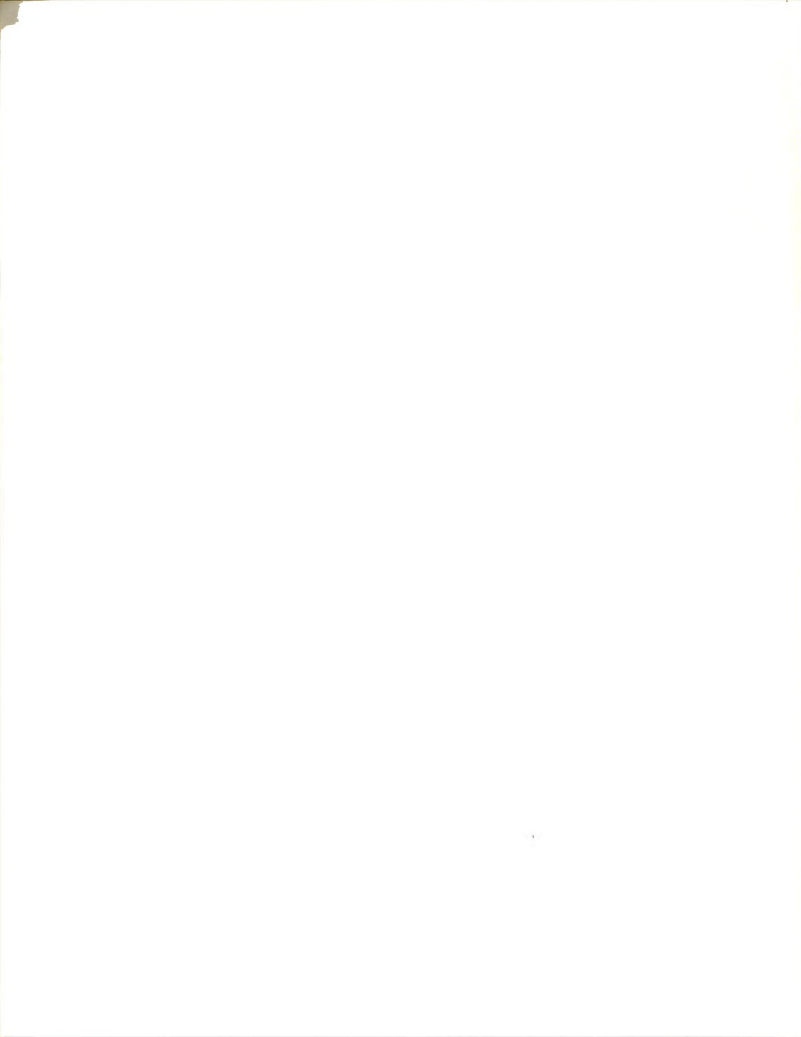

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IMPACT OF THE MALAKI DAM ON THE
AGRICULTURAL SYSTEM IN THE
WADI JIZAN AREA, SAUDI ARABIA

by

Khudhran Khadhir M. Al-Thubaity

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
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MASTER OF ARTS

Department of Geography

1978



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

In the name of God,
the most gracious, the dispenser of grace.



ABSTRACT

IMPACT OF THE MALAKI DAM ON THE AGRICULTURAL SYSTEM IN THE WADI JIZAN AREA, SAUDI ARABIA

By

Khudhran Khadhir M. Al-Thubaity

Among the numerous wadies that have some agricultural reputation in the South Tihama region of Saudi Arabia is the Wadi Jizan area. This area has been the focus for agricultural development in the region. Some basic aims of the Saudi Arabian agricultural policy in this area are: 1) to develop the agricultural potential, 2) to create a perennial irrigation system, 3) to control floods (runoff), and 4) to modernize cultivation methods and techniques. The purpose of this study is twofold: first, to investigate the potential and importance of Wadi Jizan as a prime agricultural area; and to illustrate contemporary agricultural development in the Wadi.

Based on the available data, the Wadi Jizan area contains about 43,000 hectares of land, of which 18,000 hectares are productive. When traced, the actual lands that were under cultivation during the period from 1951 to 1969 (before the recent development



started in 1970) they composed, on the average, about 3,672 hectares, or only 20.4% of the total productive lands. As far as production is concerned, sorghum has been the major field crop and production varied from one year to another (between 3,000 tons in some years to less than 100 tons in others). This unsatisfactory situation in area cultivated or size of production in the Wadi Jizan area is mainly due to fluctuation in rainfall as well as to outdated cultivation methods.

This agricultural situation, the availability of land for cultivation, the hydrological make-up of the Wadi (an average of 90 million cubic meters of runoff per year and about 2,000 million cubic meters of started groundwater), the available manpower (there are about 33,000 inhabitants in the Wadi), and the need for increased agricultural production in Saudi Arabia are all factors that justify the agricultural development in the Wadi Jizan area. A historical review of this agricultural development shows that the most basic component was the construction of Malaki Dam in 1970.

Through the use of the available statistical information and by questioning 151 farmers in 27 villages selected randomly from the Wadi Jizan area, the impact of the Malaki Dam on land and water utilization, agricultural production and/or crop diversification has been examined. Consequently, an increase of about 30 to 40% of the irrigable lands from 1972 to 1975 has been found to be irrigated from

the dam. In terms of the actual cultivated lands, and in respect to the agricultural production and crop diversification there has been no significant increase since the construction of the dam, and sorghum still represents the main field crop. In addition, though the dam has attracted some farmers to return to their villages, they did so because of the available work in companies that have accompanied the dam construction.

These results support the argument that the agricultural system in the Wadi Jizan area has remained unchanged so far. Some major factors are found to hinder the meeting of successful development in the area. These factors are: 1) the insistence of farmers to use their traditional methods in farming, 2) the continued use of traditional water distribution and priority systems, 3) the existing land tenure system, 4) the existing marketing and transportation systems, and 5) above all is the fact that agricultural development in the Wadi Jizan area has been very slowly executed and often not synchronized.

The present agricultural system in the Wadi Jizan area hinders the introduction of more sophisticated techniques for expanding cultivated areas and crop diversification. Any further development in this regard (with respect to the Wadi Jizan area or any other) must take into consideration the entire system, traditions, and methods to insure rapid improvement of these social aspects.

To my father . . .

and

To the memory of my mother.

ACKNOWLEDGEMENT

I would like to take the opportunity to express my sincere gratitude to the people of the Wadi Jizan area and the interviewed farmers for their participation. Also, the cooperation and assistance of the Administrative Staff at the Wadi Jizan Development Project are deeply appreciated. Special thanks are also extended to the personnel of the Ministry of Agriculture and the Ministry of Transportation for their generous help.

I would like to make known my deep feelings of gratitude for my academic advisor and the committee chairman, Professor David Stephenson, whose help, encouragement, and guidance are unforgettable.

Deeply appreciated is the help of other committee members: my second reader Professor Stanley Brunn and Professor Gary Manson, their guidance, remarks, and suggestions were always helpful. I am also indebted to Professor Dieter Brunnschweiler for his useful suggestions and directions since the time I started working on my master's program.

Special thanks are extended to Mr. Ralph DeVitto for his help with the preparation of the thesis illustrations. Also, my thanks are due to Mr. Morris Thomas and Miss E. Smith for their advice and



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Finally, this study would not have been completed without the financial support provided by King Abdulaziz University. Last, but not least, my deep thanks are extended to my typist Barbi Mel for her cooperation and understanding.



TABLE OF CONTENTS

	Page
LIST OF TABLES.	viii
LIST OF FIGURES	xi

Chapter

I. INTRODUCTION.	1
Purpose of the Study.	4
Procedures.	6
The Study Area.	10
Agricultural Development in Saudi Arabia.	14
II. GENERAL BACKGROUND.	24
Physical Features	25
Topography.	25
Climate	28
Hydrology	37
Soils and Land Classification	40
Natural Vegetation.	49
Human Geography	53
The People.	53
Settlement.	55
Population.	58

TABLE OF CONTENTS (Cont'd.)

Chapter	Page
III. AGRICULTURE IN WADI JIZAN	68
Introduction.	68
Land Tenure	72
Traditional Irrigation and Water Rights	78
Farm Operation.	83
Field Crops	88
Labor	92
Livestock	94
Markets and Transportation.	98
IV. THE WADI JIZAN DEVELOPMENT PROJECT.	104
Development Potentail of Wadi Jizan	104
Historical Perspective and Rationale for the Project	112
Components of the Project	127
Malaki Dam.	128
Irrigation Network Scheme and Tube Wells Development.	133
The Agricultural Experiment Station	139
V. IMPACT OF THE MALAKI DAM ON THE AGRICULTURAL SYSTEM IN THE WADI JIZAN AREA	145
Land and Water Utilization.	146



TABLE OF CONTENTS (Cont'd.)

Chapter	Page
Agricultural Production and Crop Diversification. . .	158
Socio-Economic Patterns	165
VI. CONCLUSIONS AND RECOMMENDATIONS	174
Conclusions	174
Recommendations	179
APPENDIX	
A. QUESTIONNAIRES FOR SAMPLE OF FARMERS IN WADI JIZAN. . . .	184
B. HOUSING AND POPULATION CENSUS	190
BIBLIOGRAPHY.	192



LIST OF TABLES

Table	Page
1. SAMPLE SIZE AND DISTRIBUTION FOR WADI JIZAN AREA	8
2. LIST OF CONSULTANTS AND AREAS SURVEYED IN SAUDI ARABIA . .	18
3. NUMBER OF INHABITANTS FOR THE SURVEYED VILLAGES IN WADI JIZAN	63
4. AGE STRUCTURE FOR THE INTERVIEWED FARMERS.	64
5. FAMILY SIZE FOR THE INTERVIEWED FARMERS.	65
6. LAND UTILIZATION FOR THE WADI JIZAN AREA IN HECTARES . . .	71
7. SIZE OF HOLDINGS IN THE WADI JIZAN AREA, FOR THE INTERVIEWED FARMERS.	76
8. TRADITIONAL PLANTING AND HARVESTING DATES FOR DURRA. . . .	90
9. DISTRIBUTION OF LIVESTOCK FOR RESPONDENTS IN THE WADI JIZAN AREA.	97
10. PERCENTAGES OF RESPONDENTS WHO SELL THEIR SURPLUS.	100
11. MONTHLY FLOWS OF WADI JIZAN AT MALAKI--MILLIONS OF CUBIC METERS	108
12. NET INVESTMENTS FOR THE 1970-1980 AGRICULTURAL PROGRAM EXPRESSED IN 1,000'S OF US\$ AT 1964 MARKET PRICES. . . .	115
13. AREA CULTIVATED, VALUE OF GROSS MARKETABLE PRODUCTION AND NET AGRICULTURAL PRODUCT IN THE DEVELOPMENT AREA, 1970-1980.	117



LIST OF TABLES (Cont'd.)

Table	Page
14. AREAS CULTIVATED, QUANTITY AND VALUE OF GROSS MARKETABLE PRODUCTION, NET AGRICULTURAL PRODUCT IN THE DEVELOPMENT ZONE, 1970-1980	119
15. EVOLUTION OF UNIT YIELDS 1970-1980	120
16. TOTAL DIRECT COSTS OF WADI JIZAN PROJECT, IN US\$ BROKEN DOWN INTO INVESTMENTS AND ANNUAL COSTS, REDUCED TO WORTH IN THE YEAR WHEN THE SYSTEM STARTS OPERATING, AND FOR THE YEARS OF THE PROJECT'S USEFUL LIFE	121
17. OVERALL COSTS OF PROJECT DEMONSTRATION AND EXTENSION SERVICES, BROKEN DOWN INTO INVESTMENTS AND ANNUAL COSTS, DURING THE LIFE OF THE PROJECT, REDUCED TO WORTH AT YEAR ZERO	123
18. NET WORTH OF IRRIGATED AGRICULTURE, INCREMENT IN NET PRODUCT AND YEARLY VALUES REDUCED TO WORTH, DURING THE USEFUL LIFE OF THE PROJECT	124
19. DIRECT BENEFITS ATTRIBUTABLE TO THE PROJECT.	125
20. BENEFIT-COST RATIOS ACCORDING TO TWO HYPOTHESES OF ASSOCIATED COSTS	126
21. DETAILS OF DIVERSION WEIRS AND IRRIGATION HEADWORKS.	137
22. PROPOSED SCHEDULE FOR DISTRIBUTARIES AND MINOR CANALS.	138
23. ESTIMATED IRRIGATED AREAS AND VOLUMES OF WATER IN THE WADI JIZAN FOR THE PERIOD 1951-1962.	147
24. DIVISION OF LANDS ACCORDING TO FREQUENCY OF IRRIGATION	149
25. LAND AND WATER UTILIZATION FROM 1964-1968.	151
26. SIZE OF AREAS IRRIGATED BEFORE AND AFTER OPENING THE DAM IN 1970.	153



LIST OF TABLES (Cont'd.)

Table	Page
27. AMOUNT OF PRODUCTION FOR DURRA AND AMOUNT OF AREA IRRIGATED IN WADI JIZAN FROM 1965-1975	159
28. INCREASE IN CULTIVATED LANDS FOR INTERVIEWED FARMERS IN THE WADI JIZAN AREA	161
29. INCREASE IN DURRA PRODUCTION FOR THE INTERVIEWED FARMERS .	162
30. COST OF DURRA PRODUCTION PER HECTARE	166
31. MOVEMENT OF FARMERS IN THE WADI JIZAN.	168
32. REASONS FOR MOVEMENT	169
33. REASONS FOR RETURNING TO WADI JIZAN.	170
34. FARMERS WHO HAVE JOBS BESIDES THEIR FARMS.	171

Appendix

B. HOUSING AND POPULATION CENSUS.	190
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LIST OF FIGURES

Figure	Page
1. RELATIVE SELF-SUFFICIENCY OF SAUDI ARABIA IN SELECTED AGRICULTURAL PRODUCTS	2
2. THE WADI JIZAN AREA.	12
3. WADI JIZAN STUDY AREA.	13
4. WADI JIZAN--TOPOGRAPHY	27
5. LAVA OUTCROPS EAST OF ABU ARISH.	29
6. MONTHLY TEMPERATURES	31
7. ABU ARISH: MEAN MONTHLY RAINFALLS 1953-1963	35
8. AVERAGE ANNUAL RAINFALL IN NATURAL REGIONS OF SAUDI ARABIA	36
9. WADI JIZAN AT MALAKI	38
10. GROUNDWATER LEVELS IN THE WADI JIZAN STUDY AREA.	41
11. WADI JIZAN SOIL TYPES.	42
12. WADI JIZAN--LAND CAPABILITY.	44
13. LAND CAPABILITY IN THE DEVELOPMENT AREA.	47
14. NATURAL VEGETATION ALONG THE WADI JIZAN BED.	51
15. THE VILLAGE OF HAKIMAH	59
16. THE TOWN OF ABU ARISH.	60

LIST OF FIGURES (Cont'd.)

Figure	Page
17. THE TRADITIONAL PLOWING METHOD	85
18. THE TRADITIONAL SOWING METHOD.	87
19. TRADITIONAL CUTIVATION PATTERNS IN THE STUDY AREA.	89
20. WADI JIZAN AT MALAKI: FREQUENCY OF ANNUAL FLOWS	110
21. WADI JIZAN CATCHMENT AREA.	129
22. THE MALAKI DAM	132
23. PROPOSED IRRIGATION NETWORK SCHEME	134
24. A SECTION OF THE NEW IRRIGATION SYSTEM	135
25. THE SIX NEW IRRIGATION DISTRICTS	156



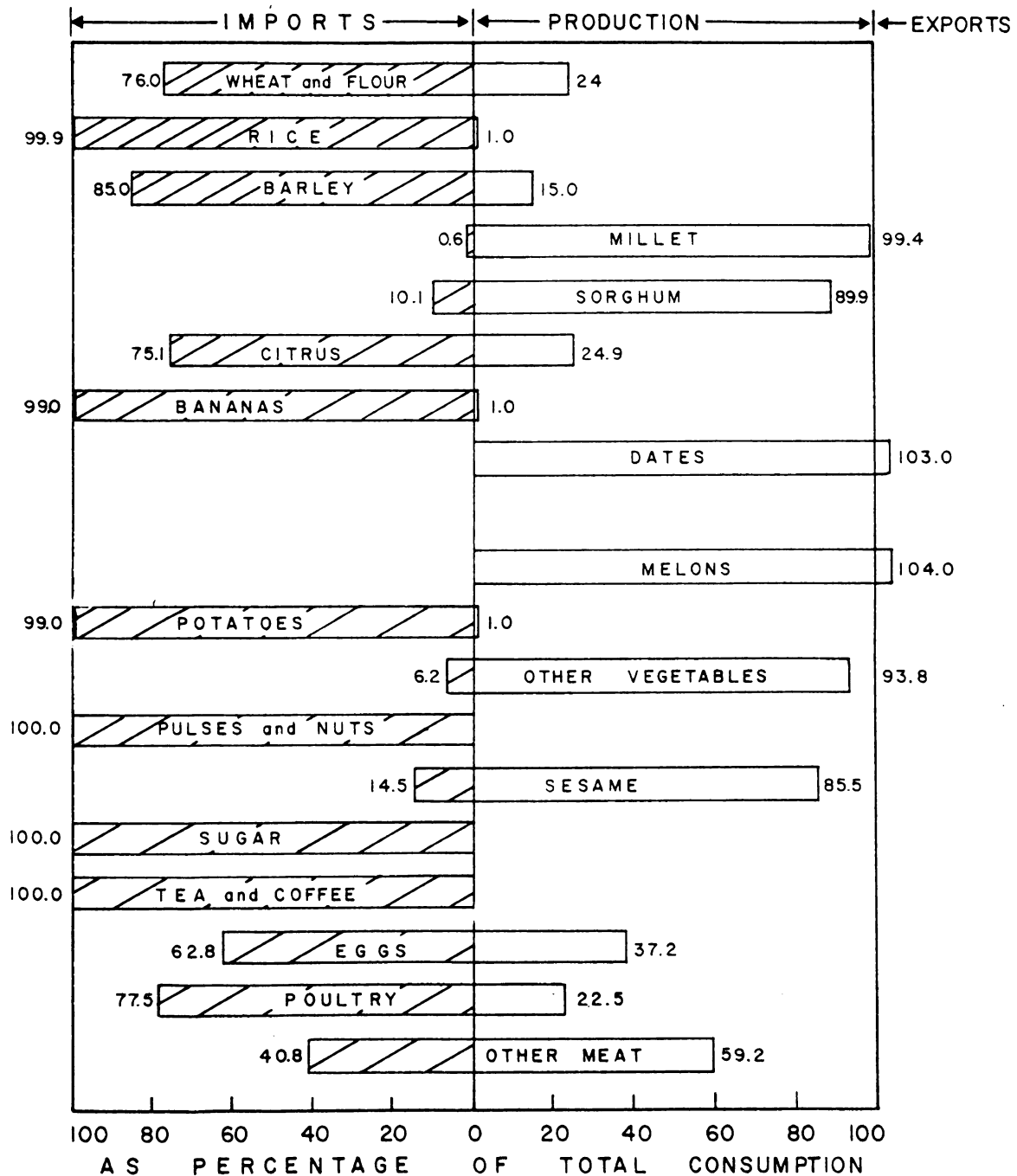
Chapter I

INTRODUCTION

Due to the physical conditions of the region, the agricultural lands in Saudi Arabia are limited. Moreover, a number of various problems concerning social and financial resources account for the fact that agricultural production comprises no more than 10% of the gross national product. These problems include: lack of agricultural education; use of a traditional land tenure system; an inadequate marketing system; and difficult economic situation of the farmers, which often hinders the resolution of problems.

Until recently, agricultural development in Saudi Arabia did not extend throughout the entire country. As a result, the amount of agricultural production is still very low, and the need for importation of grains and other foodstuffs remains high (Figure 1). The government of Saudi Arabia has sensed the problem, and as a result, several fruitful changes and positive steps have been taking place as far as agricultural and water development is concerned. In this respect, several projects have been instigated, such as the Al-Hassa project for land improvement and agriculture; the Faisal settlement

RELATIVE SELF-SUFFICIENCY OF SAUDI ARABIA IN SELECTED AGRICULTURAL PRODUCTS



SOURCE: Saudi Arabian Ministry of Planning,
Second Development Plan, 1395-1400 A.H., 1975-1980 A.D.

Figure 1



project; the Al-Qatif irrigation development plan; and the Wadi¹ Jizan development project.

Water scarcity is by far the most crucial problem which confronts agricultural development in Saudi Arabia. Water resources are dependent upon the unpredictable rainfall which, in most cases, forms a violent runoff, causing severe erosion and destruction. Therefore, in a country like Saudi Arabia, ground water is very important. To increase agricultural production, and increase the amount of potential farm land, several practical plans concerning agricultural and water development have been formulated. An efficient flood-control plan is considered the cornerstone in this respect. Thus far, dams have been constructed in almost ten Wadies, and construction is underway on several more dams. The Wadi Jizan Development Project, which includes the Malaki Dam, is one of the largest projects in Saudi Arabia, and the only one, in terms of agriculture and water development in the South Tihama² Area. The project consists of three main sections--the Dam, the Irrigation Scheme, and the Agricultural Experiment Station. These three projects are intended to meet the development needs of

¹Wadi is the arabic word for a valley with an intermittent watercourse.

²"Tihama" is the arabic term which refers to the low and hilly area along the Red Sea coastal plain. The area is characterized as hot and humid during the summer, while warm during the winter.



the Wadi by increasing the irrigable lands and utilizing the surface runoff and ground waters, as well as introducing new crops, farming methods, and mechanization. It is my intention to study the Wadi Jizan Area in terms of its physical and human characteristics as well as the types of agriculture, the traditional methods, and crop patterns. In addition, it is necessary to investigate the various justifications for the project, as well as the several effects upon the area as a result of the agricultural development projects in Wadi Jizan.

Purpose of the Study

Wadi Jizan has been receiving increasing attention from government authorities in the last few years. The Wadi is a promising agricultural district in South Tihama region, particularly as far as irrigation on a large scale is considered. The Malaki Dam, completed in 1970, is definite evidence of such development. The purpose of this study is twofold: to investigate the potential and importance of Wadi Jizan as a prime agricultural area; and to illustrate contemporary agricultural development in the Wadi, as well as its goal and effects.



The prime objectives of this study are:

- 1--to study the agricultural system in the Wadi Jizan and the need for development.
- 2--to investigate the justification for the choice of Wadi Jizan as a developmental site.
- 3--to focus upon the present development--its history and components.
- 4--to trace the impact of the Malaki Dam on the agricultural system in the area.
- 5--to make a contribution to the geography of Saudi Arabia in general and to provide useful recommendations for further development in the Wadi Jizan area in particular.

The focus of argument in this research will be the assumption that development in such an area will result in an increase in the amount of cultivated land, and a greater variety of crops, made possible because of sufficient and modern methods of cultivation and flood-control.

In addition, answers will be sought to the following questions:

- 1--what change or changes have taken place in the area in terms of water availability and distribution?
- 2--how much increase in the amount of cultivated land and agricultural production has occurred as a result of such development?
- 3--what are the major factors that may have influence on the development of the agricultural system in the area?



Procedures

The data presented in this study were collected during two periods of time. The first period (November 15, 1976, through January 15, 1977) was used for surveying literature on the study area. At Michigan State University, research immediately revealed the scarcity of material on the study area. However, there were some data on geography and agriculture in general which proved helpful in building a basic background in the subject matter. A trip to Saudi Arabia was undertaken on December 15, 1977, for the purpose of collecting the major available references about the study area. Most of these references were reports composed by representatives of various governmental departments or by consulting companies. The only way to obtain such reports was to contact the governmental agencies located in Riyadh, the capital of Saudi Arabia. The departments most frequently consulted were: the Ministry of Agriculture and Water, the Ministry of Petroleum and Minerals, the Ministry of Planning, the Ministry of Communication, and the Ministry of Commerce and Industry. Public libraries were also consulted frequently. During the visits with the government representatives, there seemed to be a lack of knowledge about the reports done by the Food and Agricultural Organization of the United Nations (FAO) between 1952 and 1955, so a trip to Rome was undertaken and the needed reports were obtained. In addition, personal



interviews with experts in the Ministry of Agriculture and Water were held, as well as with the residents of the study area.

The second period was more productive, as it involved the field research. During January 15 to March 15, 1977, questionnaires (see Appendix A) were distributed, and conversations with local people were conducted. Much insight was given into the areas of population, agricultural activity and problems, cultivation methods, water distribution and rights, and the land tenure system.

For purposes of research, Wadi Jizan was divided into two sections--the Upper and Lower. Subsequently, 50% of the villages in each part were randomly selected for intensive polling, and a sample of 27 out of 55 villages (excluding Abu Arish) was utilized. Next, 5% of the total number of families in each of the 27 villages was sampled.³ Thus, a total of 151 families was interviewed (Table 1). Since this study concerns agricultural activity, only farmers were interviewed.

The questionnaires and interviews were administered with the help of two Saudian engineers on a part-time basis. Transportation was supplied by King Abdulaziz University for almost thirty-six days of extensive traveling. Transportation for the engineers was supplied

³The statistical information on the population and families was taken after the 1972 survey by Sir William Halcrow and Partners (see Appendix B).



TABLE 1
SAMPLE SIZE AND DISTRIBUTION FOR THE WADI JIZAN AREA

Series	Villages Selected	Location	Total Families	Number of Families Interviewed*
1	Malaki	Upper Wadi	89	4
2	Al-Mahallah	"	116	6
3	Al-Uqdah	"	88	4
4	Qamirah	"	96	5
5	Al-Quwayyah	"	87	4
6	Al-Raha	"	30	2
7	Jirbah	"	15	1
8	Al-Bayyid	"	169	8
9	Al-Khadhra(J)	"	308	15
10	Falass	"	168	8
11	Al-Mujassass	"	155	8
12	Abualnurah	"	152	8
13	Al-Wasit	Lower Wadi	57	3
14	Khabtsaid	"	87	4
15	Al-Rayyan	"	148	7
16	Al-Badi	"	233	12
17	Al-Qarafi	"	181	9
18	Al-Salamah	"	78	4
19	Al-Mihsam	"	65	3
20	Al-Ghurayyib	"	107	5
21	Al-Matiri	"	45	2
22	Al-Wasili	"	242	12
23	Al-Ajabiyah	"	61	3
24	Bakhshah	"	40	2
25	Al-Kharadilah	"	91	5
26	Al-Ushwah	"	95	5
27	Al-Kawanillah	"	46	2
TOTAL				151

*To avoid decimal points, the decision was made that .5 and up would be rounded to one (e.g. $30 \times 5 / 100 = 1.5$ is rounded to 2 as in the case of Al-Raha Village), less than .5 to be truncated, or forgotten (e.g. $308 \times 5 / 100 = 15.4 = 15$ as in the case of Al-Khadhra (J) village).

**See Figure 3 for location of villages.

Source: Data collected during field work of the author in the Wadi Jizan area, Saudi Arabia, November 15, 1976 to March 15, 1977.



by the Experiment Station at Hakimah, where they are employed. The engineers worked half-days for two weeks, along with the author, and the interviewing was completed by March 15, 1977.

There were few difficulties encountered in the field work, and the task was completed according to schedule. However, with respect to the data collected, there was a severe lack of available statistics on agricultural production, farm size and income, and population. Consequently, statistical information given in this study on such topics, whether taken from previously published reports, or personally-collected data, are approximate estimates at best, and not immune to mistakes and errors.

Another slight difficulty was encountered with the base maps for the Wadi Jizan area. All the maps gathered had been compiled primarily from uncontrolled mosaic, and thus the scales were given in approximate values only. As accuracy was not considered the paramount concern, the maps are basically thematic in nature.

The study is divided into six chapters. Chapter Two is general background covering the physical and human geography of Wadi Jizan. Physical features of the area, such as topography, climate, hydrology, soils, and natural vegetation, as well as the human aspects, such as population and settlement patterns are covered. Chapter Three is exclusively devoted to agriculture in Wadi Jizan. Sections on land



tenure, traditional irrigation and water rights, farm operation, crops, labor, livestock, marketing, and transportation are included. Agricultural development in the area is the topic of Chapter Four, and the discussion serves as a background for introducing the actual Wadi Jizan Development Project. Chapter Five broaches the main topic of the study--Impact of the Malaki Dam on the Agricultural System in the Wadi Jizan Area. This discussion contains the various subjects of land and water utilization; agricultural production and crop diversification; and socio-economic patterns. To illustrate these subjects, durra (sorghum) is used as the sample crop, and its transitions during development in Wadi Jizan are carefully traced. Chapter Six, the concluding chapter, contains conclusions and recommendations which may contribute to further development in Wadi Jizan as well as in other wadies with similar conditions.

The Study Area

Wadi Jizan is a small area in the South Tihama region (Jizan Province). Of the total land area in Wadi Jizan (43,000 hectares), about half has agricultural potential. The Wadi lies on the Red Sea coast in the southwestern part of Saudi Arabia near the border of



Yemen. It is located between 16°15'N and 17°5'N latitude, and 42°30'E and 45°00'E longitude (Figure 2).

The Wadi Jizan area consists of well-established agricultural lands which utilize the traditional method of flood-irrigation. To Saudi Arabians, Wadi Jizan is known as an extensively agricultural area, and is often called the Saudi Arabian "breadbasket."

Wadi Jizan is divided into two main parts--the Upper and Lower sections. The division is based on the system of water distribution, and is also reflective of water priority. That is, the Upper Wadi Jizan has higher priority in obtaining water than the lower. Irrigable lands from the Wadi Jizan bed are classified into 37 agricultural plots, and the lands furthest upstream receive first priority. The first 15 plots lie in the Upper Wadi, while plots 16 to 37 constitute the Lower Wadi (Figure 3). These agricultural plots make up the area known as the development area.

There are sixty villages and towns in the Wadi Jizan area, comprising a total of about 33,000 inhabitants of which 90% are engaged in agricultural activities. Abu Arish, with 10,853 inhabitants, is the only town in the Wadi. It serves a commercial and government administrative center, as well as a gathering place for the local citizens. About 35km to the west lies Jizan City, located on the Red Sea, a few kilometers south of the Wadi mouth. Jizan City, which has a population



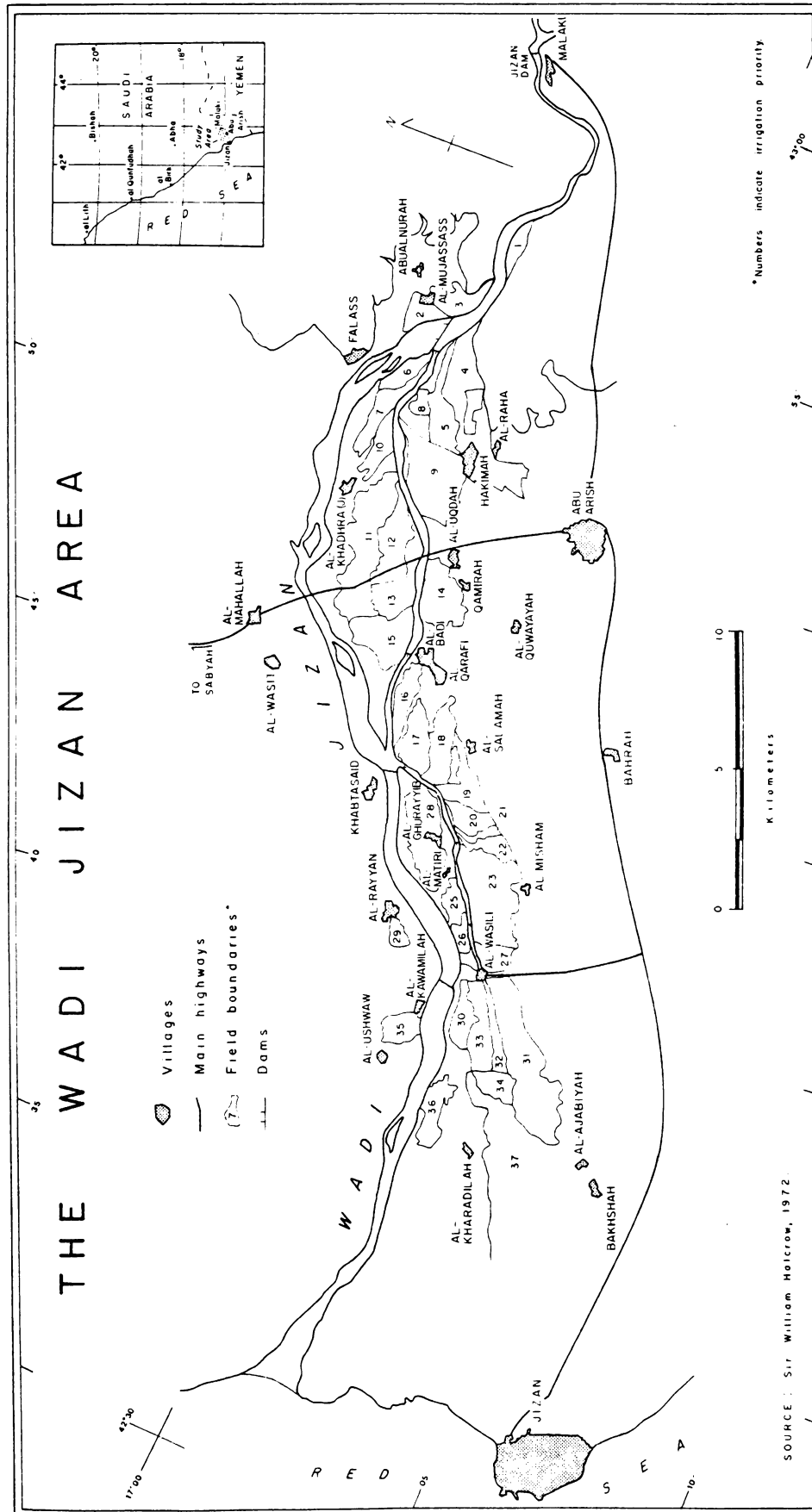


Figure 2



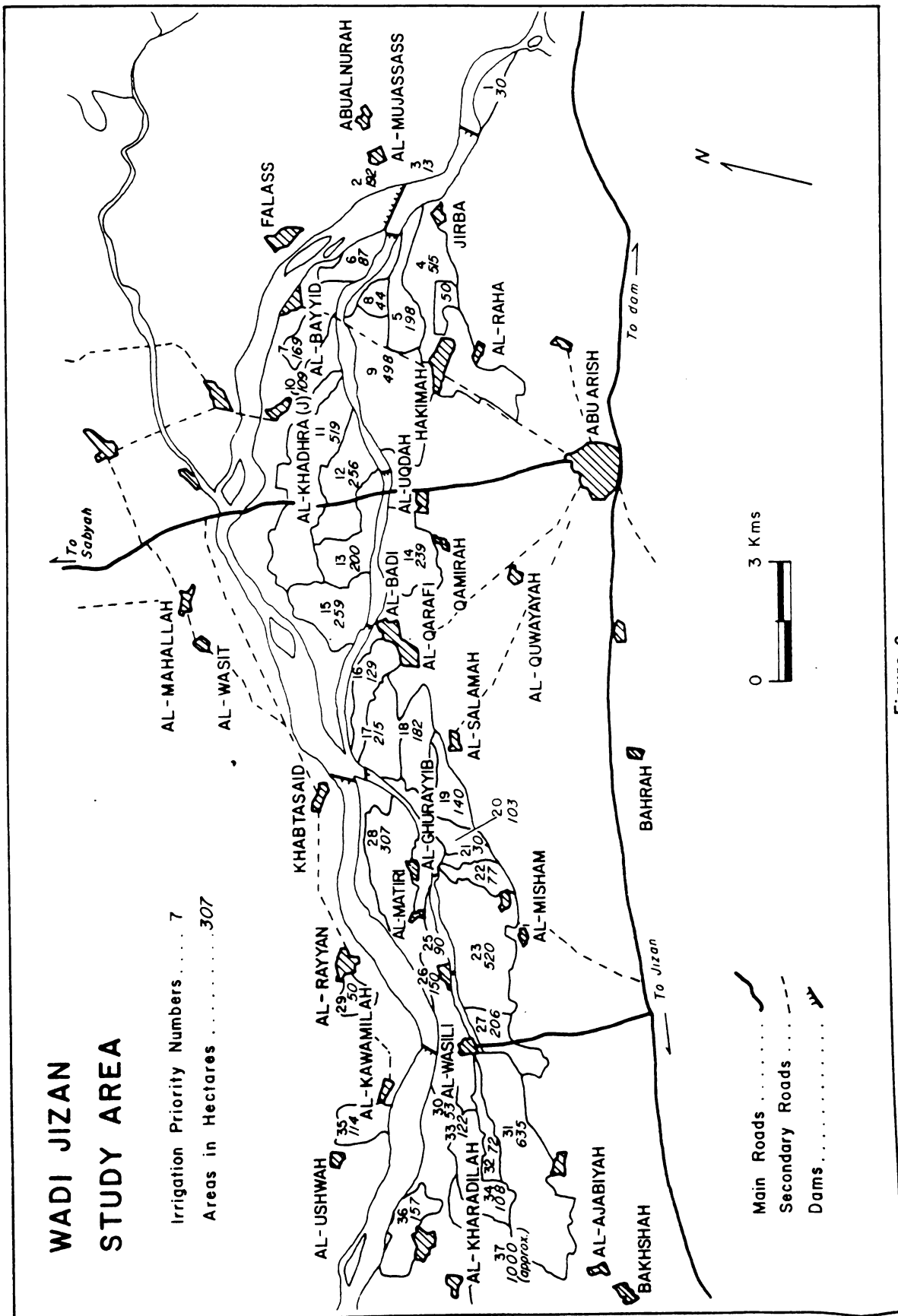


Figure 3



of 27,000, is the capital of the Jizan province and the largest urban center in South Tihama, and is the main transportation and communication center. Most of the government offices are located in Jizan City, as well as the major market places in the area.

Agricultural Development in Saudi Arabia

Studies in the areas of agriculture and applied geography have been conducted, focusing mainly upon agricultural land use patterns, major distribution factors, and trends in the land use patterns. Geography is a discipline concerned with differentiation over space. Agricultural geography aims to explain and discuss spatial differentiation in agriculture.⁴ As geographers seek to present the relationship between man and his environment, agricultural activity creates interesting topics in world geography.

Field work assumes importance for purposes of obtaining detailed information on the agricultural pattern of an area. Micro-region studies usually predominate, with the farm representing the smallest biological and economic unit.⁵ For instance, Henshall reports

⁴Howard F. Gregor, "Geography of Agriculture: Themes in Research," Englewood Cliff, N.J.: Prentice Hall, 1970.

⁵J. W. Birch, "A Note on the Sample Farm Survey and its Use as a Basis for Generalized Mapping," Economic Geography, Vol. 36, 1960, pp. 254-259.



on the condition of crops and livestock in Barbados by studying the structural characteristics of the area's farming system. Utilizing the factor analysis method, her study consists of observations on 158 farms and 48 variables. Through factor analysis, she concludes by defining four basic crop-livestock patterns, summarizing one half of all variations among farms in Barbados.⁶ Dr. Peter Scott, in studying Tasmanian farming methods, utilized another form of farm survey in which questionnaires are distributed; farm size is also considered. He concludes that farm size directly affects the type of farming practiced.⁷

A review of literature related to the geography of Saudi Arabia immediately reveals the scarcity of such information. However, there are several studies which describe, in general, the topography, geomorphology, climate, meteorology, soils, and water resources, which have made a contribution to the geographical literature of the Kingdom.⁸

⁶J. D. Henshall and L. J. King, "Some Structural Characteristics of Peasant Agriculture in Barbados," Economic Geography, Vol. 42, 1960, pp. 74-84.

⁷P. Scott, "Types of Farming in Tasmania," Tijdschrift voor Economische en Social Geografie, Vol. 10, 1961, pp. 2-7.

⁸G. H. Brown, "Geomorphology of Western and Central Saudi Arabia," 21st International Geological Congress, Copenhagen, 21, 1960, pp. 150-159. See also C. K. Davis and J. T. Neal, "Descriptions and Air Photo Characteristics of Desert Lands Forms," Photogrammetric Engineering, 29(4), 1963, pp. 621-631.



In studying agriculture, several studies made by different consultants through surveys set the general guidelines for agricultural potential, as well as agricultural problems, soil analysis, water resources, production and marketing. Such literature, however, is characterized by its scantiness. Also it was prepared for pilot studies or private corporation use.⁹ This is due to the fact that "capital is available for investment in agricultural development, which is retarded by limited supply of water, the size of the market, the need to create a rural infrastructure, and the problem of training and equipping farmers."¹⁰ Agricultural development in Saudi Arabia has been taking place for about fifty years, that is, since 1927, when the legislative council issued a resolution whereby the import of modern agricultural

⁹ Many such studies have been done by the Food and Agricultural Organization of the United States (FAO) and the U.S. Department. See the following:

- 1) J. D. Tothill, "Report to the Government of the Kingdom of Saudi Arabia on Agricultural Development," FAO, Report No. 76, Rome, 1952.
- 2) C. W. Burningham, "Land and Water Resources in Saudi Arabia," FAO, Report No. 40, Rome, 1951.
- 3) H. Holm, "The Agricultural Resources of the Arabian Peninsula," Washington, U.S. Department of Agriculture, 1955.
- 4) L. E. Moe, "Saudi Arabia: Supply and Demand for Farm Products to 1975, with Implications for U.S. Experts," Washington, U.S. Department of Agriculture, 1966.
- 5) D. D. Crary, "Recent Agriculture Development in Saudi Arabia," Geographical Review, Vol. 41(3), 1951, pp. 366-383.

¹⁰ Food and Agriculture Organization of the United Nations, "Hydro-Agricultural Development Progress Interim Report (Up to December 31, 1966) to the Government of Saudi Arabia," Rome, 1967, p. 5.

implements became free of customs duties, followed by the establishment of the Directorate of Agriculture in 1948, which was later transformed into the Ministry of Agriculture and Water (MAW) in 1953.¹¹ The basic aims of the agricultural development policy in Saudi Arabia are: to increase the agricultural and animal production by improving cultivated lands, to raise the standard of living in the rural areas and promote the welfare of the nomads, and to make the country self-sufficient in agricultural products. To carry out these goals, the MAW relies heavily upon its various departments, especially those dealing with research and especially those dealing with research and development and the agricultural extension services.¹²

Since 1964, the MAW has contracted several firms of international reputation to carry out surveys on almost the entire country. However, based on geological, topographical, climatic, hydrologic, and human considerations, Saudi Arabia was divided into eight agricultural areas. By 1970, six of the eight areas had been surveyed, covering an area of 1,281,000 square kilometers¹³ (Table 2). The

¹¹Ministry of Information, Kingdom of Saudi Arabia, "The Kingdom of Saudi Arabia Figures and Facts, Agriculture and Water," National Offset Printing Press, Riyadh, 1976, p. 5.

¹²E. Douglas Johnson, "Report on the Seed Improvement Program to the Government of Saudi Arabia," Beirut, Lebanon, 1974, p. 23.

¹³For more details on the six surveyed areas, see "Evaluation and Use of Area Resources Surveys for Agricultural Development in Saudi Arabia," Stanford Research Institute, Menlo Park, CA, January, 1971, pp. 25-57.



TABLE 2

LIST OF CONSULTANTS AND AREAS SURVEYED IN SAUDI ARABIA

Consultants	Area #	Area in KM ²	Date
Parson Basil	I	370,000	1965-68
Italconsult	II	110,000	1965-69
Italconsult	III	112,000	1965-69
Italconsult	IV	362,000	1965-69
Sogreah	V	105,000	1965-68
Sogreah	VI	194,000	1966-77

Source: Abdel Basset El Khatib, "Seven Green Spikes," Dar al-Qalam Press Co., Beirut, Lebanon, 1974, p. 12.

remaining areas, Rub Al-Khali (Empty Quarter) with 640,000 square kilometers, and the Arabian Shield consisting of 279,000 square kilometers are still being surveyed. The main objectives of the surveys were to develop water and agricultural potentials as well as to exploit more ground water for increased agricultural production. As a result of the surveys, over one hundred reports were submitted to the MAW. Those reports include detailed sketches of soils, water resources, land classification, land use, water rights, the population and labor force,

meteorological data, marketing system,¹⁴ price indexes and transportation.¹⁵ Such reports form the essential groundwork for further study in the country.

According to the surveys, water scarcity is the limiting factor in development. Ground waters are most promising in the northeastern part of Saudi Arabia, while surface waters are abundant in the southwestern region. Ground waters are found in the aquifers of the great sedimentary basin as well as in the Wadi's alluvium.¹⁶ These surveys also found 3.5 million hectares of potential arable lands; about 385,000 hectares could be brought into production.¹⁷ It was also estimated that 75% of the country's arable lands are rainfed.¹⁸ Several

¹⁴A detailed study of marketing in Saudi Arabia is presented in the work done by Clarence J. Miller and Bruce B. Baker in their report titled: "A Program for the Improved Marketing of Agricultural Commodities in Saudi Arabia," Special Report No. 3, SRI Team Series, January 1971.

¹⁵In this respect see the following: "Agriculture for Saudi Arabia," MAW, Kingdom of Saudi Arabia, pp. 1-18, and "Soil and Land Classification in Saudi Arabia," by James E. Paseur, December 1971, pp. 9-42; also, see "Soil and Water Studies in the Kingdom of Saudi Arabia," A General Report by Peter Loizides.

¹⁶Food and Agricultural Organization of the United Nations, "Hydro-Agricultural Development Progress Interim Report (up to December 31, 1966) to the Government of Saudi Arabia," Rome, 1967, p. 3.

¹⁷Abdel Basset El Khatib, "Seven Green Spikes," Dar al-Qalam Press Co., Beirut, Lebanon, 1974, xiii.

¹⁸MAW, Kingdom of Saudi Arabia, "Development Plan 1395-1400, 1975-1980," Part 1, "The Agricultural Sector," Riyadh, 1976, pp. 4-5.



projects for agricultural development stemmed from these widespread surveys, the most important of which are: the agricultural development of Al-Hassa Oases, the Al-Qatif development project, water for cities, desalination plants, agricultural laboratories, and several dams.

The surveys also helped define the biggest obstacles in successful agricultural development. The greatest problems of the farmers were found to be: soil salinity and alkalinity, lack of nutrients, lack of proper irrigation and drainage networks, lack of fertilizers and pesticides, leaching requirements, and lack of knowledge about proper planting times. To help alleviate such problems, development and training areas were set up at Al-Hassa and South Tihama where farmers obtain help with improving agricultural methods, mechanization, and irrigation systems.

In terms of the study area (Wadi Jizan), however, little material is available as very few studies have been done. Among the most important writings in this respect are: the reports submitted by FAO experts between 1952 and 1955; by Italconsult in 1965; and finally, by Sir William Halcrow and Partners in 1972. The work done by FAO experts consists of five reports:

1. N. Simansky, "Report to the Government of Saudi Arabia on the Preliminary Project for Land and Water Use Development in Wadi Jizan," FAO, Report No. 410, Rome, 1955.
2. Howard J. Ferries, "Report to the Government of Saudi Arabia on Reconnaissance Soil and Land Classification of the South Asir Tihama," FAO, Report No. 69, Rome, 1953.

3. Andrew J. de Vajda, "Proposal for the Wadi Jizan Irrigation Development Scheme--Saudi Arabia," FAO, Report No. 81, Rome, 1953.
4. C. I. Finielz, "A Soil Study Classification and Utilization with Respect to Irrigation in the Wadi Jizan Area," FAO, Report No. 13, Rome, 1955.
5. C. O. Van der Plas, "Report to the Government of Saudi Arabia on the State of Agriculture in the South Tihama Area," FAO, Report No. 80, Rome, 1953.

The previous reports are essential in studying the agricultural state of the Wadi Jizan in the past, as well as forming the preliminary work which opened the door for further investigation.

Based on the conclusions of the FAO experts, which saw in the Wadi Jizan great agricultural potential, as well as need for extensive development, Italconsult, in 1962, was contracted to provide detailed engineering design and agricultural potential. The final report by Italconsult, Land and Water Surveys on Wadi Jizan, Rome, 1965, consists of eight volumes covering the areas of climate, hydrology, soils, land use, agricultural and animal products, socioeconomic factors, geology, and groundwater. The report is an extensive compiling of description, information, figures, maps and diagrams required for an overall understanding and appreciation of the area.

The final survey in Wadi Jizan was done by Sir William Halcrow and Partners in 1972. The survey covered soil types, land classification, land tenure, and water rights; agricultural and livestock; engineering; and economic appraisal. This work is presented in the report

titled Irrigation Development in the Wadi Jizan, Saudi Arabia, London, 1972. The final report entails a main report which is supplemented by six volumes of annexes. The report is illustrated by maps, graphs, and diagrams.

The Halcrow report, along with the FAO and Italconsult reports serve as the primary references for this study, as they helped in understanding and presenting the physical and human characteristics of the area. Furthermore, they lay the foundation for presenting the existing agricultural patterns, and problems of the area, those experienced in the past, and, most importantly, those planned for the future.

There is a continuing struggle in Saudi Arabia to reach a self-sufficiency level in food production. In 1975, about 55% of the total food consumption was locally produced; however, imports are on the increase and self-sufficiency is not imminent.¹⁹ The government assists farmers by subsidizing supplies and loans and instigating development. The amounts are calculated according to region since obviously, each area has its own attributes as well as needs. Despite these government programs, there is a definite need for more research into land and water resources.²⁰

¹⁹Ministry of Planning, Kingdom of Saudi Arabia, Second Development Plan 1395-1400, 1975-1980, 1976, p. 115.

²⁰For more detail, see "A Plan for Development of the Agricultural Sector of Saudi Arabia, Proposed Courses of Action for a Near-Term of Growth" prepared for MAW, Kingdom of Saudi Arabia, by Stanford Research Institute, Menlo Park, CA, January 1971, pp. 25-59.

Agriculture, then, is a very important aspect in the economic development of Saudi Arabia. Improvements such as the Wadi Jizan Project are essential in agricultural development.



Chapter II

GENERAL BACKGROUND

In order to evaluate the agricultural potential in an area, it is necessary to have a basic understanding of the physical and human factors which are involved in its development. Such an evaluation will provide the base for expanding into specific areas of agricultural and geographical study in order to determine possible development. Such is the case in studying the Wadi Jizan area. The purpose of this chapter is to attempt to explore and define the general physical landscape and cultural base which make Wadi Jizan an interesting area with high development potential. It outlines the general physical factors, such as topography, natural vegetation, climate, soil classification, and hydrology, which establish the adequacy of Wadi Jizan as an agricultural society. Basically, it provides the necessary base for studying the landscape of Wadi Jizan.



Physical Features

Topography

The area above the Malaki Dam is part of the Asir mountain range, from which numerous water-courses descend. These tributaries result from the recurring floods during the monsoon summer. Moving eastward from the plain, there are three zones which can be identified with altitudes of 200-1500M, 1500-2000M, and over 2500M respectively. Generally, this area consists of precambrian, plutonic, magnetic and metamorphic rocks combined with tertiary plateau basalts.¹ The area just above the plain forms the catchment basin of Wadi Jizan and is an open plateau, a configuration which has undergone extensive erosion.

The area below the dam is distinguished by the watercourse and the Wadi Jizan Plain. The watercourse rises to an altitude of approximately 2500M above sea level in the Asir mountains as it passes through the catchment area mentioned above. Running in a westerly direction, it cuts through a recent basalt flow which confines the Wadi to a narrow channel near the Malaki village. Subsequently, the river opens into the plain alluviums located between the Al-Mujassass

¹N. Simansky, "Report to the Government of Saudi Arabia on the Preliminary Project for Land and Water Use Development in Wadi Jizan," Food and Agriculture Organization of the United Nations (FAO) Report, No. 410, Rome, 1955, p. 17.

and Al-Rahah villages. The river bed consists of fine silty sands together with fragments of basic rocks and a few pebbles (Figure 4). At Aqum Al-Difa,² the Wadi Jizan divides into two branches: the northern, which is 70-80M wide, and the southern, which is 20-30M wide. The two branches merge again at Aqum Al-Za'jah to make one main watercourse of the Wadi Jizan. In addition, there is a little branch which splits out from the main valley to flow in a south-westerly direction, ending at Aqum Al-Qunayman. The forementioned portion is clear of vegetation and is composed of medium-grain sand rich in quartz, and also basic rock fragments. The remaining portion of the watercourse bed from the Al-Rayyan to Al-Khasawiyah Al-Shamiyah villages is wider, more consistently planed and composed of medium-grained quartz sands, which are smaller than those in the preceding stretch of bed.³ As the Wadi flows downstream the bed broadens considerably and becomes densely vegetated. The river is no longer discernible below Al-Khasawiyah Al-Shamiyah village, as it loses itself in the central plain before reaching the sea a few kilometers north of Jizan town.

²Aqum (Pl. Uqum) Earthbound for the diversion of flood waters from the Wadi bed to the fields.

³Italconsult, "Land and Water Surveys on the Wadi Jizan," IV, pp. 23-26, Rome, 1965.



The Wadi Jizan plain is a subdued alluvial plain built by the river and reaching westward almost as far as the Red Sea. This alluvial plain consists of sedimentations eroded from the older rock formations within the drainage area of Wadi Jizan. Since there are numerous floods in this area, the deposition which formed the plain was a rapid process. The plain is bordered by the edge of the outcrops of lava in the east, by the end of the agricultural lands five kilometers before reaching the sea in the west, the northern branch of Wadi Jizan, and the area about five kilometers south of the northern branch of the Wadi Jizan. This area represents most of the agricultural lands which are irrigable by the run-off water of Wadi Jizan.

Other features include the basalt flow which covers a vast area east and south of the Wadi Jizan plain as far as the town of Abu Arish (Figure 5). Dunes are scarce in the upper Wadi Jizan, but are seen south of the irrigable plain between Al-Qwayah and Al-Fuqaha villages and the Jizan-Abu Arish highway. Dunes are also clustered south of Bakhsha Yamaniyah and throughout the coastal plain.

Climate

From the available information on the weather conditions in the area, it is possible to briefly discuss the climatic elements of Wadi Jizan.





Lava outcrops east of
Abu Arish.

Photograph taken by author.

FIGURE 5



Temperature

The monthly mean temperature at Abu Arish (69M above sea level) ranges from 22.5°C in January to 34.3°C in July. This is only slightly different from the monthly mean at Malaki village (178M above sea level), which ranges from 22.3°C to 32.2°C, and at Ardah Village (228M above sea level), where mean temperatures range from 18.2°C to 24°C. The highest temperatures were recorded in June at 38.7°, 34.4°, and 28.0°C; while the lowest readings were in January at 20.4°, 19.9°, and 15.8°C at Abu Arish, Malaki, and Ardah respectively. The hot season is from May to October, while temperatures are relatively lower the remainder of the year (Figure 6). In evaluating this data it should be kept in mind that differences in elevation between the three observation points, as well as their various distances from the sea level could have an appreciable effect on these findings, although the influence of the sea diminishes rapidly as distance from the coast increases.

Humidity

Readings taken at the three weather stations indicate that the relative humidity in Wadi Jizan has been consistently high. The greatest average annual percentages were found to be 97%, 91%, and 73% at Abu Arish, Malaki, and Ardah villages respectively. The mean



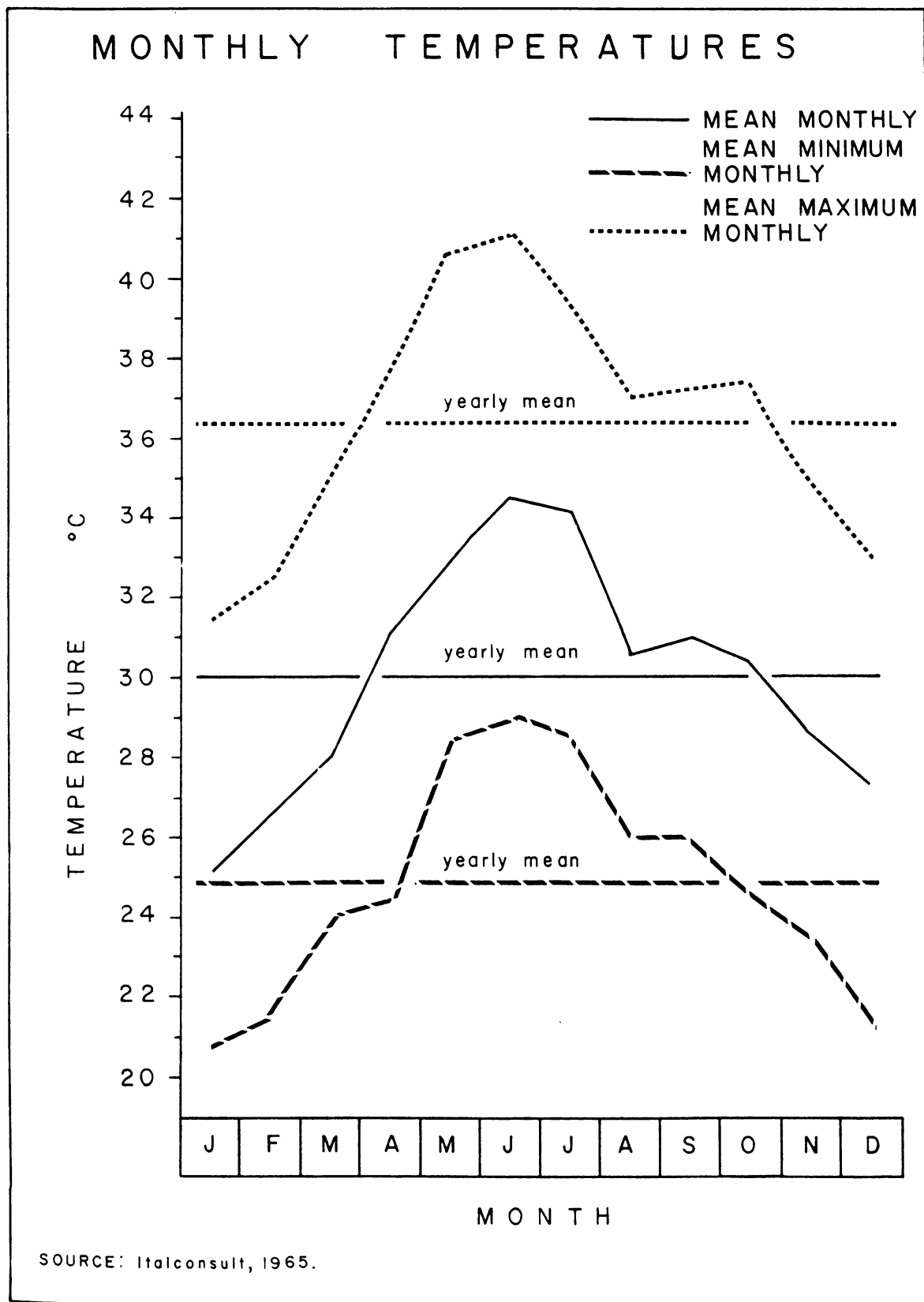


Figure 6

monthly relative humidity varies from 30% to 42% at Abu Arish and is more than 50% at both Malaki and Ardah. The monthly average shows a peak of 80-90% between June and August, while this measure is less than 60% for the remainder of the year.

Wind and Air Pressure

The most prevalent winds in Wadi Jizan are the southwesterly winds which occur during the monsoon season, and the northeasterly winds which occur during the winter months. They are basically mild and records show means from 250 KM per day in January to approximately 325 KM per day in July 1968-1970.⁴ The high pressure occurs between December and January when the anti-cyclone of northeast African and the Arabian Peninsula are most dominant. Low pressure occurs in July and August when the depression of south and central Africa moves northward to include the Red Sea, and when the monsoon formations act over southern Saudi Arabia and Yemen.

Rainfall

Wadi Jizan lies on the southern side of Saudi Arabia known as the southwestern Asir region. Although the agricultural lands in the

⁴Sir W. Halcrow and partners, "Irrigation Development in the Wadi-Jizan--Saudi Arabia," Annex 4, p. 5, London, 1972.



Wadi are found in the lower part of the region (South Tihama), the most important and valuable section of the Wadi is the catchment area above the dam, because of its comparatively high altitude and suitable location with respect to "the Inter Tropical Front, which brings [it] for part of the year under the monsoonal effect of the Indian Ocean."⁵ It is obvious that the climate of Wadi Jizan is governed by the movement of the Inter Tropical Front and the geographical features of the area. Thus, the most abundant rainfall occurs in the Asir mountains when the edge of the monsoon extends northward into Saudi Arabia. Actually, rainfall is very irregular and concentrated in relatively short but heavy storms. The rainfall distribution pattern may be seen as classified into those areas above the dam, and those below. In the catchment area records show that the mean annual rainfall at Jebel-Sala (Elev. 900M) is 534.8MM and at Ardah (Elev. 223M) it is 593.5MM. The highest monthly rainfall at both stations in August of 1974 was recorded to be 340.5MM at Jebel-Sala, and 283.4MM at Ardah.⁶ However, the minimum monthly rainfall for the remainder of the year is zero.⁷

⁵W. B. Fisher, "The Middle East," Sixth Ed., printed in Gr. Britain by Butler and Tanner Ltd., Frame and London, 1971, p. 447.

⁶Hydrologic Division, Ministry of Agriculture and Water, Saudi Arabia, Hydrological publications of 1974, Riyadh, S.A.

⁷Sir W. Halcrow and partners, "Irrigation Development in the Wadi Jizan, Saudi Arabia," Annex 4, London, 1972, p. 6.



The area below the dam, which is the area of the project itself, represented by Abu Arish, experiences a mean rainfall of 247.5MM. This amount decreases to less than 100MM in the area from Abu Arish to the Red Sea. The rainy season is from July to September (Figures 7 and 8) when 90% of the runoff occurs, with negligible amounts from December to May.⁸

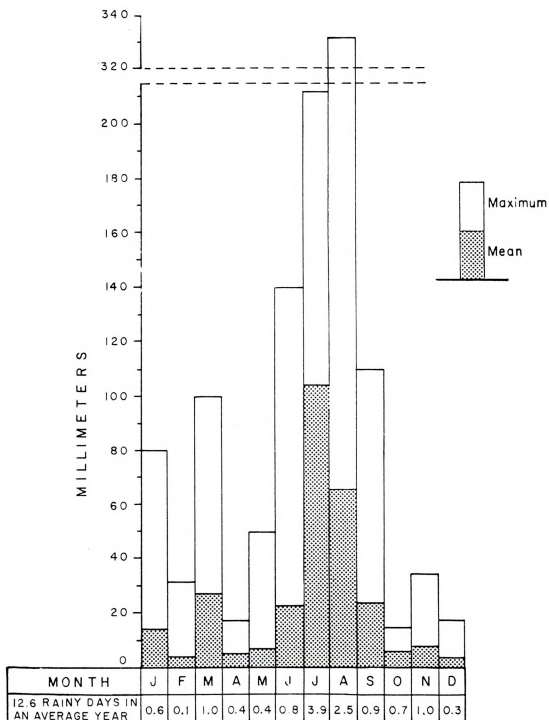
From the previous discussion, one may conclude that the most prevalent climatic elements in the area are temperature and rainfall. Temperature is consistently high year-around, but is highest during the summer. Variations in temperature are limited and accounted for by distance from the sea as well as level of elevation. The coastal plain is dry and warm in the winter, and hot and humid in the summer. As the area rises toward the dissected highlands, the temperature regularly drops, resulting in increased precipitation.

The Wadi Jizan area has a typical desert to semi-tropical climate consisting of high winds and dust storms, which occur particularly in the coastal plain and foothills.

⁸N. Simansky, "Report to the Government of Saudi Arabia on the Preliminary Project for Land and Water Use Development in Wadi Jizan," FAO, Report No. 410, Rome, September, 1955, p. 13.



ABU ARISH: MEAN MONTHLY RAINFALLS 1953-1963



SOURCE: Italconsult, 1965.

Figure 7



AVERAGE ANNUAL RAINFALL IN NATURAL REGIONS OF SAUDI ARABIA

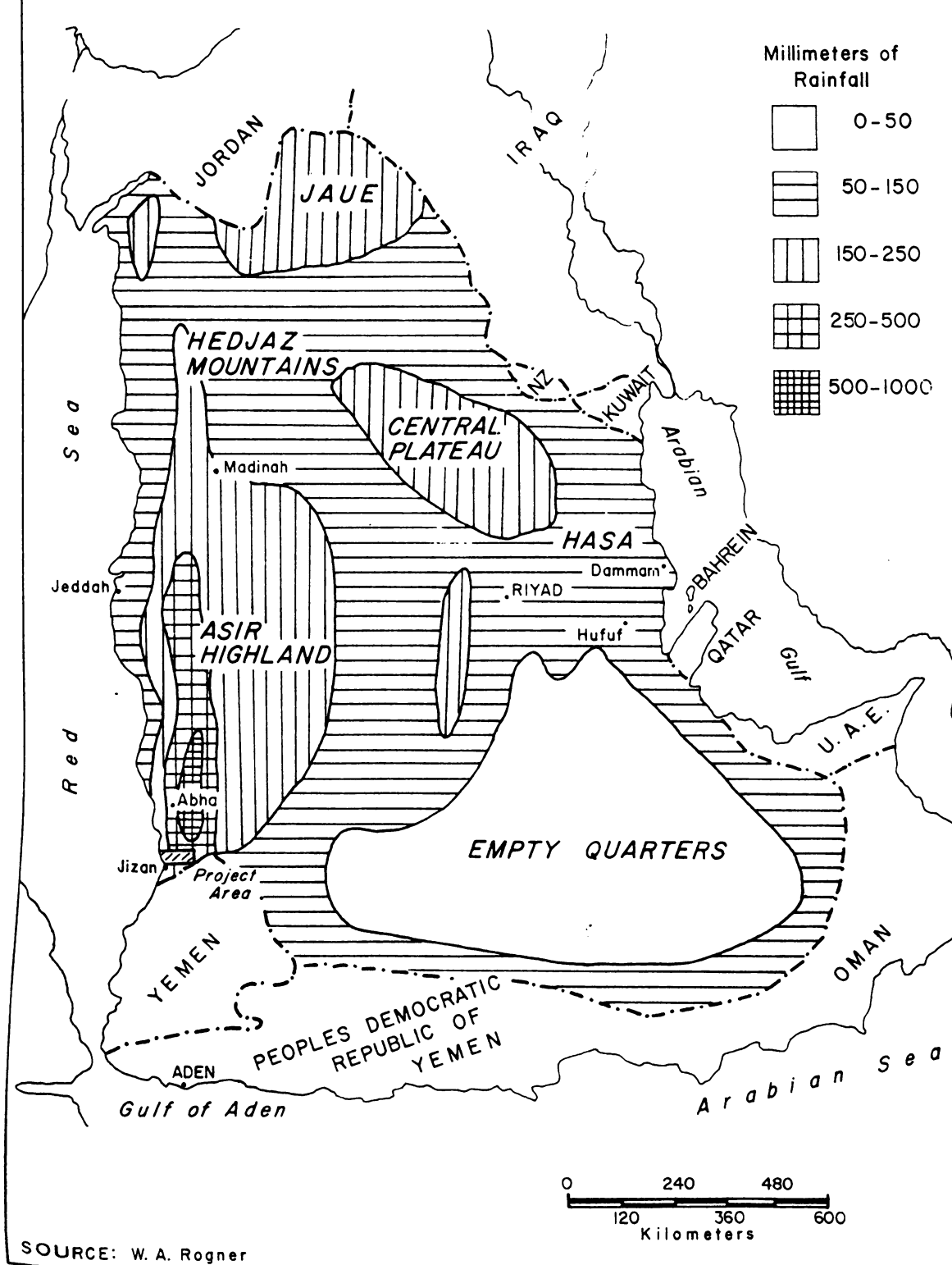


Figure 8



Hydrology

Two main water resources, surface and ground water, can be considered in studying the hydrologic situation in Wadi Jizan. Floods occur during the rainfall season, but their distribution through the year does not follow a uniform pattern. The annual flows vary from year to year, and floods number from "15-33 per year with a volume of 0.5-10 MCM per flood."⁹ From the available records on the hydrologic information for the 19 years from 1953-1971 at Malaki station, monthly and annual flow volumes are extremely varied. The highest amount of annual runoff was 192.0 MCM in 1964 while the lowest volume was 21.0 MCM in 1971 with a mean of 79.5 MCM for all of the 19-year volumes. The highest monthly average volume of floods occurs from July to September with a few other rather small ones in January and February (see Figure 9). Two periods--the wet and the dry seasons--occur mainly in February to September and October to January, respectively. The typical floods rise to their peak in a few hours and then subside almost as quickly.¹⁰

In addition to the surface water floods, the ground water is of great significance for irrigation in the area. Based on

⁹Abdel Basset El Khatib, "Seven Green Spikes," Dar al-Qalam Press Co., Beirut, Lebanon, 1974, p. 134.

¹⁰Sir W. Halcrow and partners, "Irrigation Development in the Wadi Jizan, Saudi Arabia," Annex 4, London, 1972, pp. 4-5.



WADI JIZAN AT MALAKI

TYPICAL FLOW DIAGRAMS

SOURCE:
Italconsult, 1965.

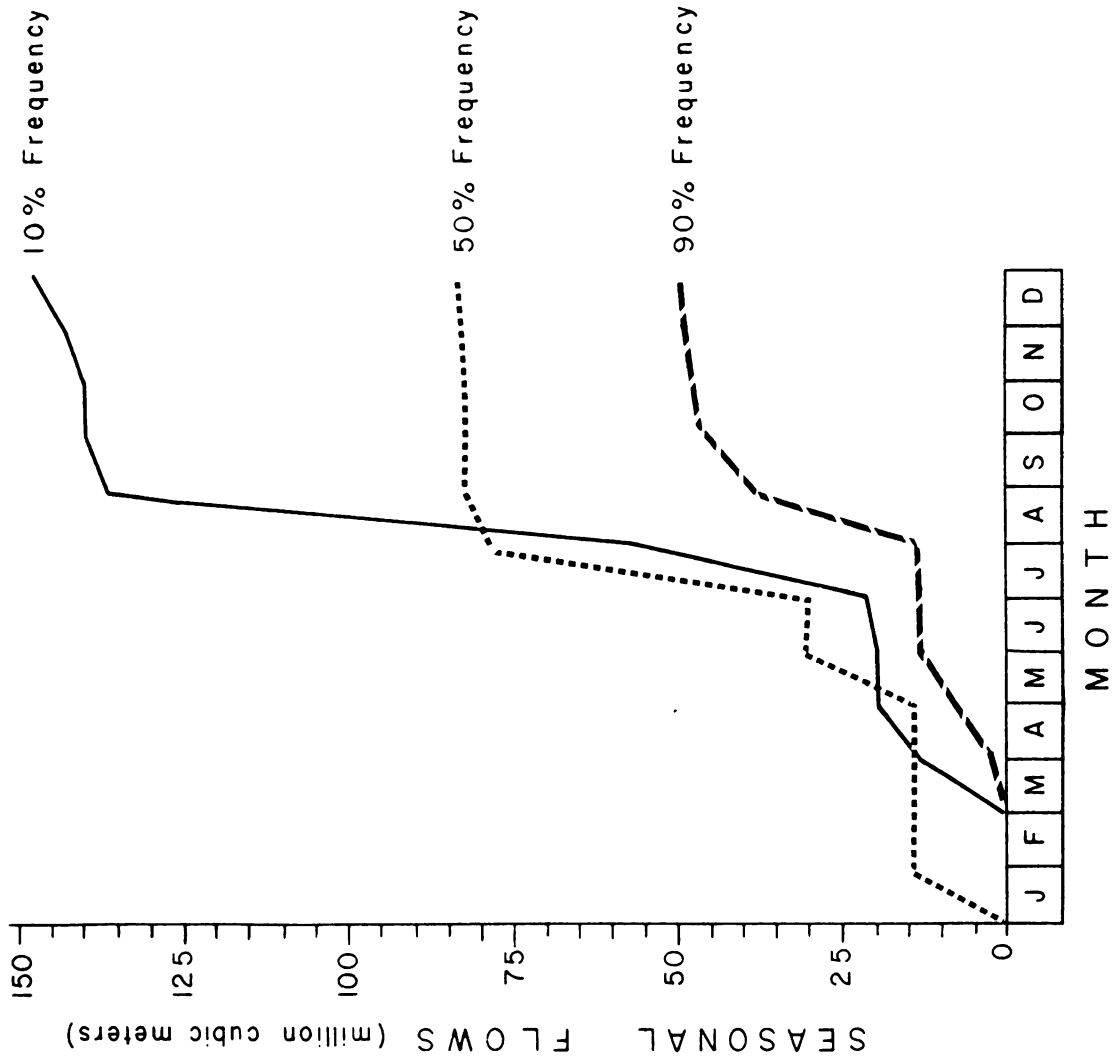


Figure 9



hydrological and topographical consideration, Charles Bettinger considers the ground water in the area as a result of interconnections among

three zones, recharge, conduit, and discharge. The recharge zone is at the upper part of the plain where principal ground water intake occurs. The transmission of ground water is through the conduit zone. This zone includes the area of moderate topographic and water table slope and moderate ground water fluctuation. Transmission depends on intake efficiency and supply of recharge zone, on the efficiency of the discharge zone, and on generally moderate permeability. The discharge zone, an area of ground water escape, is caused by lessening topographic slope and low permeability. This results in intersection of the water table with ground surface, making ground water available for use by plants and disposal by evaporation.¹¹

Studies on the ground water in Wadi Jizan have proven the presence of an aquifer underlying almost the entire Wadi Jizan Plain. This aquifer contains an estimated 2000 MCM of ground water. The aquifer, however, is fed by percolation from flood spates through the Wadi Jizan bed and from other neighboring Wadi beds as well as by direct and small runoff of more or less recharge effect. The major aquifer of Wadi Jizan is in the alluvial deposits with thicknesses varying from a few meters adjacent to the lava flows, up to 100M in the center of the Wadi Jizan plain with an associated ground water table which varies from a depth of 3M below the Wadi bed, up to 10M below ground level

¹¹C. Bettinger and T. Dincer, "Report on Ground Water Possibilities in the Wadi Jizan," Riyadh, Saudi Arabia, 5-1-1972, p. 5.



(see Figure 10). This aquifer consists of heterogenous alluvial deposits, involving rocks, shales, and sandstones covered by the alluvial sedimentations added by floods. Finally, studies with respect to ground water quality state that areas of least salinity hazard occur at the eastern edge of the Wadi, wherever the salinity increases down the Wadi toward the coast.¹²

Soils and Land Classification

Detailed studies of the soils and land distribution were made by C. I. Finielz in 1955. Finielz described the soils as being quaternary sediments, mainly alluvial, ranging from sands to clay loams. Six soil types comprised the Finielz classification (Figure 11). His classification was based on three criteria: origin of soil material, development, and texture. The distribution established by Finielz categorized Wadi Jizan into three land groups. He estimated that soils of classes I, II, and III cover an area approximately 8,120 hectares which are suitable for all irrigable crops. Soils of classes IV and V cover an area of 15,190 hectares which are suitable for deep-rooted plants, but less sufficient for other root systems.

¹²Sir W. Halcrow and partners, "Irrigation Development in the Wadi Jizan," Saudi Arabia, Annex 4, London, 1972, pp. 19-26.



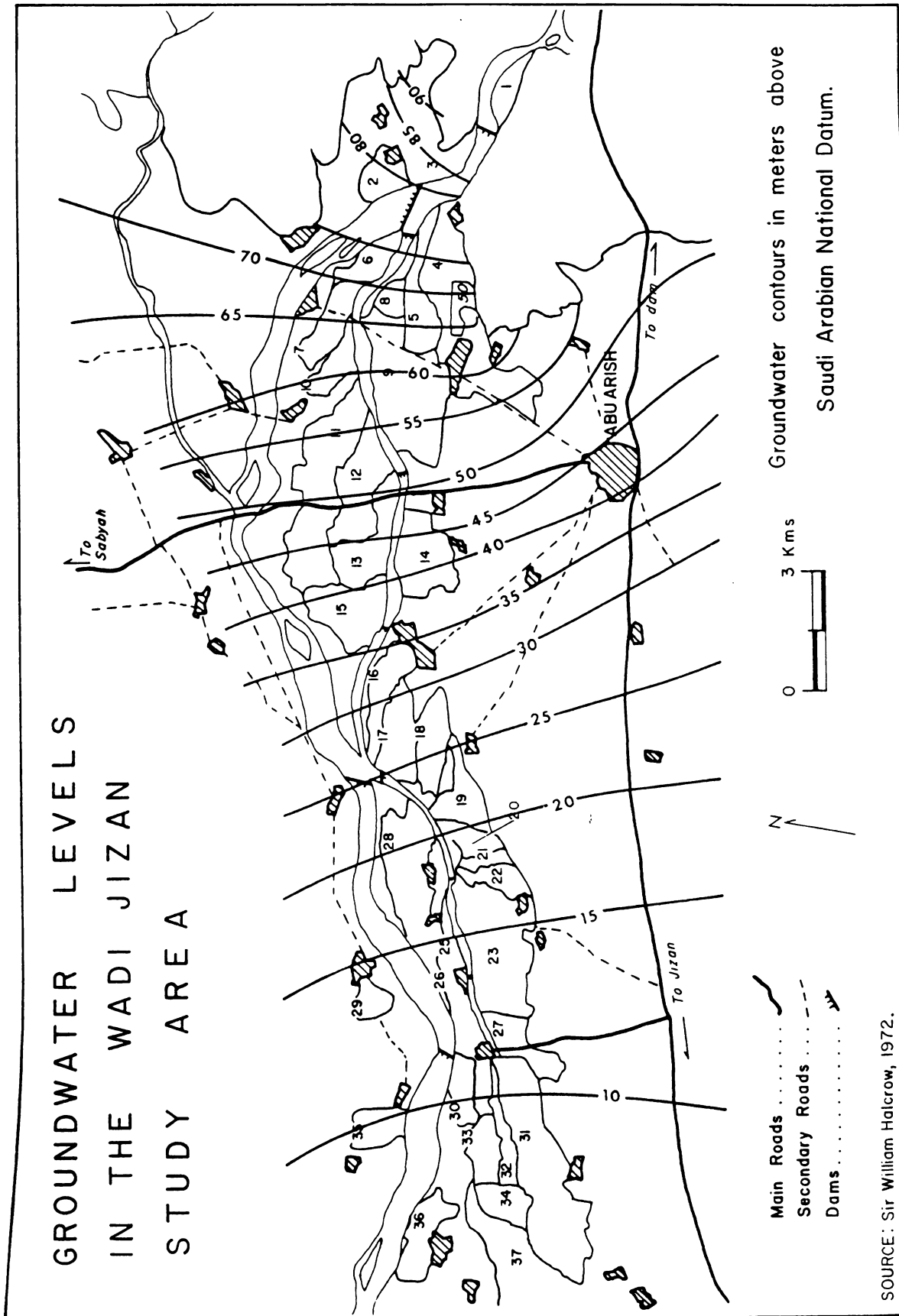
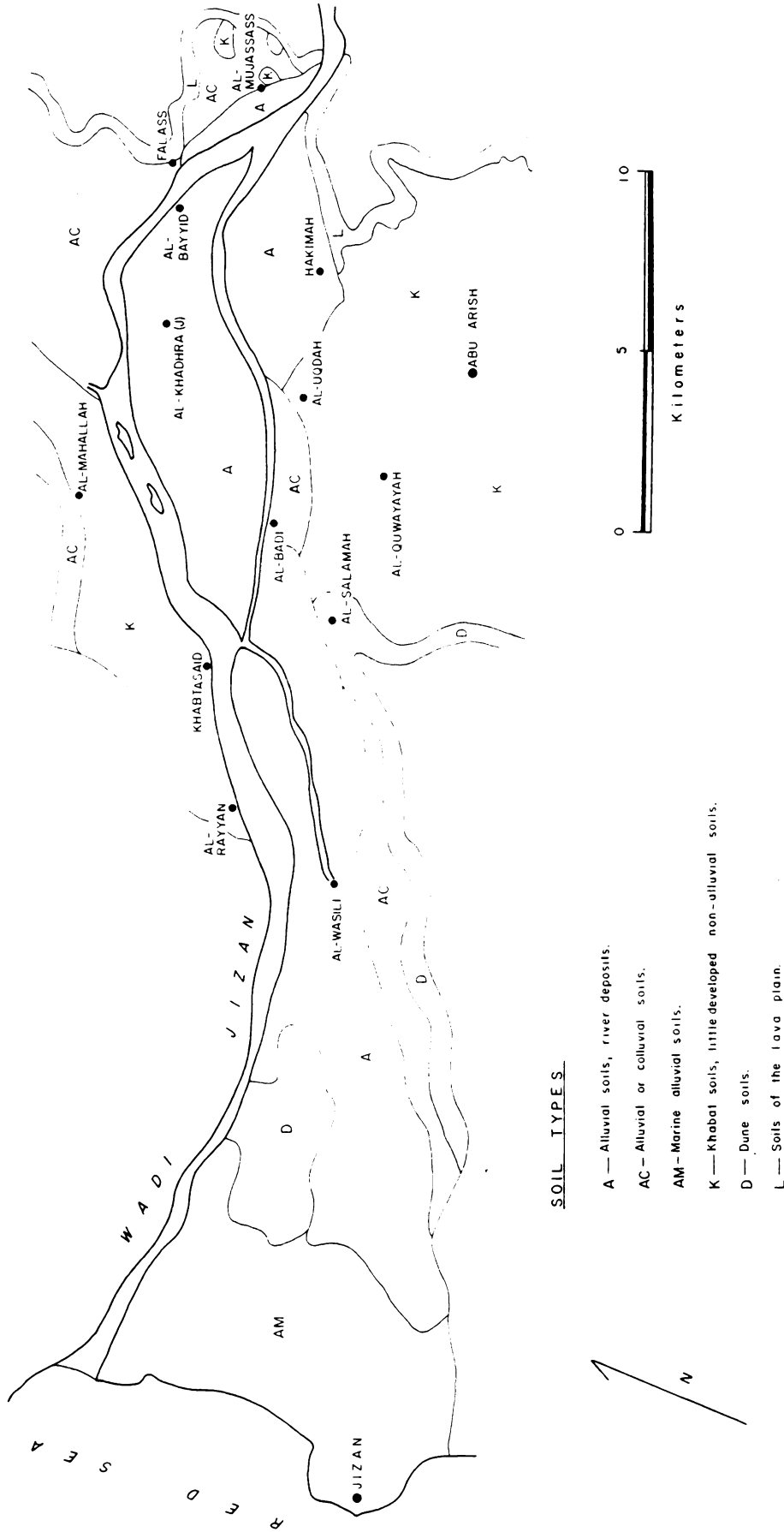


Figure 10



WADI JIZAN SOIL TYPES (FINIELZ CLASSIFICATION)



SOIL TYPES

A — Alluvial soils, river deposits.

AC — Alluvial or colluvial soils.

AM — Marine alluvial soils.

K — Khabat soils, little developed non-alluvial soils.

D — Dune soils.

L — Soils of the lava plain.

Source: C.I. Finielz, 1955.

Figure 11

Finally, soils of class VI cover an area of 1,440 hectares which are capable of yielding shallow-rooted crops.¹³

Italconsult made use of this study in 1962-63 and supplemented it by examining a number of additional samples collected at various points throughout the Wadi Jizan plain. Their results were basically in agreement with those of Finielz' survey.

Carrying his research one step further, Finielz made use of his soils classification to produce land capability classifications. The classification according to land capability made by Finielz (Figure 12) indicates that about 24,750 hectares of the lands in Wadi Jizan are suitable for irrigation. Italconsult found that areas potentially irrigable from the Wadi Jizan, or those which are agriculturally or economically linked to it, amounted to 22,500 hectares.¹⁴ Indeed, the soils analysis made by Italconsult showed that on the whole, the fertility of the soils is not high, and furthermore, may be affected by changes in conditions.

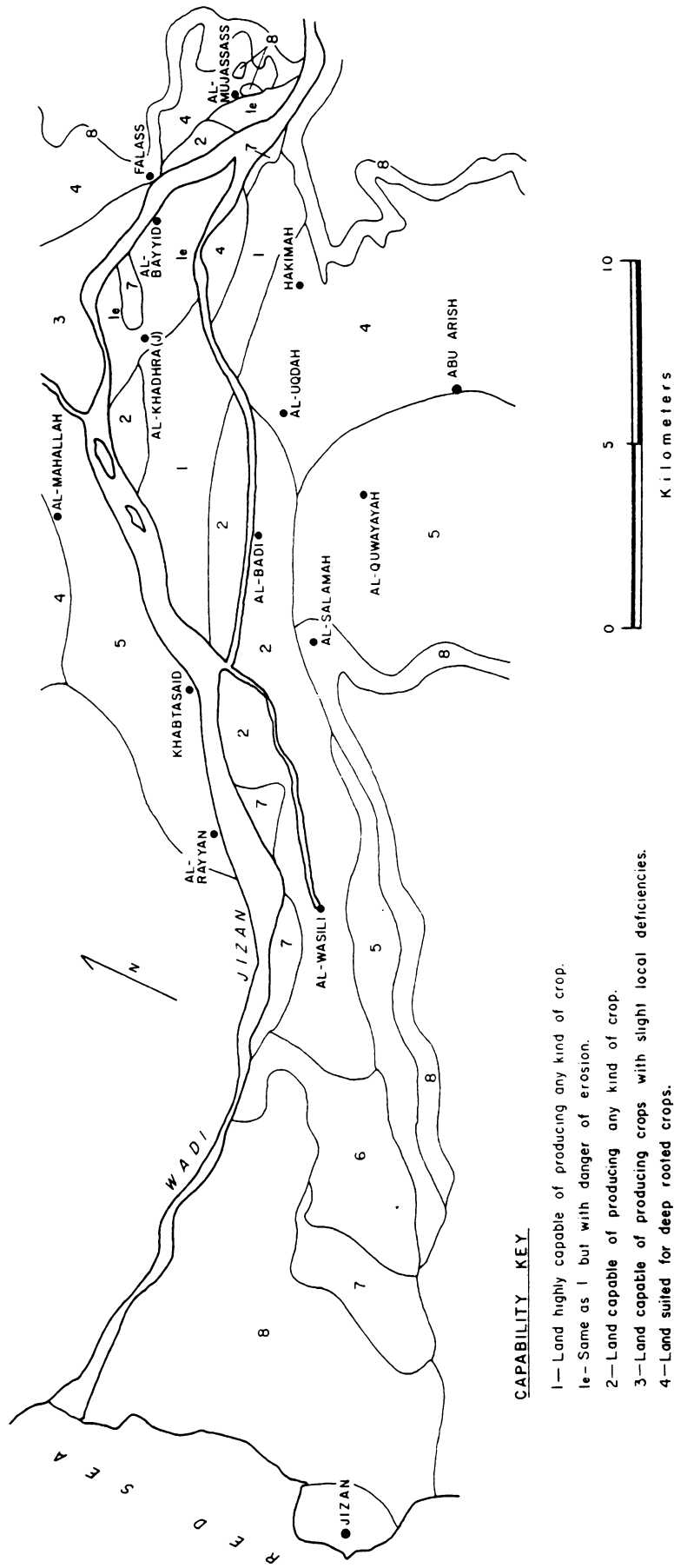
A more detailed study on soils and land classifications was undertaken by Sir W. Halcrow et al. in 1972. This study was

¹³C. J. Finielz, "A Soils Study, Classification and Utilization with Respect to Irrigation in the Wadi Jizan Area," FAO, Report No. 13, Rome, Oct. 1955, pp. 4-11.

¹⁴FAO, "Land and Water Surveys in the Wadi Jizan, Saudi Arabia," Vol. 1, General Report, Rome, 1966, p. 22.



WADI JIZAN — LAND CAPABILITY (FINIELZ CLASSIFICATION)



CAPABILITY KEY

- 1—Land highly capable of producing any kind of crop.
- 1e—Same as 1 but with danger of erosion.
- 2—Land capable of producing any kind of crop.
- 3—Land capable of producing crops with slight local deficiencies.
- 4—Land suited for deep rooted crops.
- 5—Land of inferior quality, suitable for deep rooted crops.
- 6—Land suitable for shallow rooted crops.
- 7—Land with restricted utility for irrigation.
- 8—Land not suited for irrigation.

Source: C. I. Finielz, 1955.

Figure 12



essentially initiated to meet the need for more accurate and well defined information on the soil types and irrigable areas of Wadi Jizan. It was principally based on the soil's overall textured profile and on the presence or absence of older, redder, and more compact sediments in the top 75 CMS of the soil. The conclusion of this study identified seven depositional soil series, of which several were further subdivided into phases. Soil texture ranges from coarser, silty clay loams to light loams in the upper Wadi Jizan north and east of Hakimah. In the areas north and south of the Wadi, in the center of Al-Uqdah, Al-Khadra Al-Shamiyah and Al-Qarafi, soils become loams and sandy loams. Further west, beyond the preceding villages, substantial areas of fine- and medium-texture soil continue. Soil colors vary from dark brown to dark yellow-brown and in some cases, red is observable. With respect to soil structure, the most distinct depositional features are the platy structure of medium and fine textured flood sediments. Generally, soils in the Wadi Jizan exhibit moderate to weak structure.¹⁵

The land classification made by Sir W. Halcrow et al. was based on that of the United States Department of the Interior.¹⁶

¹⁵Sir W. Halcrow and Partners, "Irrigation Development in the Wadi Jizan, Saudi Arabia," Annex 1 (Soils and Land Classification), London, 1972, pp. 17-57.

¹⁶As laid down in their Bureau of Reclamation Manual, Vol. V, Part 2 (1953).



Although they followed this classification, some differences were introduced in view of the circumstances prevalent in Wadi Jizan. That is, since the classification of the soils of Wadi Jizan was based on the nature of the texture profile, as well as overall moisture capacity and suitability for irrigation agriculture, the land classification boundaries frequently followed those of the depositional soil series mentioned before (Figure 13). In addition, factors influencing land capability, such as soil texture, nutrient status, salinity, and alkalinity, available moisture capacity, drainage, and landform were taken into consideration.

As a result, four classes of land were developed. Classes one, two, and three are considered arable lands, while the fourth type is considered unarable land, which is designated class six by the U.S.D.I.R. The four land categories as prepared by Sir W. Halcrow and partners are summarized in the following data:

Categories	Characteristics
Class One	--highly suitable for irrigation agriculture
	--capable of producing high yields
Land	--have level or very gently sloping
(100 hectares)	--soils deep and of medium to fairly fine texture
	--free drainage and good available moisture capacity
	--land development can be accomplished at relatively low cost



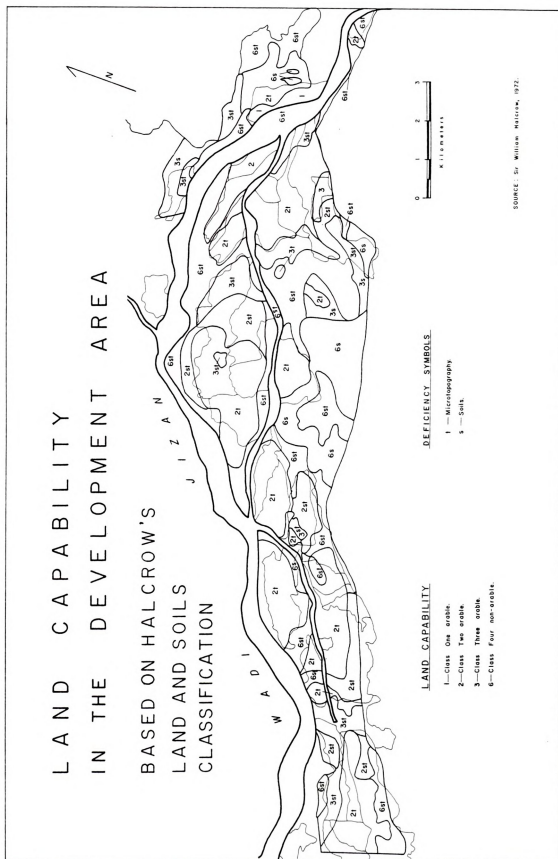


Figure 13

Class Two	--lands of moderate suitability for irrigation
	--lower than Class One in productivity capacity
Land	--more expensive to prepare for irrigation
(3,950 ha)	--soils have lower available moisture capacity
	--more stratified soil, and have infield topography
	--a degree of salinity and farm drainage at moderate costs
	--have an intermediate payment capacity

Class Three	--suitable for irrigation development, but have more extreme deficiencies in soil and topography
Land	--low in available moisture capacity
(2,000 ha)	--soils are coarse and stratified with very poor topography
	--a high risk is involved in farming Class Three
	--under a proper management it is expected to yield adequate returns

Class Six	--extreme deficiencies in soils and topography
	--very coarse, high stratified and have irregular topography
Land	
(4,100 ha)	--do not have sufficient payment capacity

It is obvious that soil and land classification, as made by Finielz and later adopted by Italconsult, based on the same criteria, showed broad generalization and did not take into account the applicability or cost of irrigation from Wadi Jizan to the 24,750 hectares estimated by Finielz or the 22,500 hectares estimation of Italconsult. The estimation of land capability given by Sir W. Halcrow and partners which covers an area of 10,150 hectares seems to be more conclusive, since it takes into consideration more factors, such as soil types, topography, drainage, salinity, among others.



Natural Vegetation

An area of about 50,000 hectares of range land is being utilized by livestock from Wadi Jizan.¹⁷ This area consists of a variety of native plants, of which only the dominant types are considered. Rainfall and land types along with range conditions, plant species, and livestock are factors taken into consideration in presenting the general landscape of Wadi Jizan.¹⁸

Keeping these factors in mind, the Wadi Jizan area is classified into range sites. The alluvial plain of Wadi Jizan consists of an area of about 33,000 hectares of rangeland surrounded by the agricultural areas as well as the villages and the river bed. In addition, there are approximately 7,600 hectares, presently used for dry farming, which would be suitable for use as rangeland.

Various grasses, trees, bushes, and weeds exist in the rangeland areas. The most prominent tree varieties are *Paspalidium disertorum* (Toman),¹⁹ *Panium turgidum* (Ushb), *Acacia tortiles* (Somar), and

¹⁷C. E. Kingery, "Report on Study of Wadi Jizan Project," 13-17 September, 1970, Riyadh, Saudi Arabia, p. 11.

¹⁸A study on the natural vegetation in Wadi Jizan was made by Italconsult in 1962-63. A number of 53 species of variety of plants were identified in their final report "Land and Water Surveys on the Wadi Jizan, Saudi Arabia," Vol. 3, Rome, 1965, pp. 24-26.

¹⁹The Botanic classification is given with local Arabic name in parenthesis.



Acacia flaura (Salam). The latter two species are especially common, common bush types are *Leptodermis spartea* (Marakl) and *capensis* decidua (Tundub). *Dipterygium glaucum* (Saferia) and *Blepharis limiae-folia* are representative of the weed types in this area. In addition along the Wadi Jizan bed (Figure 14), one can observe a variety of trees and shrubs such as *Salvadora persica* (Arak), *Spinachristic* (Nabak), and Dom palm.

Another rangeland is the rocky, hilly land on each side of the dam, which drains down into Wadi Jizan. It is a basaltic range site, comprising an area of approximately 17,000 hectares. This area consists of many woody plants, among which *Lasiurus husutus*, *Indigofera spinosa*, and *Cenchrus ciliatus* are dominant. In other rangeland areas, including Sabkha (saline soils) and sand to sandy loams (coastal plain), the most common plants are *Suaeda frutescens*, *Lasiurus hirsutus*, *Acacia tortilis*, and *Dipterygium glaucum*. On the sand dunes, *Dipterygium glaucum* is found also, as well as *Panicum turgidum* and *Leptodermis pyrotechnica*.

Although the general landscape presents a picture of moderate to good range productivity, areas to the north of Wadi Jizan show fair to poor range conditions, as do the areas to the south. Range conditions vary from fair to good on the coastal plain to good in the Wadi Jizan plain and in the Wadi bed. In the mountains range conditions are





Natural vegetation along
the Wadi Jizan Bed.

Photograph taken by author.



generally good to excellent. In fact, rainfall distribution allows a more regular growth of plants in the mountain area than on the coastal plain. This being the case, the local flora consists of few species, and even these are limited in development due to the extreme lack of rain and the high prevailing temperatures.²⁰ The existing local flora show extremely heavy use and are relished by all kinds of livestock. Herds of cattle, sheep, goats, and camels traverse the area, which shows signs of overgrazing, almost without exception.

Human influence is reflected in the diminishing supply of timber, mainly used for the building of houses, which are mainly huts in the broad sense. There were no strict regulations involving the cutting down of trees for quite some while, as demand for timber and firewood was high, the area experienced a severe depletion of woodland. Although restrictions were eventually placed on the number of trees which could be cut down, very few people changed to cement-built houses because their economic resources were not sufficient to purchase such buildings materials. And so the problem of diminishing woodland continues. As building materials are made more accessible to the people of Wadi Jizan, and job opportunities are more widespread, the problem will be resolved.

²⁰ Italconsult, "Land and Water Surveys on the Wadi Jizan," Vol. 3, Rome, 1965, pp. 24-26.



Human GeographyThe People

For the most part, the people of Wadi Jizan are of Arabic, or semetic origin, but there are also a few Negroes of African descent which help make up the population. Van der Plas writes that the Arabs in South Tihama "have the short, slight and graceful but wiry stature of the Yemenis and strikingly fine features."²¹ While the people of Wadi Jizan form a society which is homogeneous, they also conform to Saudian society in the areas of religious belief, attitudes, and values. Islamic traditions and teachings are passed along from generation to generation, and their faith exerts a great influence on the daily life. Although Arabic is the exclusive language of Wadi Jizan and Saudi Arabia as a whole, the people of Wadi Jizan speak a dialect which more closely resembles the Yemeni dialect.

The tribe is the dominant feature of the social structure of Wadi Jizan. The people are characterized by their fierce loyalty to tribe, family, and land. Most of the modern inhabitants of Wadi Jizan were descended from several tribes, of which the Al-Massrahi and the Banishubel are dominant. These tribes migrated to Wadi Jizan from

²¹C. O. Van der Plas, "Report to the Government of S.A. on the State of Agriculture in the South Tiham Area," Rome, 1953, p. 2.



the mountains or from the coastal plain along the Red Sea. However, it is virtually impossible to distinguish descendants of one of the original tribes from the other, since there were frequent interactions between them, and no available record of such information.

The head of the tribal structure is the tribal chief (Shiekh) whose leadership potential is usually determined by age and experience. Although tribal chiefs had almost absolute control over the affairs of the people in their tribe in the past, the emergence of a centralized government has greatly limited their power.

The prevalent family arrangement is the extended family system. Families are predominantly large and headed by the eldest male. The strong kinship which characterizes Wadi Jizan families is not isolated here, but rather, is the rule throughout the Middle East.²² In addition to exhibiting strong kinship, Saudi families are seen as economic units, in which all members work together for the family benefit.

The governor of the area (the Emir) functions as the link between the tribes and the central government, and is the sole indication of modern organization. "Surpassing tribal boundaries, the task of administration is to transfer collective allegiance from the tribe to the state, and to create a civic conscience within the

²²Joanne E. Holler, "Population Growth and Social Change in the Middle East," George Washington University, Washington, D.C., 1964, pp. 3-4.



population, a condition which is essential to development of any kind."²³

The life of the inhabitants of Wadi Jizan has always been deeply influenced by environmental conditions as well as by their traditional attitude toward their surroundings. Since they are farmers, their living conditions depend upon the availability of land and water. Thus, for the most part, their life is basically a hand-to-mouth existence. Any move to improve their situation would require vast changes in both human and natural resources. Social life has seen rapid modifications in the past few years, stemming from the establishment of schools, health centers, roads, and other amenities.

Settlement

Since the majority of Wadi Jizan's inhabitants are farmers, their society can be characterized as sedentary. Their settlements are of two types: urban and rural. Abu Arish is the largest urban center, followed by several secondary centers that function as periodic markets and administrative centers.

²³Sogreah, "Land & Water Resources, Area VI, Saudi Arabia," Final Report, Part 1, p. 6.



Settlements in Wadi Jizan are clustered along the Wadi plain. A few villages also can be found in the mountains of the eastern Wadi, such as Malaki and Ardah. The tendency to cluster is derived from several circumstances. Originally, clustering provided security and protection for the tribal bands. Although this need is no longer apparent, clustering today results because of the strong kinship ties among families and tribes. The need for land utilization also contributes to clustering, as does the fact that Wadi families are emotionally tied to their land and are not inclined to leave traditional farming areas. Finally, the limited water supply and inadequate road system aid the formation of clusters.

Each village is under the control of a village head (Shiekh) who can resolve minor problems among the villages and refer major ones to the local governor. In most cases, the Sheikh is selected by the people of his village, and his appointment is subject to the approval of the government. Each Sheikh is responsible for seeing that his people are identified and that those who need it are supplied with financial aid from the social security office. More than one tribe may be found in a village, so lands are often partitioned. One Sheikh remains the head of the village, however, regardless of the number of tribal heads that live there. Furthermore, one Sheikh may have jurisdiction over more than one village.

The next level of tribal organization is the "general supervisor" (Sheikh Ashaml) who acts as a middle-man between the governor and the village sheikhs. His task is to represent the villages as a whole, to sit on committees which instigate programs and governmental aid, and most importantly, to collect the zakat (taxes) from the inhabitants of his area. Generally, then, the villages and settlements are the foundations for the governmental organization in Wadi Jizan.

The typical Wadi village consists of a cluster of huts surrounded by a "fence" of bushes. Most of these huts are constructed from branches and twigs which are plastered with dry loam, but a small number of mud and brick buildings can also be found. For the most part, the huts are cylindrical in shape. Huts are the most suitable form of housing for Wadi Jizan for several reasons. First, the availability and relatively low cost of hut-building materials make them feasible. Secondly, huts are well-suited for high temperatures. Finally, huts are easily built and torn down, a feature which is necessary since Wadi families are susceptible to torrential floods, which would necessitate a slight change of location. House size, of course, tends to vary according to family size, but for the most part houses are no larger than twelve or sixteen square meters. The number of huts per family also varies, but the average is from one to three.

Each village contains a mosque, one or more wells for drinking water, and winding, narrow streets. For the most part, the clusters



are located in the center of the agricultural lands and close to the bank of the river (Figure 15). Abu Arish is the largest urban center in Wadi Jizan. This town is considered the oldest market in the Wadi and it performs several important functions. As the administrative center of the Wadi, it houses the governor's (Emir's) office, the municipal building, the post office, and the court. It also contains the largest market in Wadi, where wholesalers, retailers, and shopkeepers congregate. Wadi farmers, as well as the Bedouins from the mountains come to Abu Arish not only to bring their products to market, but to be entertained in the coffee shops there and to purchase the commodities they need in the numerous shops. Abu Arish has also become the health and education center for Wadi Jizan with the building of a hospital and numerous secondary schools. Although Abu Arish remains a typical Wadi village in some aspects (Figure 16), its asphalt and paved roads, wider streets, and masonry buildings reflect the coming of a new age of city-building in the Jizan area.

Population

There is no reliable official population record for the Wadi Jizan area. Although an official census of Saudi Arabia as a whole was conducted in 1974, the information was not available at the time of the field work. Surveys by Italconsult in 1962-63 and by Sir W.

THE VILLAGE OF HAKIMAH

AERIAL PHOTOGRAPH SHOWS VILLAGE LOCATED IN AGRICULTURAL LANDS, TYPICAL IN THE WADI JIZAN AREA.



PHOTO SOURCE: Ministry of
Petroleum & Minerals,
1974.

Figure 15



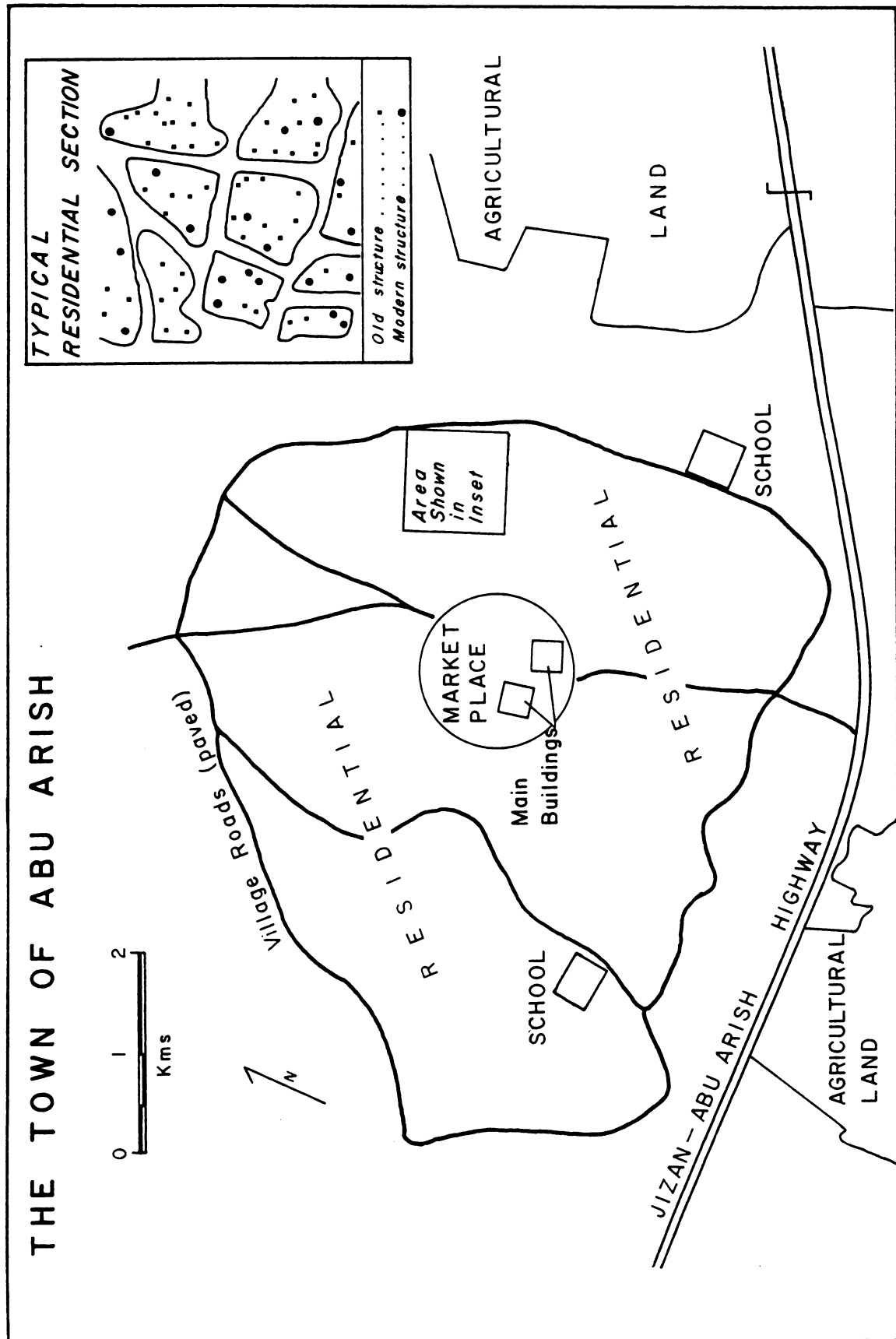


Figure 16

Halcrow and partners from February to April of 1972 furnish the only source of population information.

The Italconsult survey is a general estimation, based on surveys in several villages and conversations with village leaders, resulting in extremely general and rounded-off figures. The findings showed a population of 48,100 in the Wadi Jizan area (43,000 ha.), and 37,000 in the specific development area (estimated by Italconsult to be 22,500 ha.). Population density was estimated at 164 persons per square kilometer. Villages reported populations of 100-2,000 people, excluding Abu Arish, giving an average village population of 400-600 people.

The survey of Sir W. Halcrow in 1962 covered 60 villages, 54 of which were in the Wadi Jizan area, including 36 from the development area. This survey was based upon a drawn sample of 70 huts per village, which would seem to give a superior and more reliable estimate. Factors taken into consideration in the Halcrow survey include: number of huts, number of families, number of persons per village, average number of persons in each hut, and average number of huts per household. Halcrow's findings gave a population estimate of 32,724 for the Wadi area. This figure would seem to indicate a

²⁴Italconsult, "Land and Water Surveys on the Wadi Jizan," VI, Socio-Economic Report, Rome, 1965, pp. 1-2.

wide discrepancy between Italconsult and Halcrow sources, since it is doubtful that the Wadi population would have retrograded between 1963 and 1972. Such a discrepancy arises again regarding the estimates of the population of Abu Arish. Italconsult estimated a population of 15,000, while Halcrow gives the number as 10,853. Since the Halcrow survey takes into consideration more variables and was conducted more recently, it is assumed for the purposes of this work that the Halcrow survey is the more reliable.

Demographically speaking, it is rather difficult to measure population growth in Wadi Jizan since there are no existing natality and mortality figures. This also poses a problem when comparing the two surveys, and in comparing the 1972 Halcrow survey with the present Wadi population. However, during the field work, an effort was made to collect such information by direct interviews with the village chief in each surveyed village (Table 3). The results indicate that a general population increase of about 2.4% per year for the five-year period from 1972 until 1977 for all of the twenty-seven villages surveyed has occurred. The fundamental problem with this information is that it is difficult to establish whether this increase is natural (due to increased natality and mortality) or caused by migratory factors, all due again to the lack of concrete supportive evidence. However, it must be noted here that some of the surveyed villages, especially those with a small population, have shown some decrease

TABLE 3

NUMBER OF INHABITANTS FOR THE SURVEYED VILLAGES IN WADI JIZAN

Series No.	Villages Surveyed	Halcrow's Survey of 1972	Field Work Figures of 1977 as Estimated by Village Heads
1	Malaki	240	350
2	Al-Mahallah	650	890
3	Al-Uqdah	393	500
4	Qamirah	343	480
5	Al-Quwayyah	436	450
6	Al-Raha	179	190
7	Jirbah	78	50
8	Al-Bayyid	670	750
9	Al-Khadhra(J)	1,377	1,550
10	Falass	770	800
11	Al-Mujassass	643	600
12	Abualnurah	507	700
13	Al-Wasit	258	200
14	Khabtsaid	378	350
15	Al-Rayyan	686	730
16	Al-Badi	1,026	1,300
17	Al-Qarafi	859	1,000
18	Al-Salamah	415	490
19	Al-Mihsam	324	380
20	Al-Ghurayyib	526	600
21	Al-Matiri	219	180
22	Al-Wasili	873	1,000
23	Al-Ajabiyah	316	260
24	Bakhshah	193	180
25	Al-Kharadilah	695	790
26	Al-Ushwah	484	460
27	Al-Kawanillah	224	180
	TOTAL	13,762	15,410

Source: Data collected during field work of the author in the Wadi Jizan area, Saudi Arabia, November 15, 1976 through March 15, 1977.

in their population while large villages are experiencing relative growth. This result may be accounted for by out-migration in terms of small villages and in-migration in case of large villages as it will be discussed in the following chapters.

In the area of age structure, it is observed that people over 50 years of age and those between 36 and 50 are the dominant age groups, representing 51.65% and 35.1% of the total interviewed people, respectively (see Table 4). The relative absence of younger people may be attributed to the availability of jobs outside Wadi Jizan and the rapidly growing interest in higher education.

TABLE 4
AGE STRUCTURE FOR THE INTERVIEWED FARMERS

Categories	Number of Respondents	Percentage
Less than 20 years	--	--
20 - 35 years	20	13.25
36 - 50 years	53	35.1
More than 50 years	78	51.65
TOTAL	151	100.00

Source: Data collected during field work of the author in the Wadi Jizan area, Saudi Arabia, November 15, 1976 through March 15, 1977.

The population distribution in Wadi Jizan is not even; it varies depending on village area and location (i.e. whether the village is in Upper or Lower Wadi), factors which will be discussed later. In addition, the number of persons per hut varies from 2.4 to 5.6, while the number of persons per household ranges from 3.1 to 6.6 in the Wadi as a whole. These figures are generally in agreement with the results of the field work (Table 5). That is, the majority (54.30% of the respondents) have a family size of 3 to 5 persons, about 25.83% have a size of 6 to 8 persons, while 17.22% of the respondents declared less than 3 persons and only 2.65% have more than 8 persons per household. These results were generally standard for the 27 surveyed villages.

TABLE 5
FAMILY SIZE FOR THE INTERVIEWED FARMERS

Number of Persons per Household	Number of Respondents	Percentage
Less than 3 persons	26	17.22
3 - 5 persons	82	54.30
6 - 8 persons	39	25.83
More than 8 persons	4	2.65
TOTAL	151	100.00

Source: Data collected during field work of the author in the Wadi Jizan area, Saudi Arabia, November 15, 1976 through March 15, 1977.

In considering population density in Wadi Jizan, three cases are examined. First, there are 76.1 persons per square kilometer when considering the entire Wadi Jizan area (43,000 ha.; 14 by 31 KM). Secondly, this figure changes to 145.44 persons per square kilometer for the agricultural or arable lands in Wadi Jizan (22,500 ha). Finally, the density will increase to 327.24 persons per square kilometer, when attention is centered upon the irrigable lands from Wadi Jizan (the development area of approximately 10,000 ha), the results differed significantly if the town of Abu Arish (10,853 inhabitants) is excluded. With this exclusion, the densities would measure 50.8, 97.2, and 218.71 persons per square kilometer for each of the above-mentioned cases respectively. Actually, one may conclude that even when Abu Arish is excluded, population density is relatively high, especially in the development area.

Wadi Jizan is divided into two parts, the Upper and Lower Wadi. The population distribution is not even; consequently, the population density is also varied. There are about 10,186 people (excluding the 10,853 inhabitants of Abu Arish) in the Upper Wadi, and approximately 11,685 in the Lower. The population density in the Upper Wadi (only for the irrigable land, i.e. 3,327 ha) is 308.6 individuals per square kilometer, and 265.5 persons per square kilometer in the Lower Wadi (about 4,410 ha of irrigable land). Generally speaking, population density is relatively high in whole Wadi

Jizan area (43,000 ha) with higher concentration in the development area (10,000 ha) and in the Upper Wadi Jizan in particular.

This general discussion of the Wadi Jizan area in respect to its physical features or in terms of its human geography is very essential. It demonstrates the actual amount of the interaction between man and his environment. This interaction shows that Wadi Jizan is a suitable environment for human settlement. This suitable environment has attracted men from neighboring areas and thus helped create a permanent society. This type of society has coped with its environment by creating different types of social and economical settlements and political organization. Sedentary life is the common characteristic of the Wadi Jizan population. As a rule, agriculture was and still is the main activity for most of the inhabitants.

Agriculture in the Wadi Jizan area is a distinctive type of agriculture. It is mainly based upon the production of a single crop. Nonetheless, several other aspects such as land tenure, irrigation and water rights, or livestock raising as well as marketing are all tied to the agriculture. Because of this, the people of the area have developed some traditions in respect to those aspects. Agriculture as the main activity in the Wadi Jizan is well traced and demonstrated through the following chapter.

Chapter III

AGRICULTURE IN WADI JIZAN

Introduction

As mentioned before, Wadi Jizan is an agricultural community, with over 90% of its citizens engaged in some aspect of farming. There is evidence that farming as a way of life has existed in the Wadi Jizan area for a long period of time. For example, land patterns in the Wadi are very structured, with neatly divided rectangular plots known as Blad or Rukban (singular Rakeeb). Use of flood control methods are evident in the construction of embankments, or UQUM (dikes and diversions) which are distributed along the river bed and the agricultural lands and form the irrigation system. The fact that UQUM are very simply constructed, and have a minimal effect on the torrential floods is a minor detail. What is more important is that they convey the farmer's interest and experience in cultivation, soil conservation, and water control, and also give some insight into the environment in which such a farmer lived. Typically, the presence of large and small clusters of settlements is an indication of an agricultural society. As observed, Wadi Jizan's citizens attest to the accuracy



of such an indicator of an agricultural society being a sedentary life-style. Such a sedentary life-style leads to the formulation of settlements, which in turn allows for a highly developed culture. Through Wadi Jizan's irrigation system, regulations on water distribution, formation of a sharecropping system, and regulations on the construction and maintenance of UQUM, discussed later in more detail, it becomes clear that the early inhabitants of Wadi Jizan were able to accurately perceive and positively react to the particular factors in their environment while developing their agricultural society.

The farmers in Wadi Jizan had, and still have, a keen sense of land and water utilization.

All along the Red Sea coast the Asir Tihama's cultivators from time immemorial have used flood water for raising their crops. They have done this with great skill and assiduity against heavy odds and have become real masters in the art of using and distributing water.¹

In documenting land utilization in Wadi Jizan as a whole (43,000 ha), four zones are described, which are employed as follows: lands which are productive, but not cultivated and relying on rainfall (18,000 ha); land utilizing run-off from lava plain and waters collected in channels (3,000 ha); lands which are irrigated from well-waters (no more than 100 ha); and finally, lands that are flooded annually (4,100 ha--

¹N. Simansky, "Report to the Government of Saudi Arabia on the Preliminary Project for Land and Water Use Development in Wadi Jizan," FAO Report No. 410 (Rome, 1955), p. 5.

intermittent flooding 9,000 ha).² More specifically, the Wadi Jizan agricultural area (22,500 ha) has two distinguished types of agricultural land use, dry and irrigated (Table 6). Irrigated farming is dependent upon irrigation from floods through use of the UQUM, while dry farming depends only upon rainfall. The two dominant crops in the area are sorghum and millet. Although both crops can be grown in irrigated as well as dry farming, sorghum is more widely-grown in an irrigated area, while millet is more dominant in dry farming areas.

Agriculture in Wadi Jizan is limited by natural conditions as well as cultural factors. Wadi Jizan farmers are mostly at a subsistence level of agriculture, growing sorghum and millet, and grazing cattle, camels, sheep, and goats. Subsistence agriculture is not limited to Wadi Jizan, however. Rather, it is common to many areas of Tihama, as well as certain parts of Saudi Arabia.³ Productivity is extremely low, due to several factors, among which are the scarcity and irregularity of rainfall, as well as outdated methods of cultivation. Another factor which sharply limits productivity is the reliance upon animals for farming operations. Although there is some

²Italconsult, "Land and Water Surveys on the Wadi Jizan," Volume 3, Rome, 1965, pp. 28-37.

³Saudi Arabia Ministry of Commerce and Industry, "Agriculture Opportunities in Saudi Arabia" (Riyadh: Arthur D. Little, 1969), p. 9.

TABLE 6
LAND UTILIZATION FOR THE WADI JIZAN IN HECTARES

Description	Irrigated	Dry Farming	Fallow	Total
Irrigated by Wadi Jizan	4,350	1,000	2,650	8,000
Irrigated by run-off	650	--	350	1,000
Irrigated by well water	100	--	--	100
Land for dry farming	--	5,500	2,600	8,100
Uncultivated productive land (pasture)	--	--	--	3,300
Unproductive land	--	--	--	2,000
TOTAL	5,100	6,500	5,600	22,500

Source: Italconsult, "Land and Water Surveys on the Wadi Jizan,"
Vol. 3, Rome, 1965, p. 16.

indication of the potential use of machinery in the future, the practice is definitely not widespread at this time.

Obviously, there is room for improvement in the agricultural situation in Wadi Jizan. Limited production and a low level of land productivity are influenced not only by the land itself, the scarcity of water, of cultural trends, but rather, an inter-mixing by these factors. Water scarcity seems to be the most serious of these problems, but a successful solution for the Wadi Jizan area should include all three. (A more detailed development of this topic will be found in Chapter Four.) Through the following sections, an attempt will be made to further explore the several aspects which compose the general agricultural picture of Wadi Jizan.

Land Tenure

Like the remainder of Saudi Arabia, Wadi Jizan's tenure system is based on Islamic Law (the Sharia'h), as are the traditional systems of land ownership, inheritance, water utilization and payment of the zakat (taxes).⁴

⁴In this respect, see Parsons, Penn and Raup (eds.), "Land Tenure," Madison, Wis., 1956, and also Mohammed Marmaduke Pickthall, "The Meaning of Glorious Kora'n, Mentor Religious Classic," New York, 1956.



There are three types of land tenure in Wadi Jizan. A large portion of the land in Wadi Jizan (almost 20,000 ha) comes under the category of barren land. This land is available for use by anyone who has a genuine need for it and receives the approval of the government. This land is usually granted for agricultural use; at the present time, it is used for the grazing of animals.

A second land-tenure type is the public, or communal land. This is land owned by a certain village or tribe, and mainly used by them. It is generally available to any member of the community or tribe if there is a definite need, such as land for building a house or a new Aquam (dike) for irrigation. If a conflict over right to the land should occur, the dispute is settled by the village or tribal chief (sheikh) or may be sent to the court. If the dispute is not easily resolved by the court, the government has the right to confiscate the land.

The third land-tenure type is privately-owned land, and this type is further divided into sub-types: Waqf and Mulk lands. Waqf lands are privately-owned lands, but have several distinct stipulations. Often, they are lands which have been granted by their owners for charitable or religious purposes, such as the building of mosques. Or, they may be lands which have been willed to the successors of the owner with strict provisions attached. For instance, Waqf lands are only left to sons of the deceased, not the daughters; they cannot be



divided between the beneficiaries (but the profit from them is shared); and they cannot be sold. In the area of inheritance, too, the profits may often go for religious purposes.

Mulk lands are privately-owned lands which are obtained through normal buying or selling, or by inheritance customs as set up in Islamic Law. As land holdings are passed down from generation to generation, there is an emergence of many small farms.⁵ In the Wadi Jizan area, this occurrence causes problems in two respects: first it often creates arguments between land-holders as to their water rights; and second, the fragmented distribution of land causes a decrease in agricultural productivity; as one owner may use his small plot of land to grow a certain cash crop, when the greatest productivity would come from several plots all growing sorghum, or other widespread crops. In addition, wealthy landowners who buy plots of land in several places also contribute to the fragmentation of the land, a characteristic which is very common in Wadi Jizan.

Land ownership is confirmed by the registration of the land at the court, in the name of the owner(s). There is no registration fee, nor is there any sort of municipal or state tax imposed on the property.

⁵Ghadri Nihad, "The Great Challenge" (1968), p. 124.



The size of land holdings seems to vary from one village to another, and from the Upper Wadi area to the Lower. Generally, it appears from the fieldwork that there are three categories of holdings in Wadi Jizan (see Table 7). From the table, it can be seen that small holdings are common, while large holdings are quite rare. It is also observable that the larger holdings are more evident in the Upper Wadi Jizan. This may be accounted for by the fact that the Upper Wadi was more easily irrigable than the Lower and this attracted many of the wealthy and powerful farmers, who extended their holdings throughout the Upper Wadi, leaving the Lower Wadi to the poorer farmers. As these poorer farmers passed their already small plots on to their descendents, the size of holdings decreased further. According to the Halcrow survey:

The richer and better lands in Wadi Jizan are those nearer the watercourse. They are mostly situated in the Upper Wadi Jizan; at Waynah, the land attached to the village of Al-Mujassass; at Falass, the land attached to the villages of Falass and Al-Bayyidh; at Al-Jarah, the land attached to Hakimah and Abu Arish; some are to be found at Al-'Ugdah and Al-Badi', the lands attached to the villages of Al'Ugdah, Al-Badi' and Qamirah. The lands of lower Wadi Jizan are in most cases poorer.⁶

The tenancy system (IJAR) of Wadi Jizan is sharecropping (MUZARA'H). Under this system, landowners announce that their land

⁶Sir William Halcrow and Partners, "Irrigation Development in the Wadi Jizan, Saudi Arabia," Annex II (London, 1972), p. 4.

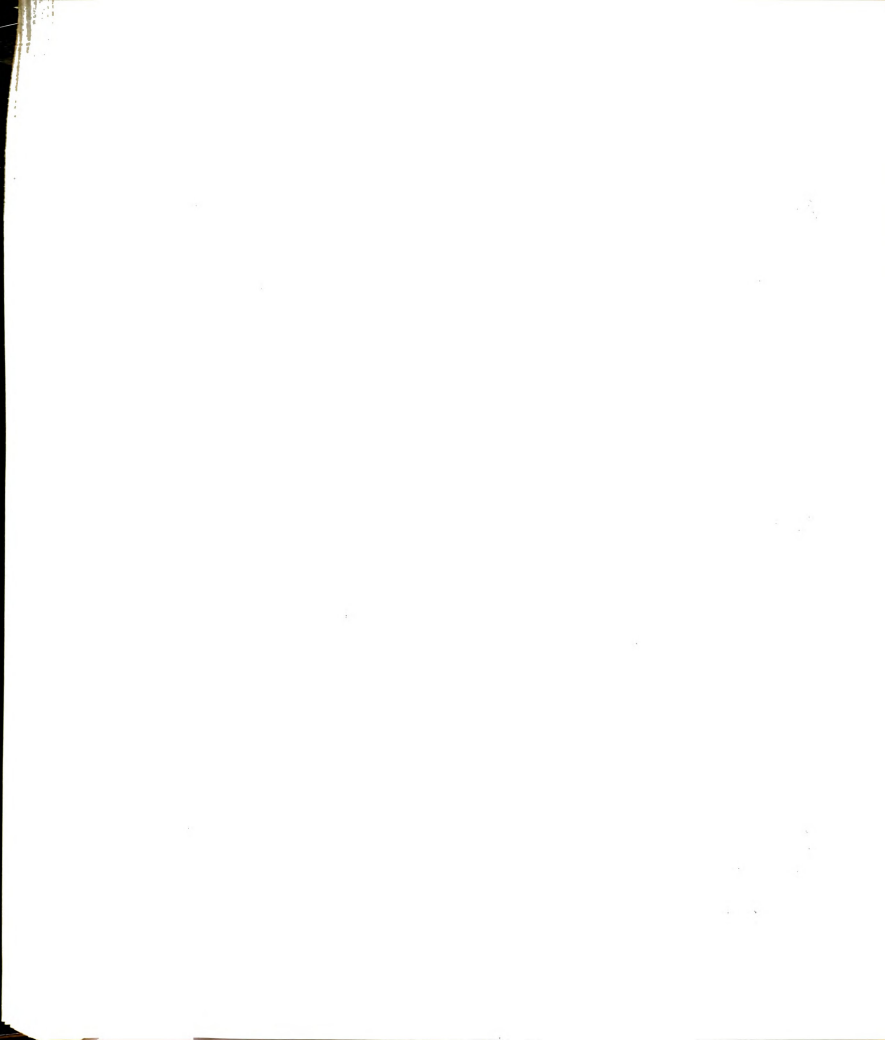


TABLE 7

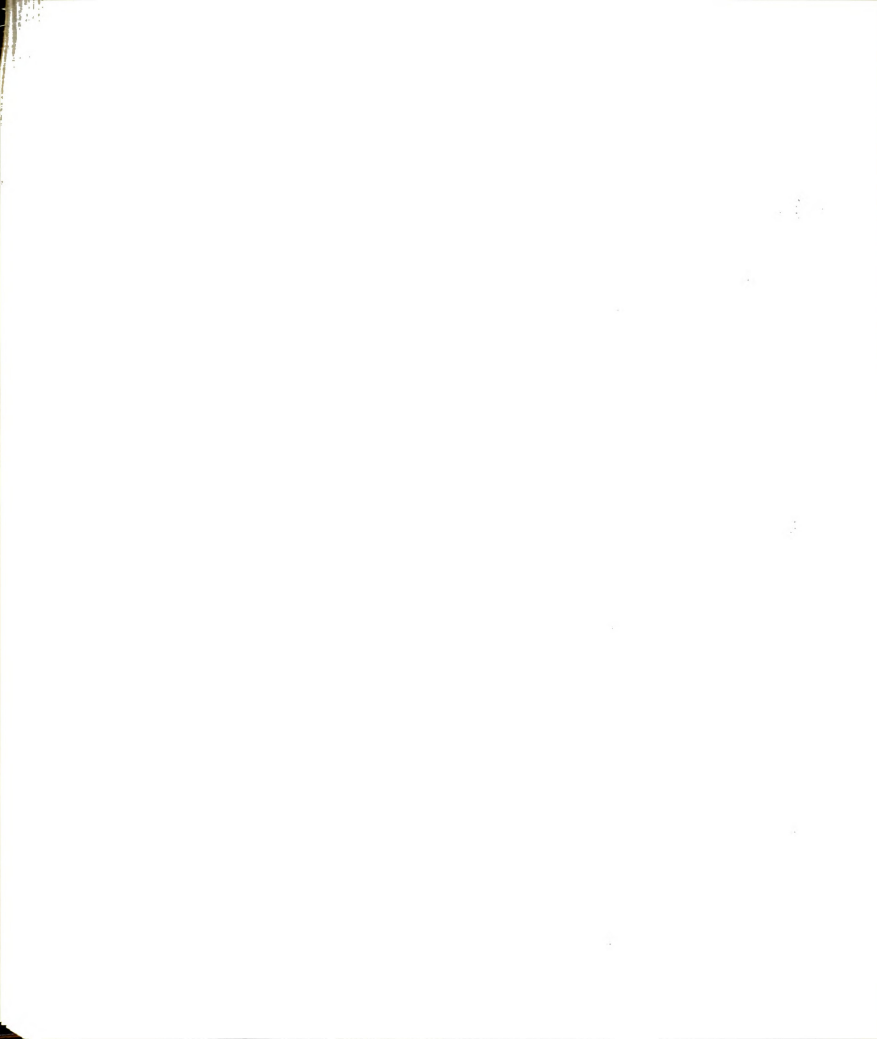
SIZE OF HOLDINGS IN THE WADI JIZAN AREA, FOR THE INTERVIEWED FARMERS

Type of Holdings	Size of Holdings	WADI JIZAN		UPPER WADI		LOWER WADI JIZAN	
		Number of Observations	%	Number of Observations	%	Number of Observations	%
Small	10-59	60	39.7	24	32.87	36	46.15
Medium	60-109	48	31.8	17	23.28	31	39.74
Large	More than 110	43	28.5	32	43.85	11	14.11

TOTAL		151	100.0	73	100.00	78	100.00

*Size of holdings is presented in Wadi Jizan measurement, known as Ma'ad.
One Ma'ad = 3600 m² = .36 ha.

Source: Data collected during field work of the author in the Wadi Jizan area, Saudi Arabia,
November 15, 1976 through March 15, 1977.

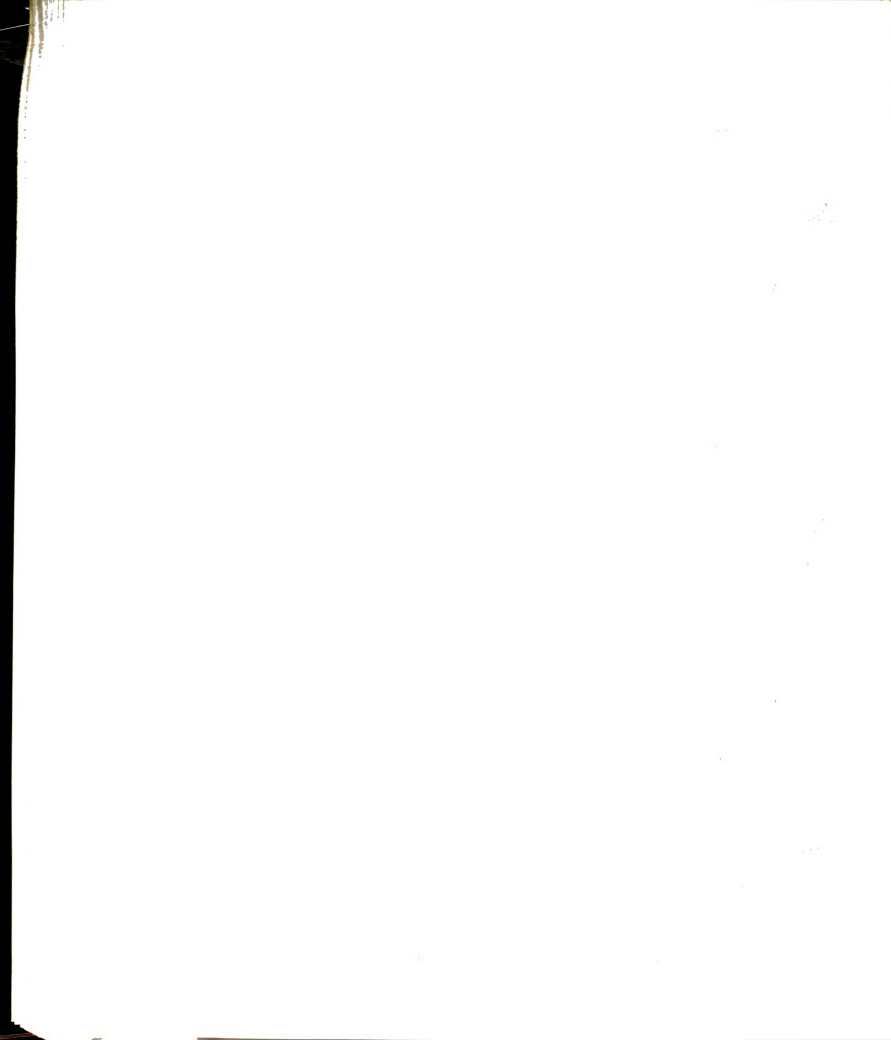


is available for sharecropping and an agreement is set up. The usual stipulations are:

1. The land owner is in full control of his land.
2. The sharecropper should take care of the land, level it, and repair the bunds (ZUBIR) of the plots (RUKBAN). In addition, the sharecropper should supply the seeds, tools, and animals.
3. The number of laborers to be used is almost always a joint decision between owner and sharecropper.
4. The land owner usually reserves the right to terminate the agreement under certain conditions, such as poor watering or cheating by the sharecropper. If forced to leave, the sharecropper may expect that the owner will repay him for expenses incurred.
5. The sharecropper may terminate the agreement in cases of severe drought. Again, the owner will reimburse him.
6. Contracts are usually made for one season (one flood period) or more.

There are two types of farming in which sharecropping is used--flood- and dry-farming. In both cases, final production is divided between owner and sharecropper after 20% is deducted--10% for labor, and another 10% for zakat. In the flood-farming areas, profit is divided equally between owner and sharecropper, but in dry-farming situations the owner may receive no more than one-third of the profits.

In summation, sharecropping is a common occurrence in Wadi Jizan used by 56.2% of the interviewed farmers in the Upper Wadi Jizan and about 20.5% of those in the Lower Wadi Jizan.



Traditional Irrigation and Water Rights

Agriculture in the Wadi Jizan is based on the irregular pattern and scarcity of surface water; thus, production is limited and varies from year to year according to the amount of water received. Availability of irrigation water also controls the size of the cultivated lands in Wadi Jizan. Obviously, water for irrigation is a major agricultural determinant in Wadi Jizan. Since irrigation does play such an important role in agriculture, certain rules were set up among farmers in Wadi Jizan to regulate its use.

Rights to irrigate land are fashioned by custom and burnished by long practice and it is only because of this that a community of farmers assumes full control over a stream or a flow of water, and not by reason of ownership.⁷

The use and distribution of water are governed by old traditions and based on Islamic Law.⁸ Two types of water ownership are recognized in Wadi Jizan--public and private. The public water is that which comes from nature, such as springs, floods, etc., while private water is that which is derived from man-made sources, such as wells. There are usually several wells scattered along the villages, however,

⁷Sir William Halcrow and Partners, "Irrigation Development in the Wadi Jizan, Saudi Arabia," Annex (4) (London, 1972), p. 8.

⁸See A. Caponera Dantia, "Water Law in Moslem Countries" (Rome: FAO Publications, 1954), pp. 79-79.

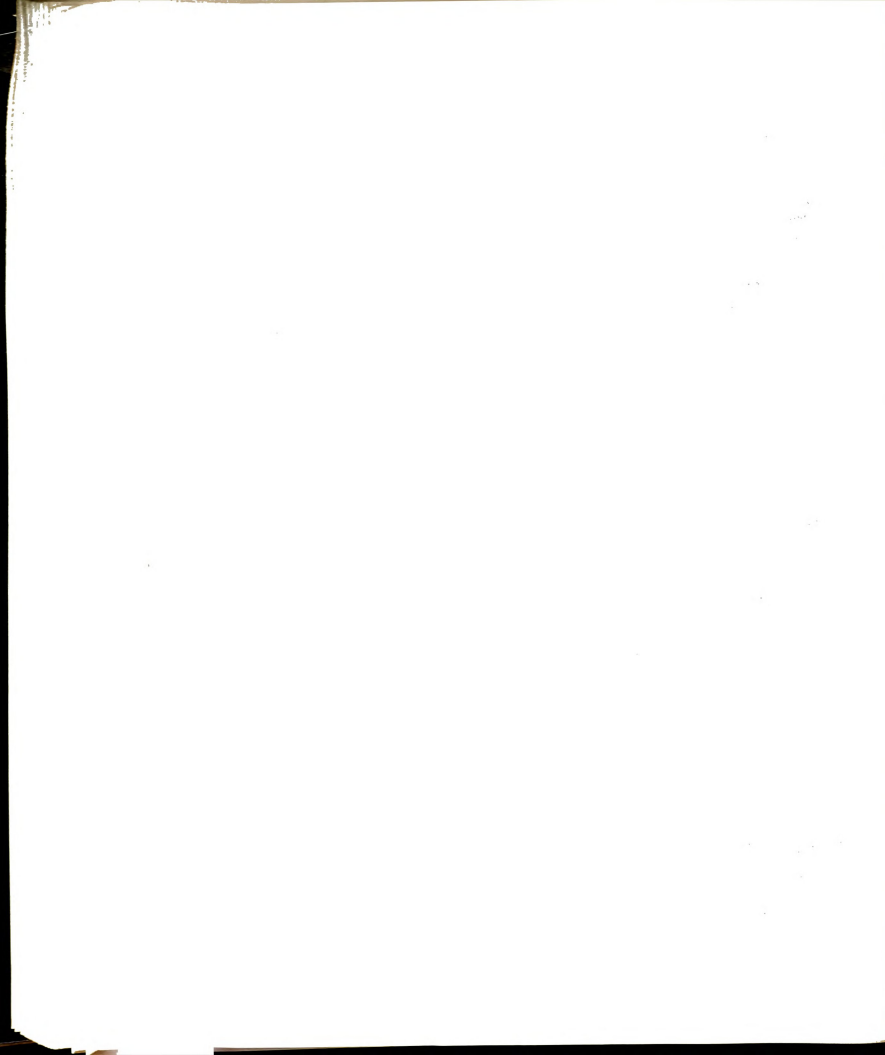


which are communal--that is, used by the community as a whole, for drinking and in some places for gardens and orchards.

Most public waters in Wadi Jizan are surface waters--usually floodwater. Since some of the agricultural lands in Wadi Jizan need irrigation, it is necessary to regulate water use in the area. Although there is no formal written agreement on this subject, Wadi Jizan farmers have a standing general agreement, with the following basic components:

- 1) All farmers have the right to irrigate their lands once they own the lands (sharecroppers are included), and the lands are determined to be irrigable from the Wadi bed.
- 2) Upper Wadi lands have priority over Lower Wadi lands in obtaining irrigation water. The lands farthest upstream receive first priority.
- 3) No one may water more than he needs, nor more than once, until all the Wadi lands are irrigated.
- 4) No one may build a new Aquum or establish any form of irrigation system which will interfere with the traditional system.

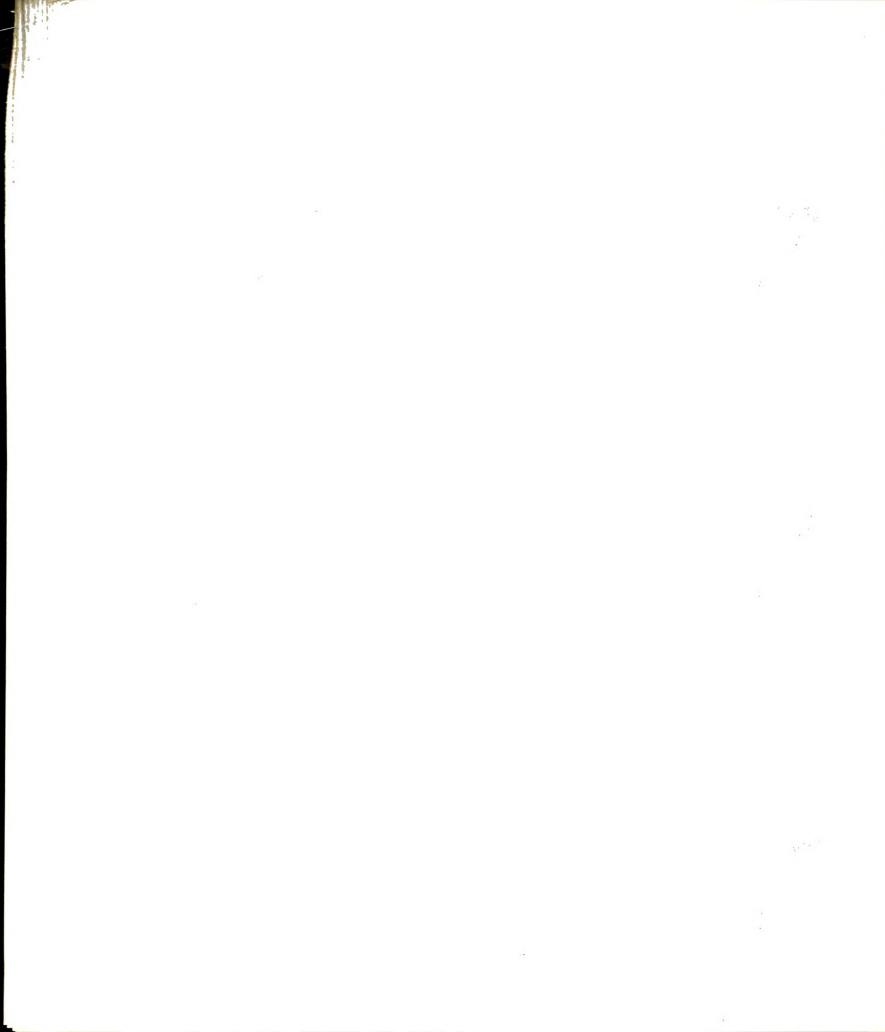
Farmers have constructed major UQUM (diversions) and several minor dikes. At the present time, there are approximately thirty UQUM in the Wadi Jizan area, of which two are considered central--the Aquum AL-DIFA and the Aquum AL-ZA'JAH. Aquum Al-Difa is located in Upper Wadi Jizan; it is a high bund blocking off the northern or flood arm of the Wadi, and is intended not to be breached, as its purpose is to direct the water flow down the southern arm. Aquum



Al-Za'jah directs the water flow to basins in the Lower Wadi Jizan along a small arm which splits off the main Wadi in an east-west direction. In addition, several dikes deflect the water flow onto agricultural basins.

The Wadi Jizan agricultural lands are divided into 37 basins, or plots of land, known locally as mi'mal. These mi'mal are further divided into a small series of fields known as Rukban (singular, Rakeeb), which are surrounded by bunds (Zubur). Mi'mal classification is based upon irrigation priority; thus, mi'mal number one, in the Upper Wadi Jizan is irrigated first, and mi'mal 37 (in the Lower Wadi) is 37th in priority. Although the classification of land into mi'mal is based on irrigation, the classification of mi'mal into a series of fields is based strictly on land ownership.

UQUM, through long experience, are strategically placed and take the form of earth-dams or spur-dikes along the river bed. The purpose of such UQUM is to deflect water into the mi'mal. When the first mi'mal is filled, and the land thoroughly saturated, farmers breach the UZUM to allow water to flow to the succeeding mi'mal. The water runs from one field (Rakeeb) to another through cuts made in field bunds, and continues down the Wadi for as long as the flow lasts, and until the last mi'mal and series of fields are irrigated. If the flood is extremely low, the mi'mal and field complexes of the Lower



Wadi receive no water. Frequently, however, the floods are so strong that they then burst through the diversions and rush to the sea, sometimes overflowing river banks and causing damage to villages and fields. When these diversions are breached by high floods, the series of mi'mal are not always filled, although some may fortuitously be flooded.

The construction of the main UQUM, as well as their maintenance, is the responsibility of all Upper and Lower Wadi farmers. The farmers of the Upper Wadi Jizan take responsibility of AQM Al-DIFA, while Aquum AL-ZA'JAH is maintained by the Lower Wadi farmers. The care of the small UQUM (dikes) is restricted to those farmers inside each mi'mal, and the cost is divided among each farmer according to the size of the farm. A committee composed of the local sheikhs, as well as several others, is set up to see that the rules are obeyed and the costs evenly divided.

The annual construction and repair of UQUM is expensive, but a very necessary expenditure. It has been estimated that UQUM cover 10% of the agricultural land area of Wadi Jizan. There is thus a loss of good soil scraped up to build the dikes, a high percolation rate in the fields, and uneven, and therefore wasteful watering.⁹

⁹W. A. Ronger, "Agronomic Practices and Management of Irrigated Crops in the Wadi Jizan" (Rome: FAO Publications, 1971), p. 5.



It should be noted here that there are both advantages and disadvantages in the traditional irrigation methods. Although one major advantage of this system is the fact that UQUM allow for the transporting of silt and sediments which fortify the soils further downstream, there are some major disadvantages, namely:

- 1) the difficulty in controlling big flows, as they often cause severe damage to surrounding areas.
- 2) the high cost of reconstruction of the UQUM.
- 3) the unnecessary re-watering of areas to enable the flow to reach the fields further downstream.
- 4) the breaching of the main UQUM (diversions) due to high flows, in which case the flow goes to the lower UQUM, or straight to the sea.
- 5) the inaccessibility of fields after irrigation for a considerable period of time.
- 6) the loss of good soil in building UQUM.

In considering land and agricultural development in the Wadi Jizan area, the traditional irrigation methods are an essential factor. It is necessary to critically evaluate the effectiveness of such methods, observe the present changes in irrigation systems, and if required, suggest viable modifications or alternatives. This sort of analysis will be covered in subsequent sections.



Farm Operation

As farming is the major occupation in Wadi Jizan, the farm is the economic unit of production. A successful economy, then, depends on the farmer's agricultural skill. As the typical farmer in Wadi Jizan is illiterate (95% of the interviewed farmers), his knowledge stems mainly from handed-down farming practices, as well as past experience. Often farmers only grow enough for their own needs; the factors of product cost, fertilizer costs, labor, etc. which determine the external characteristics of the farm, or others like capital stocks, financial assets, yield products and total land available in the farm, which form the internal characteristics¹⁰ are not taken into consideration by the Wadi farmers. Decisions regarding the amount of production are made rather haphazardly, and production itself is extremely limited as far as methods and physical factors are concerned.

The farming system, based on old traditions and primitive methods, still involves the use of simple, locally-made tools. Land preparation, sowing, and harvesting, are accomplished through the use of animals. Oxen are most commonly employed, for the actual farm work, while camels and donkeys are used for transport.

¹⁰D. W. Harvey, "Theoretical Concepts and Analysis of Agricultural Land Use Patterns in Geography," Annals of the Association of American Geographers, Vol. 56 (1966), pp. 341-343.



Plowing is achieved through the use of a plow--drawn by a team of oxen (Figure 17), which breaks the soil into furrows of ten to twelve centimeters deep. Sowing is accomplished at the same time by means of a wooden seedroll attached to the hoe. Fertilizers, including manure, are not used, and modern agricultural equipment is a rarity, as only two or three tractors are to be found in the entire Wadi. While some farmers now have water pumps, others still use animal-drawn wells. The Ministry of Agriculture and Water now provides low-rented tools and equipment such as tractors, cultivators, and threshers, but so far, the use of such equipment is minimal. Several factors may account for this: 1) the economic state of most farmers prohibits the rental of such tools, 2) the lack of experience in using such tools, and 3) the agricultural system currently employed in the Wadi Jizan is not receptive to mechanization. The main hindrance to mechanization is the smallness and irregular shape of the land plots (Rukban). These basins and fields are also virtually inaccessible to machines such as tractors, harvesters, and particularly, plows and grain drills. Thus, the relative absence of agricultural technology at Wadi Jizan is understandable.

Sowing begins early in Wadi Jizan, before the wet season, after the ground is cleared of the remains of previous crops and natural flora. Wadi lands are plowed twice, both before and after





The traditional plowing
method.

PHOTO SOURCE: Agricultural Experiment
Station at Hakimah.

FIGURE 17



the flood. The seeds are sown into the furrows through a bamboo tube, attached behind the plow sole (Figure 18). Sorghum (durra) is sown as mentioned above, but millet (dukhn) and sesame are sown differently. When sowing dukhn, seeds are placed in the ground in small holes spaced three paces apart. After inserting the seeds, the farmer covers the hole and stomps the ground with his foot. Sesame seeds are sown in rows, or planted individually.

Harvesting in Wadi Jizan is a primitive, lengthy, and costly procedure. Until recently it was a cooperative effort--a celebrated occasion during which all community members worked together. In harvesting durra, the crops are sickled at the foot of the stem, left to dry in the field for a couple of days, and then tied into bundles of about 20 kg for use by the farmer's livestock, or to sell. After the first harvest, the durra often stumps again for a second harvest. If weather and other conditions, such as water availability, are favorable, even a third harvesting may occur. Dukhn is harvested by picking the heads out of the stems. Secondary sprouts often mature after the first harvesting, and cobs may be cut again. In the case of sesame, plants are uprooted, collected into sheaves, and left in the fields to mature.

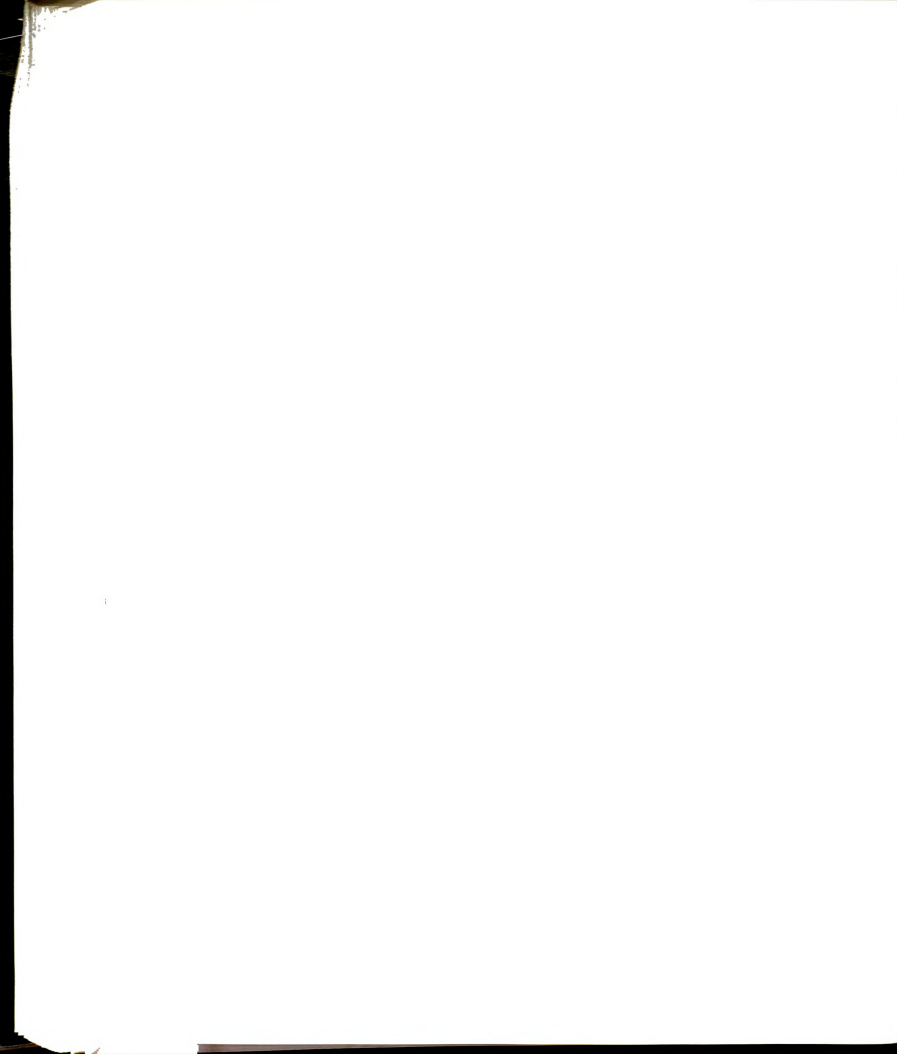
Only one method of threshing is used: the crops are taken to the beaten-earth threshing floor, where they are threshed with the



**The traditional sowing
method.**

PHOTO SOURCE: Agricultural Experiment
Station at Hakimah.

FIGURE 18



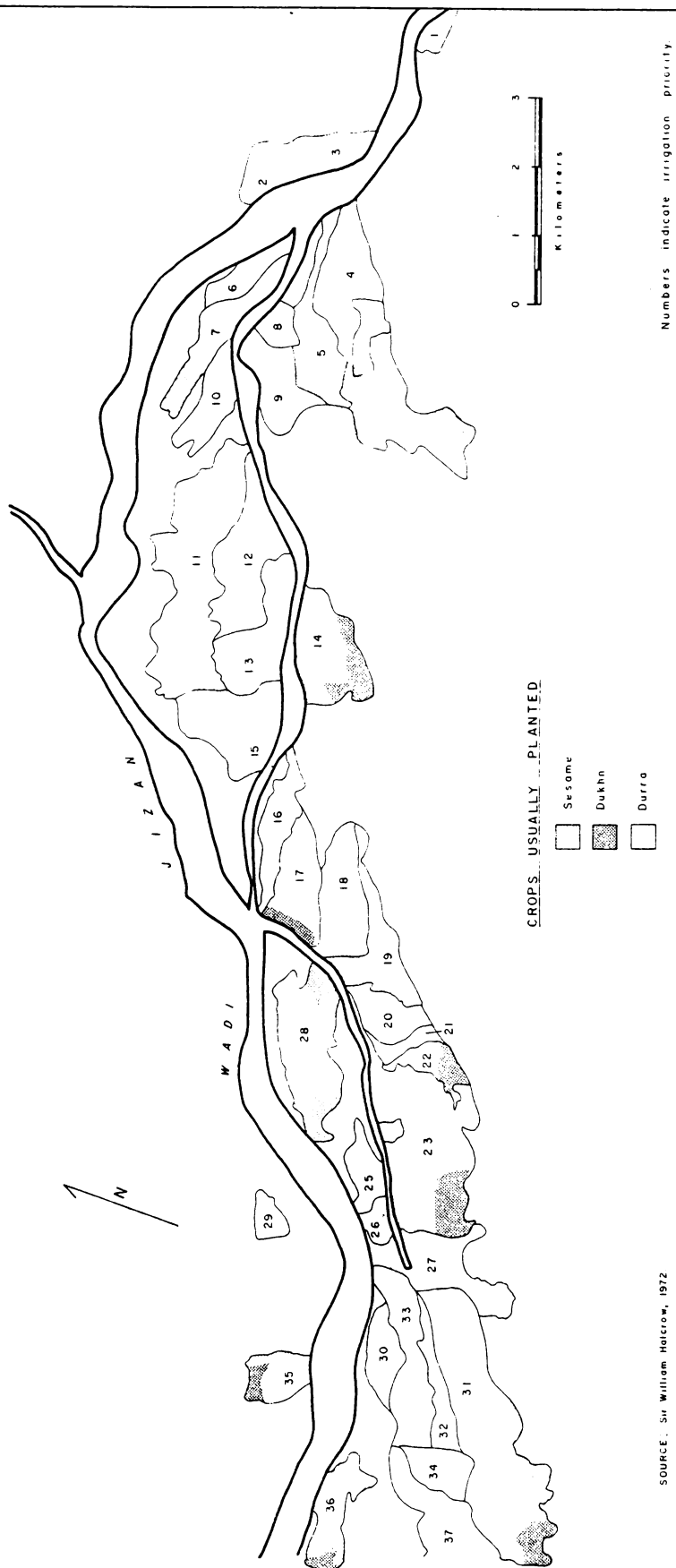
heavy flail which characterizes this method. Sesame seeds are subsequently pressed to extract the edible oil.

Field Crops

Of the three main crops grown in Wadi Jizan, sorghum (durra), is considered the most valuable, principally because of its greater resistance to drought. "In extreme cases of drought, durra can arrest its growth, and roll up its leaves, thus reducing the area available for transpiration."¹¹ Durra also constitutes the basic foodstuff of the people in the Wadi Jizan area. It is grown throughout the Wadi, and covers an estimated 73% of the agricultural lands. A specific planting chart has been adopted in Wadi Jizan, in which there are four planting seasons: Kharif, Makhrat, Saudat, and Saif (Figure 19). Kharif is considered the "prime" season, because of the high productivity experienced then. The growth cycle of durra is about 160-170 days in the case of two harvests, or 240 days in the case of a third harvest. There is no reliable record as to the average and maximum yield of durra, and even the analysis by Sir William Halcrow and Partners has not been proven accurate (Table 8). The amount of

¹¹ Italconsult, "Water Surveys on the Wadi Jizan," Vol. 3 (Rome: 1965), p. 54.

TRADITIONAL CULTIVATION PATTERNS IN THE STUDY AREA



SOURCE: Sir William Halcrow, 1972

Figure 19

TABLE 8
TRADITIONAL PLANTING AND HARVESTING DATES FOR DURRA

Season	Sowing Dates	Harvesting Ratoons (1)	Grain Yield Kg/ha.*	Fodder Yield bundles/ha.
Kharif	August 5-	1	760	830
		2	380	460
	September 16	3	190	190
		4	40	40

Makhrat	October 30-	1	610	770
		2	310	420
	November 16	3	150	130
		4	40	30

Saudat	January 20-	1	460	770
		2	190	280
	February 18	3	40	130

Saif	May 28-	1	690	830
		2	110	250
	June 18	3	40	130

*Figures taken from Sir William Halcrow and Partners, "Irrigation Development in the Wadi Jizan, Saudi Arabia," Annex 3 (London, 1972), p. 31.

(1) The first harvest is 90 days in duration, the second, third, and fourth are 60-70 days, 50-55 days, and 45-50 days, respectively.

production varies from year to year; and there is a difference between Upper and Lower Wadi yields, depending on the amount of water received and the soil fertility. Durra grows in the form of tall stems--approximately 250 centimeters in height. This makes it practically unsuitable for harvesting by modern equipment, such as combines, for these machines are best suited for crops of no more than 200 centimeters in height.

Millet (Dukha) is second in importance as a foodstuff, and also second in distribution level. It is grown widely in the dry areas, since it is highly xerophilous. (A rainfall of 150-200 mm is suitable for ripening.) Millet occupies 14% of the cultivated area, and takes about 90 days for the first heads to be harvested, after being planted in August or September. Yields vary from 600-800 kg per hectare. After sufficient rain, a second, and sometimes even a third, harvest is obtained. Fodder from Dukhn is of poor quality, and so usually only used by the owner, rather than sold.¹²

Sesame, the third common crop, is an oil crop, grown in flooded areas. It is found in about 11% of the irrigated lands. Sesame is sown in early August and harvested in late October, with a low average yield of about 275 kg per hectare. There has been a decline in the amount of sesame grown in recent years, because of

¹²Ibid., Annex 3, p. 5.

a lack of adequate markets and oil presses. This, coupled with the labor shortage, makes sesame an unprofitable crop.

Several types of vegetables which are new to the Wadi Jizan area are now being grown, although not in great quantities. Tomatoes, peppers, okra, watermelon, and radishes are grown in the scattered restricted areas with tube-wells and often, pumps. It should be mentioned, however, that, owing to several factors--lack of good roads, inadequate marketing and equipment, and lack of knowledge among farmers, the production of all varieties of vegetables is virtually unknown in Wadi Jizan.

Labor

Land preparation and cultivation is a time-consuming and demanding process, especially during the harvest season. For instance, one harvest of durra requires about 86 working days per hectare, not to mention the allotment of about 40 days for the transport of grain and forage by dromedaries. While the actual number of workers required is not known, farmers in the area estimate that approximately 10-15 workers per hectare are needed. However, most workers are seasonal laborers, used during the harvest period, a relatively short span of time. For the remainder of the year, families are usually

sufficient in number to sustain a farm, as usually the entire family is involved in the farming process. Until recently (within 5 or 6 years), harvesting was a shared responsibility of all the community, and a cooperative system was utilized. Now, however, it is generally the responsibility of each farmer to find his own labor force. Two reasons account for this change: 1) the exodus of young men into major towns such as Jizan, Abu Arish, and Sabiya, for education or for higher-paying jobs, and 2) the prospects of employment in Saudi Arabia because of swift progress, which attracts laborers from the entire country.

There has always been migration to the Wadi Jizan area from the neighboring mountain areas and from Yemen. For the most part, it is a temporary migration (for the harvesting season). The number of Yemeni immigrants varies from season to season, and year to year.¹³ However, according to Wadi Jizan farmers interviewed, the number of Yemeni immigrants is higher than before. It was observed during the field work that there are several Yemeni families in the area, with seemingly large numbers of people. Such families settle in the Wadi in hopes of finding jobs with Wadi Jizan companies where they receive more than the little wages paid by Wadi farmers.

¹³There is no available record on this subject, but an Ital-consult estimation in 1963 showed about 1500-4000 Yemenis in the area. A 1972 Halcrow estimation found about 920 Yemenis.

The Wadi Jizan is currently experiencing a shortage of agricultural labor because of such competition. In the past, farmers usually gave part of their production from the main crops as payment, but there is a willingness now to be paid in cash. However, wage demands are currently high in relation to the cash supply of Wadi farmers.¹⁴ As stated before, manpower shortage is mainly evident during harvesting; the remainder of the year the problem of high unemployment is chronic. The manpower shortage could be overcome, by the mechanization of farming methods, while an increase in the variety of year-round crops should offset unemployment.

Livestock

Agriculture is not the only important economical aspect of Wadi Jizan. Livestock-raising is an activity which is widely practiced. As observed earlier, the climatic conditions in the area make the raising of stock a viable endeavor,¹⁵ and several species have adapted well to this environment. In addition, animal husbandry

¹⁴Wages in the past few years did not exceed 300 Riyals per month, or about 10 Riyals per day. At the present time, wages range between 700-1000 riyals per month, or 50-70 riyals per day.

¹⁵Ibid., Natural Vegetation section in this thesis, pp. 16-19.

complements the agricultural economy. Oxen are often used for cultivation, while camels and donkeys are used to transport agricultural products to other villages and markets. The abundance of forage (durra fodder) is absorbed by livestock breeding. Cattle, sheep, goats and camels are a source of meat for the area, as well as a supplement for the meat supplies in the cities of Jeddah and Mecca, especially during the Haj. The unemployment rate may also have an effect, as members of the farmer's family or hired workers often supplement the farm income by breeding livestock.

Surveys of the livestock population in Wadi Jizan were made by Italconsult in 1962-63,¹⁶ and by Sir William Halcrow and Partners in 1972.¹⁷ Despite the time difference of the two surveys, their findings were virtually the same. They found approximately 3,500 cattle, 3,000 sheep, and 3,500 goats in the area. Neither estimation approximated the number of camels and donkeys. The Italconsult survey also estimated that there were 40,000 chickens in the area. Conversations with local farmers and sheikhs found that the numbers of livestock are gradually decreasing, generally due to the high wages offered by the companies near Wadi Jizan, which have caused a migration to the

¹⁶Italconsult: "Land and Water Survey on the Wadi Jizan," Vol. 3, Rome, 1965, p. 20.

¹⁷Sir William Halcrow & Partners: "Irrigation Development in the Wadi Jizan, Saudi Arabia," Annex 3, London, 1972, p. 20.

industrial areas and the abandonment of agricultural and livestock occupations. Camels and donkeys are presently almost extinct in the area, due to the introduction of motorized vehicles.

There are several outstanding differences in the distribution of livestock in the Upper Wadi as compared to the Lower (Table 9). Cattle, for example, are much more prevalent in the Upper Wadi. The results of the field work interviews found that 58.90% of the Upper Wadi farmers own between 3 to 5 head of cattle, while the number is only 26.92% in the Lower Wadi Jizan. Those farmers with 8 head or more numbered 4.11% in the Upper, as compared to 2.57% in the Lower. This drastic difference may be accounted for by the fact that the Upper Wadi has a greater abundance of natural flora in the mountains. In general, the percentages of those farmers who have less than 3 head of cattle and those of 3 to 5 head are high throughout the whole Wadi (54.30% and 42.38% respectively). The distribution of sheep is more evenly spread. The number of interviewed farmers with 100 sheep or more was 46.15% in the Lower Wadi and 46.58% in the Upper. Goats, however, are more common in the Lower Wadi Jizan. The number of interviewed farmers with 100 head or more are 53.85% in the Lower Wadi, and only 12.32% in the Upper Wadi. This sharp difference may be explained by the vast area in the Lower Wadi and the coastal plain where goats can traverse freely, and pasture area is ample. Cultural



TABLE 9
DISTRIBUTION OF LIVESTOCK FOR RESPONDENTS IN THE WADI JIZAN AREA

Type of Animals	Number of Heads	Upper Wadi Jizan Resp.	Upper Wadi Jizan %	Lower Wadi Jizan Resp.	Lower Wadi Jizan %	Overall Total No.	Overall Total %
Cattle	Less than 3 heads	27	36.99	55	70.51	82	54.30
	3 - 5 heads	43	58.90	21	26.92	64	42.38
	6 - 8 heads	--	--	--	--	--	--
	More than 8 heads	3	4.11	2	2.57	5	3.32
	TOTAL	73	100.00	78	100.00	151	100.00
Sheep	Less than 20 heads	--	--	--	--	--	--
	20 - 39 heads	12	16.43	8	10.26	20	13.25
	40 - 59 heads	11	15.07	--	--	11	7.28
	60 - 79 heads	--	--	22	28.21	22	14.57
	80 - 99 heads	16	21.92	12	15.38	28	18.54
	More than 100	34	46.58	36	46.15	70	46.36
	TOTAL	73	100.00	78	100.00	151	100.00
Goats	Less than 20 heads	33	45.21	--	--	33	21.85
	20 - 39 heads	21	28.77	--	--	21	13.91
	40 - 59 heads	10	13.70	4	5.13	14	9.27
	60 - 79 heads	--	--	16	20.51	16	10.59
	80 - 99 heads	--	--	16	20.51	16	10.59
	More than 100	9	12.32	42	53.85	51	33.79
	TOTAL	73	100.00	78	100.00	151	100.00

Source: Data collected during field work of the author in the Wadi Jizan area, Saudi Arabia,
November 15, 1976 to March 15, 1977.

and individual preferences may also account for the differences in the amount of cattle and goats in each area.

Generally, the animal husbandry system in Wadi Jizan is unsatisfactory, due to several factors: 1) the poor condition of the range lands, 2) the deficient food supply provided by durra fodder, 3) the lack of animal husbandry knowledge which results in poor care, and 4) the absence of a vaccination program, resulting in reductions in the life span, productivity, and birth potential. Any improvements or development in the area of livestock breeding will first have to deal with and compensate for these factors.

Markets and Transportation

There are two types of markets in the Wadi Jizan area--weekly and daily. Abu Arish, the most heavily populated town in the area, opens its markets on Wednesday. Sabya, 40 km northwest of Abu Arish, has market on Tuesday. Another weekly market, which operates on Thursday, is Ardah. The Abu Arish and Sabya markets, however, since about 1970, have become almost daily markets, probably because of the competition they faced from the large daily market at Jizan City, located on the Red Sea, about 40 km from both Abu Arish and Sabya. Jizan City is the largest commercial center, with 27,000 inhabitants,



in the South Tihama region. Weekly markets are a common phenomenon in the southwest region of Saudi Arabia, since they are evenly distributed throughout the area and allow buyers and sellers to attend all the markets in the area. Wadi Jizan markets consist of the minute amount of surplus farm products produced by area farmers. With the instigation of larger central markets and a more accessible highway system, the weekly markets will most likely vanish.

As the Wadi farmer's economy is a subsistence type, most of the produce is consumed, and very few farmers (10.59% of all respondents) sell even one half of their total harvest (Table 10). Those farmers who do manage to sell any substantial surplus (only one-fourth) numbered 31.51% of the interviewed farmers in the Upper Wadi Jizan, and 20.51% in the Lower. The majority of farmers (63.58% of respondents) sell nothing. Durra is the main cereal in Wadi diets, and is the most abundant product in the markets. Locally-grown durra is not sufficient for demand, or always fit for selling, so much of the durra found in the markets comes from Sudan. The durra from Sudan is widely distributed throughout the existing markets, and its presence indicates the small surplus of durra locally, because of little rainfall and/or poor cultivation methods. Millet and sesame are two other marketed grains, but they are found in extremely small amounts. Vegetables are often marketed, and are mainly grown on

TABLE 10
PERCENTAGES OF RESPONDENTS WHO SELL THEIR SURPLUS

Categories	Upper Wadi Jizan		Lower Wadi Jizan		Overall Total	
	Resp.	%	Resp.	%	No.	%
All of it	--	--	--	--	--	--
3/4 of it	--	--	--	--	--	--
1/2 of it	11	15.06	5	6.41	16	10.59
1/4 of it	23	31.51	16	20.51	39	25.83
None	39	53.43	57	73.08	96	63.58
TOTAL	73	100.00	78	100.00	151	100.00

Source: Data collected during field work of the author in the Wadi Jizan area, Saudi Arabia, November 15, 1976 through March 15, 1977.

small plots of land along the asphalt roads connecting Abu Arish, Sabya, and Jizan City.¹⁸

Wadi Jizan's marketing system is primitive, which can probably be traced to several causes. Firstly, farmers lack knowledge in agricultural trends. As observed before, farm management is not sufficient and the following of traditional methods leads to a very limited

¹⁸Vegetables are found near Abu Arish, Hakimah, Baydh, Khashabyah, and AlWasily villages.



degree of progress in marketing. Farmers not only need to raise their production to self-sufficient levels, but they also need to realize how to plan for and obtain profit from surplus. The fragmentation of agricultural lands, as well as physical and cultural factors play an important role in production goals and marketing conditions. Also, the conditions of the markets themselves and/or their organization keep the conditions from improving. All of these factors, in varying degrees and amounts, combine to keep a subsistence level of agriculture.

Closely tied to the marketing system is transportation. The Wadi Jizan area was isolated for the most part, until the 1976 completion of the Taif-Jizan highway, which runs between Jeddah and Jizan City through Taif and Abha, and crosses the Asir mountains. Another important roadway is the triangle road between Jizan City, Abu Arish, and Sabya. Interior roads in the Wadi Jizan area, however, are still of earth and dirt. Such roads commonly have Abu Arish as their central point. Generally, they are small, and in poor condition; worstly, the villages they lead to are virtually inaccessible during the irrigation season, since roads run directly through the irrigated areas. Lorries and landrovers are used for transporting goods, while donkeys and dromedaries still provide most of the passenger transport. Transportation costs vary according to road condition, location, and season, and prices are set only by shrewd bargaining. Pack transportation from the mountainous area to the Wadi are common.



The marketing system starts with small farmers who sell their production to middle men or to the larger landowners who collect the produce and send it to the market. Vegetable farmers usually take charge of their own products at the market. Auctioneers then sell the produce to retailers who distribute it in the area markets. At the present time, such vegetable products are the only evidence of new commercial agriculture in Wadi Jizan. Animals, such as sheep, goats, and cattle, are also sold; there is a large export of such animals to Jeddah and Mecca, especially during the Haj. Such animals are usually driven by the owner or his hired hands to the market, they are rarely transported.

Marketing and transportation are essential aspects of the present Wadi Jizan agricultural system. The transformation of Wadi Jizan's economy from a subsistence form of agriculture to a marketing economy certainly will have to include restructuring and re-planning the marketing and transportation practices.

From the previous discussion one can conclude that the agricultural system of Wadi Jizan is primitive and is based upon the production of a single crop (sorghum). It became clear that there is a lack of correct agricultural knowledge among farmers in the area who still follow old traditions in farming their lands. Nevertheless, the existing land tenure system in the area has, since long ago, led to the formation of many small farms. In addition to this,

the very simple ways that are used for controlling floods, the distribution of water in the fields, the lack of good transportation roads inside the agricultural lands, and the existence of primitive marketing system all are factors that have kept the Wadi Jizan agricultural system at the subsistence level.

Obviously, there is a serious need for improvement in the agriculture situation in Wadi Jizan. It is believed here, that any improvement must overcome all of the previous stated factors in order to transfer the old traditional agricultural system in the area into a more sophisticated modern one based on the introduction of new crops and the use of modern techniques and machinery. In this respect, the following chapter is devoted for the discussion of two major themes: the justifications for which the Wadi Jizan area has been selected for agricultural development in South Tihama, and the Wadi Jizan Development Project in terms of what is to be improved in the agricultural system of the area.

Chapter IV

THE WADI JIZAN DEVELOPMENT PROJECT

Development Potential of Wadi Jizan

The Saudi Government's decision to pursue agricultural development is not surprising. In fact, the Government has a history of using its oil revenue for development. As previously stated, a major objective of such investment is to develop water and agricultural potentials. Accordingly, in choosing development sites, the Government consulted surveys carried out in the eight land and water survey areas which were partially based on the abundance and effectiveness of ground water aquifers.¹

Selecting proper sites was not an easy task. Agricultural advisors outlined three types of projects: 1) those for improving irrigation and drainage, 2) those for utilizing ground water, and 3) utilizing and controlling surface water through the construction of dams. By carefully studying the surveys, the idea for pilot

¹Ministry of Agriculture and Water, Kingdom of Saudi Arabia, "Development Plan 1395-1400 (1975-1980)," Part 2, "The Water Sector," 1975, p. 27.

projects was developed. Such projects would have two main objectives: to develop the chosen area, and to give insight and practical experience in developing similar areas. Wadies were chosen for studying the relationship of precipitation to run-off, and infiltration to shallow aquifers. Moreover, these studies may furnish information that can be applied to much larger areas having similar climatic and hydrologic features.²

The South Tihama region was considered as a possible pilot project because it was an obviously improvement-seeking region. Surveys conducted since 1952 indicate a strong agricultural potential as well as great need for improvement. The South Tihama region consists of about 30 Wadies which vary in size, and has a well-known reputation for agricultural diversity. As mentioned before, water plays the most crucial role in this area. The most necessary reformation, then, was to find a way to control the monsoon floods and utilize runoff. The Wadi which was chosen for experimentation, Wadi Jizan, is basically similar to the other wadies in South Tihama, but there are some qualifications which justify its selection.

First, Wadi Jizan is about medium-sized in comparison to the other wadies. Its size makes it a good testing area, since the results

²Ibid., Ministry of Agriculture and Water, Kingdom of Saudi Arabia, p. 22.



can then be applied to both smaller and larger regions. Jizan City, on the Red Sea, also had an impact on the selection, since it is a commercial center for the area. Thirdly, the town of Abu Arish was influential, as it is a promising market and trade site. Additionally, Andrew J. deVajda describes "The existence of an industrious sedentary population accustomed to the irrigation farming,"³ another important aspect of the selection process.

The Government outlined several goals for the development of Wadi Jizan among them were: developing the agricultural potential, raising the standard of living, creating a perennial irrigation system, controlling the floods, and modernizing cultivation by using new and better machines. As tangents to these goals, they also planned for vast improvements in the areas of transportation and marketing.

This alone, however, does not explain totally the consideration given Wadi Jizan. This area also had some problems common only to few areas. For example annual destruction of houses and land by floods is a specific problem of Wadi Jizan. Wadi Jizan development "appears to be justified by the pressure of calamities affecting the landowners and cultivation . . . , loss of crops, and property."⁴

³Andrew J. deVajda, "Proposal for the Wadi Jizan Irrigation Development Scheme, Saudi Arabia," FAO Publications, Report No. 81, Rome, January 1953, p. 1.

⁴N. Simansky, "Report to the Government of Saudi Arabia on the Preliminary Project for Land and Water Use Development in Wadi Jizan," FAO Publication, Rome 1955, p. 1.

Pilot studies conducted by the FAO of the United Nations from 1952-1955 declared:

there was sufficient water available to justify development. It was highly probable that ground water could be developed, and there was ample first-class land available. Also, the project would be intermediate in size and would be a good pilot project to provide experience in meeting the cultural and legal adjustments.⁵

The government's request of November 10, 1965, also spells out what they hoped to achieve:

The new Wadi Jizan Irrigation Project will be considered as a pilot irrigation-marketing scheme, whose results will be applicable to the other wadies and communities of South Tihama.⁶

Another advantage which Wadi Jizan possessed was the availability of surface and ground water. The rainy season, which occurs from July to September provides 90% of the rainfall.⁷ The hydrological make-up of Wadi Jizan as reported by Italconsult is summarized herein.⁸ The following table reports the monthly flows at Malaki Village for the ten years between 1953 and 1963:

⁵Thomas O. Smallwood, "Notes on the Wadi Jizan Project Water Supply," FAO Publication, Rome, 1952, as quoted by deVajda, p. 9.

⁶Request from the Government of the Kingdom of Saudi Arabia to the Special Fund of the United Nations for Cooperation in the Executing of a Proposed Project, the Wadi Jizan Irrigation Project, Saudi Arabia, submitted through the Office of the Director of Special Fund Projects in Saudi Arabia, Riyadh, November 10, 1965.

⁷Chapter II, page 34 in this thesis.

⁸Italconsult, "Land and Water Surveys on the Wadi Jizan," Vol. II, Rome, 1965, pp. 20-33 and 88-99.

TABLE 11

MONTHLY FLOWS OF WADI JIZAN AT MALAKI--MILLIONS OF CUBIC METERS

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1953	-	-	-	-	-	-	(60.00)	34.27	6.28	0.61	0.95	1.43	-
1954	0.12	0.06	0.76	0.01	3.89	1.21	17.93	89.26	13.64	1.85	0.86	0.93	130.52
1955	1.49	0.93	0.23	-	-	-	-	-	-	-	-	-	-
1958	(29.97)	0.84	0.23	-	-	-	-	-	-	-	-	0.86	-
1959	12.80	0.25	0.00	0.00	14.75	0.00	41.37	3.70	0.04	0.00	0.27	0.21	73.39
1960	0.00	0.54	0.95	0.34	12.98	0.62	18.71	14.43	4.83	3.04	1.05	1.78	59.27
1961	0.33	0.00	11.95	6.00	0.21	2.76	32.45	72.80	2.93	0.03	2.78	4.48	136.72
1962	0.35	0.00	1.72	(7.00)	5.05	0.43	1.26	25.99	8.60	0.97	2.49	0.43	54.29
1963	1.07	0.37	-	-	-	-	-	5.37	3.80	3.87	6.46	(0.70)	-

Figures enclosed in brackets, such as (29.97), are uncertain or incomplete, but may be taken as approximations.

Source: Sir William Halcrow, "Irrigation Development in the Wadi Jizan, Saudi Arabia," Annex 4, London, 1972, p. 88.

A frequency flow curve was also defined (Figure 20), and it can be seen from it that:

Flows exceeded in 90% of cases	50 cu hm. ⁹
Flows exceeded in 80% of cases	60 cu hm.
Flows exceeded in 60% of cases	75 cu hm.
Flows exceeded in 50% of cases	83 cu hm.
Flows exceeded in 40% of cases	95 cu hm.
Flows exceeded in 30% of cases	115 cu hm.
Flows exceeded in 20% of cases	130 cu hm.

All information obtained in the Wadi Jizan area shows the great irregularity of the flows. The average flow in Wadi Jizan was calculated to be 90 million cubic meters; maximum annual flow is 137 million cubic meters; and minimum annual flow was 23 million cubic meters. Despite this great variation, the general outlook for Wadi Jizan was hopeful, which encouraged the government to continue their development project with the construction of the Malaki dam. With regard to ground water availability, the main concern in Wadi Jizan was not flood control, but the utilization of ground water in irrigation. Farmers in the area had been obtaining ground water from hand-dug wells with depths of 10-25 meters. The FAO in their report of 1954, as well as Italconsult's 1962-1963 report characterized Wadi Jizan's groundwater as such:¹⁰

⁹One cubic hm. = 1×10^6 cubic m.

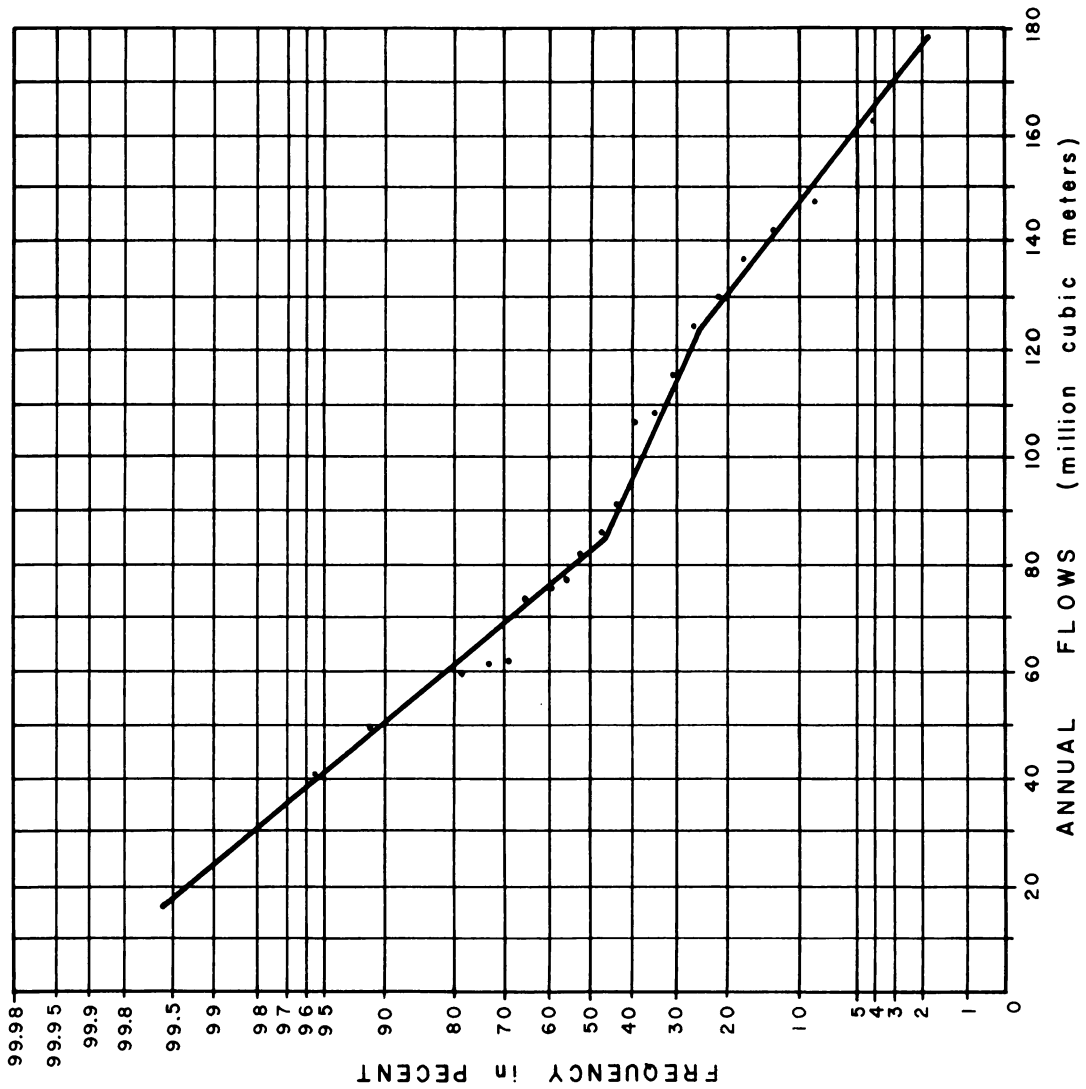
¹⁰Food and Agricultural Organization of the United Nations, "Land and Water Surveys in the Wadi Jizan, Saudi Arabia," Vol. 1, General Report, Rome, 1966, pp. 18-19; see also, Italconsult, "Land and Water Surveys on the Wadi Jizan," Vol. II, Rome, 1965.

WADI JIZAN
AT
MALAKI

FREQUENCY OF
ANNUAL FLOWS

SOURCE:
ITALCONSULT, 1965.

FIGURE 20



- 1) There is an aquifer underlying the entire Wadi Jizan area.
- 2) The aquifer consists of alternating layers of sand and sandy gravel, as well as silty sands and clay.
- 3) The aquifer is estimated to consists of 2000 million cubic meters.
- 4) It is essentially fed by percolation from flood irrigation.
- 5) About 8 million cubic meters per year could probably be drawn out without depleting underground storage.

The discovery of such an aquifer also helped justify the selection of Wadi Jizan as a pilot project area. Through the Malaki dam construction, the building of an agricultural experiment station, and the newly-begun irrigation network, the Saudi Arabia government is illustrating its faith in the promising future of Wadi Jizan as an agricultural area, and the great potential for crop development and expansion.

The government considers the Wadi Jizan together with the lands on the adjacent Wadi Baysh and Wadi Khulab, as the breadbasket of Saudi Arabia and they intended to push development here as rapidly as possible. This area offers a combination of climate, soil and available water such that irrigation with crop diversification can provide



vegetables, fruits and other food crops greatly needed by the country.¹¹

Historical Perspectives and Rationale
for the Project

Upon request of the Saudi Arabian Government, the Food and Agricultural Organization of the United Nations (FAO) commenced some preliminary studies of land and water resources, agricultural development, and further irrigation possibilities in South Tihama, which began in 1951 and were carried out until 1955.

The results of these studies showed Wadi Jizan to be a promising area for a pilot project in irrigation development for South Tihama.

In 1960 the Government petitioned the Special Fund of the United Nations for help in carrying out further investigation, with the Food and Agricultural Organization designated as the executing agency.

The FAO, in January of 1962, further requested the firm of Italconsult to develop a potential method of irrigation development.

¹¹W. A. Lucas, "Investigation Regarding Action to be Taken for Continuation and Completion of UNSF Wadi Jizan Project," FAO Publication, Rome, Dec. 1964, p. 3.



Italconsult presented its final report to the Government of Saudi Arabia in 1965, covering hydrology, geology, agronomy, meteorology, and economy. The report included two main proposals: one which promoted the construction of a dam in the Upper Wadi Jizan at Malaki Village, and another which included the research on irrigation development planning. On the basis of such research, Italconsult was commissioned by the Government to design the flood-control dam and supervise its construction for the period of 1967-1970.

Once the dam was built, the Government obtained assistance from the United Nations Development Program (UNDP) in funding and carrying out the development plan which included irrigation development in Wadi Jizan. By June of 1970, a Plan of Operation had been drawn up and signed by the Saudian Government, UNDP, and FAO for a four-year project including the planning and designing of a new irrigation system, the training of Saudi staff, and the establishment and operation of an agricultural experimental station. In February 1970, FAO subcontracted Sir William Halcrow and Partners to plan and design the irrigation system. The Halcrow survey, submitted in September 1973, promoted the importance of a new irrigation system for Wadi Jizan, and also suggested the introduction of new crops, such as cotton, beans, and groundnuts to the area. Their report also proposed the establishment of an authority for project organization

management and operation to be performed by a Wadi Jizan Board. The irrigation system proposed by Halcrow is currently under construction.

In the brief history of the project, two themes are stressed, development of the dam, as well as development of an irrigation network. Considered in the development program were such factors as farm investment and corollary services, such as infrastructure, experimental farms, and technical assistance. Italconsult estimated the cost of implementation as summarized herein.¹²

The figures from the table appear to be sound and have been adopted as a basis for planning; Italconsult also found the investment to be economic and justifiable on the basis of the statistics in Table 12 alone. By the innovation of water control and available water volume, Italconsult assumed an effective change in production structure. However, the effects of the Wadi Jizan as a pilot scheme will have to be evaluated in order to confirm or negate the economic advantages. Italconsult predicted that an economic evaluation could be obtained by calculating the cost and benefit figures of the project. It was assumed that the usefulness periods of the Malaki dam and other related work was as follows:

Dam-----	70 years
Barrages, canals, hydraulic works-----	25 years

¹²Italconsult, "Land and Water Surveys on the Wadi Jizan," Final Report, Vol. 1, Rome, 1965, pp. 59-85.

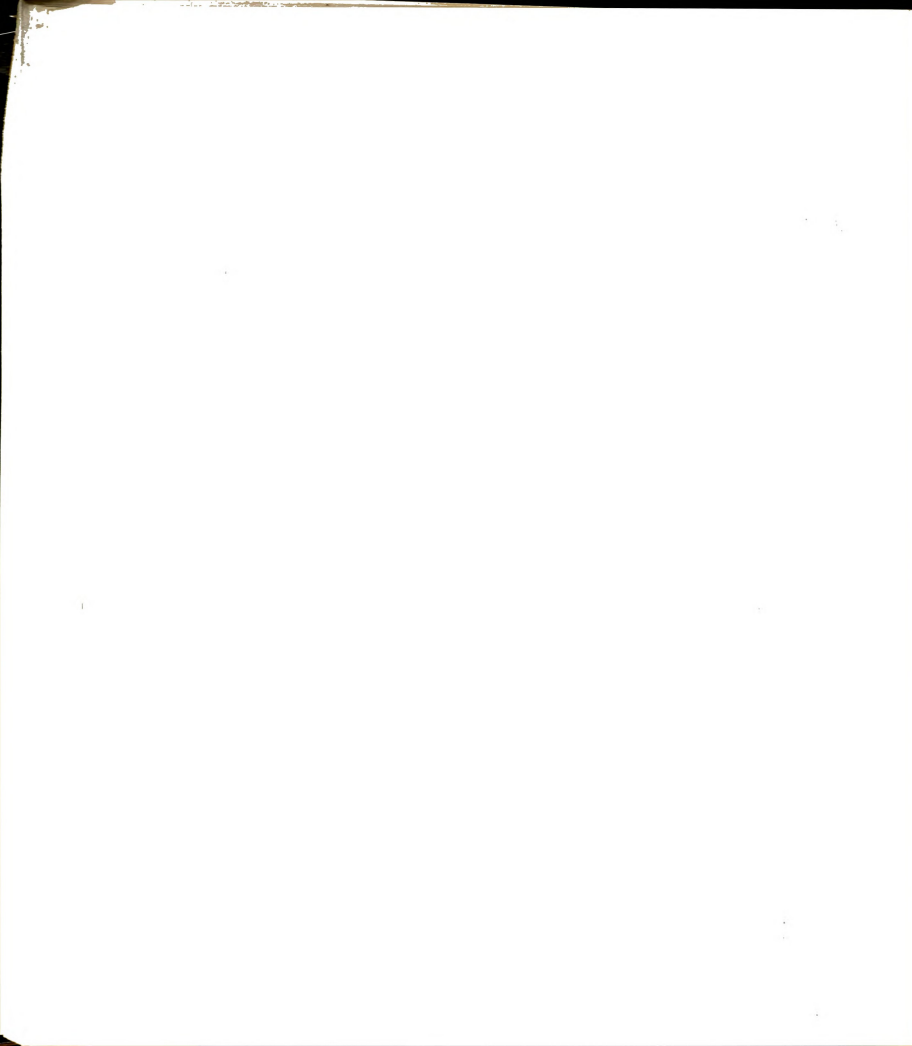
TABLE 12

NET INVESTMENTS FOR THE 1970-1980 AGRICULTURAL PROGRAM
EXPRESSED IN 1,000'S OF US\$ AT 1964 MARKET PRICES

Description	Total		Public	Private
	(1,000 US\$)	%	(1,000 US\$)	(1,000 US\$)
1. <u>Irrigation works</u>	<u>6,920.0</u>	<u>76.7</u>	<u>6,750.0</u>	<u>170.0</u>
Dam	5,100.0	56.5	5,100.0	-
Barrages, main canals and hydraulic works	1,500.0	16.6	1,350.0	150.0
Walls for tapping groundwaters*	320.0	3.5	300.0	20.0
2. <u>Farm investments</u>	<u>1,364.0</u>	<u>15.1</u>	<u>404.0</u>	<u>960.0</u>
Improving and enlarg- ing existing farm equipment and installations	544.0	6.0	-	544.0
Land leveling in irrigation basins	384.0	4.3	384.0	-
Farm equipment for citrus culture	416.0	4.6	-	416.0
Leveling of land irri- gated from wells	20.0	0.2	20.2	-
3. <u>Infrastructures and related services</u>	<u>743.6</u>	<u>8.2</u>	<u>703.6</u>	<u>40.0</u>
Main access roads and bridges	600.0	6.6	560.0	40.0
Experimental farm	60.0	0.7	60.0	-
Demonstration farm	42.0	0.5	42.0	-
Technical assistance services	41.6	0.4	41.6	-
TOTAL	9,027.6	100.0	7,857.6	1,170.0

*Considering 20 wells with average depth of 60 m.

Source: After Italconsult, "Land and Water Surveys on the Wadi Jizan,"
Vol. 1, Rome, 1965.



Wells-----20 years
 Roads and bridges-----25 years

The average life of all these works, taking into account the capital costs, is 55 years, presumably commencing in 1970.

Italconsult considered the first ten years the basis of evaluation, meaning that most likely, increases in production will occur over the ten-year period, excluding the area of citrus production. Comparing the agriculture production forecasts for 1970 and 1980 shows (Table 13) an increase of 81 points from the 1970 figure (181 against 100), for the net internal agricultural production, corresponding to an annual rate of 6.1% for crops and 5.5% for animals. Moreover, it shows an irrigated production of 129 points, or 8.6% per annum, and an 11.6 point increase in dry farming production, equalling a 1.1% per annum increase. By the end of this period, irrigated production will represent almost 75% of the total production, as compared to 60% in 1970. Furthermore, an extension of the irrigated areas will be possible by bringing 83 million cubic meters of water from the dam. Estimates predict that by 1980 there will be 7,400 hectares of land irrigated annually, as opposed to 5,100 in 1964, a 44% increase.

Italconsult forecasts the agricultural production structure to be: 48% in the production of traditional crops, durra and millet, 69% sesame, 90% vegetable, and 75% irrigated pulses. By 1980, it predicts the introduction of new crops, such as cotton (1,050 ha),

TABLE 13

AREA CULTIVATED, VALUE OF GROSS MARKETABLE PRODUCTION AND NET AGRICULTURAL PRODUCT IN THE DEVELOPMENT AREA, 1970-1980

Production	1970				1980				
	Area Cultivated (aad) (4)	GMP (1,000 RIs)	Net Product (3)		Area Cultivated (maad)	GMP (1,000 RIs)	Net Product		
			(1,000 RIs)	%			(1,000 RIs)	% Index (1970=100)	Annual Rate %
Irrigated Crops	14,178 (1)	4,499.8	4,423.3	56.2	11,237.4	10,204.4	71.6	230.0	8.7
Dry farmed Crops	18,070 (1)	2,700.2	2,668.7	33.9	2,812.6	2,742.3	19.2	102.8	0.3
Total	32,248 (1)	7,200.0 (2)	7,092.0	90.1	14,050.0	12,946.7	90.8	145.8	3.4
Animal products attributable to irrigation	-	289.8	231.9	-	525.0	473.0	3.3	204.0	7.4
Other Animal Products	-	676.2	541.1	-	1,021.0	841.0	5.9	155.4	4.5
Total	-	966.0	773.0	9.9	1,546.0	1,314.0	9.2	170.0	5.5
Total Production	-	8,166.0	7,865.0	100.0	15,596.0	14,260.7	100.0	181.3	6.1
--irrigated	-	4,789.6	4,655.2	59.2	11,762.4	10,667.4	74.8	229.2	8.6
--dry farmed	-	3,376.4	3,209.8	40.8	3,833.6	3,583.3	25.2	111.6	1.1

(1) Net of repeated areas.

(2) Including the value of the production from repeated areas.

(3) Zakat (10% of the crop GMP) has been included in the net product unlike the method adopted for the farm calculations.

(4) Maad = 0.36,00 ha.

Source: After Italconsult, "Land and Water Surveys on the Wadi Jizan," Vol. 1, Rome, 1965, p. 69.

citrus (400 ha), and irrigated fodder crops (700 ha) (See Tables 14 and 15). Citrus is estimated to be of bearing age about the sixth year, but not in full yield until about 1990. Livestock are expected to increase by about 70% in the ten-year period, in accordance with the expansion of both dry and irrigated fodder crops. The unit value of livestock products per maad (.36 ha) of pasture or fodder is expected to rise from 30 riyals (dry pastures) to 40 riyals (by 1980); it will be over 30 riyals on irrigated fodder. Consequently, the expected value of production increases will amount to 81% in the ten-year period, or 6% annually.

Net investments programmed (as shown in Table 16) including irrigation works, farm investments, infrastructure and related services amount to 40,624,200 riyals (9,027,600 U.S. dollars). According to Italconsult, 87% of the costs will be met by the state, with the remainder coming from private sources. For economic evaluation of the project, Italconsult determined profitability on the basis of all costs; capital, future operation and maintenance, associated additional costs, and all net values of future production are reduced to their corresponding worth at zero year 1970, assuming a 6% rate of interest. Here, Italconsult only included items of direct cost and direct benefits, a practice FAO declares sound.¹³ The total direct cost of the

¹³ Food and Agricultural Organization of the United Nations, "Land and Water Surveys in the Wadi Jizan, Saudi Arabia," General Report, Vol. 1, Rome, 1966, p. 52.



Products	Area of P Maad Saa	Net Product			
		In 1,000's of Rls	% of Total Crops	Index (1970=100)	Annual Rate (%)
<u>Durra (combined)</u>	<u>12,232 2.0</u>	<u>5,795.0</u>	<u>40.6</u>	<u>160.3</u>	<u>4.8</u>
--dry	1,807 7.8	270.9	1.9	103.2	0.3
--irrigated	10,425 4.2	5,524.1	38.7	164.8	5.1
<u>Millet (combined)</u>	<u>18,209 6.0</u>	<u>3,069.0</u>	<u>21.5</u>	<u>110.7</u>	<u>1.0</u>
--dry	16,263 0.2	2,437.7	17.1	102.5	0.2
--irrigated	1,946 5.8	631.3	4.4	169.4	4.8
Sesame (irrigated)	1,529 8.4	753.0	5.3	169.2	6.0
Cotton (irrigated)	- 8.5	2,248.7	15.8	-	-
Vegetables (irrigated)	278 0.0	360.0	2.5	190.4	7.4
Citrus (irrigated)	- 4.0	571.0	4.0	-	-
Forages (irrigated)	-	-	-	-	-
<u>Pulses (combined)</u>	<u>(3,058) 1.1</u>	<u>150.0</u>	<u>1.1</u>	<u>214.2</u>	<u>8.8</u>
--dry	(1,807) 4.6	33.7	0.2	116.2	1.5
--irrigated	(1,251) 6.5	116.3	0.8	283.6	11.0
<u>Total Crops</u>	<u>(32,248) 0.0</u>	<u>12,946.7</u>	<u>90.8</u>	<u>182.6</u>	<u>6.2</u>
--dry	(18,070) 2.6	2,742.3	19.2	102.7	0.3
--irrigated	(14,178) 7.4	10,204.4	71.6	230.7	8.7
<u>Total Animal Products</u>	- <u>16.0</u>	<u>1,314.0</u>	<u>9.2</u>	<u>170.0</u>	<u>5.4</u>
--attributable to irrigation	- 25.0	473.0	3.3	203.9	7.3
--other	- 21.0	841.0	5.9	155.4	4.5
<u>Total Production</u>	- <u>96.0</u>	<u>14,260.7</u>	<u>100.0</u>	<u>181.3</u>	<u>6.1</u>
--dry	- 33.6	3,583.3	25.1	111.6	1.1
--irrigated	- 762.4	10,677.4	74.9	229.3	8.6

- (1) Average estimate.
(2) Crops consociated on repeated areas
(3) Net of repeated areas.
(4) Including the GMP of the repeated a

TABLE 15

EVOLUTION OF UNIT YIELDS 1970-1980
(In Saha/maad and q1/ha)

Crops	1970 (1)		1976		1980
	Saa/maad	q1/ha	Saa/maad	Saa/maad	Index (1970=100)
<u>Traditional crops</u>					
Dry-grown durra	25	8	30	30	120
Irrigated durra	55	16	75	94	171
Dry-farmed millet	25	8	30	30	120
Irrigated millet	35	11	47	59	169

<u>Cash and industrial crops (irrigated)</u>					
Sesame	25	5	35	44	176
Vegetables	468(3)	-	-	693(3)	148
Cotton (2)	-	-	5.4	8	-
Citrus	-	-	-	313	-

<u>Repeated crops</u>					
Pulses					
--dry-grown	4	1.20	5	5	125
--irrigated	8	2.40	11	14	175

(1) Equivalent to 1964.

(2) In q1/maad.

(3) Average estimate.

Source: Italconsult, "Land and Water Surveys on the Wadi Jizan,"
Vol. 1, Rome, 1965, p. 71.



TABLE 16

TOTAL DIRECT COSTS OF WADI JIZAN PROJECT, IN US\$ BROKEN DOWN INTO INVESTMENTS AND ANNUAL COSTS, REDUCED TO WORTH IN THE YEAR WHEN THE SYSTEM STARTS OPERATING, AND FOR THE YEARS OF THE PROJECT'S USEFUL LIFE

Description	Total Cost (in US\$)	Years					
		1(1967)	2	3	4(1970)	5 2	6 3
1. <u>Dam</u>							
a) total investment	5,475,000						
--fixed investment	5,100,000	600,000	2,500,000	2,000,000			
--interest during construction	375,000			375,000			
b) operating and maintenance costs							
--yearly for 55 years (0.7%x1000)					35,700	35,700	35,700
--reduced to worth at year zero	570,878						
2. <u>Barrages, canals and hydraulic works</u>							
a) --total investment	1,500,000			3 300,000	600,000	600,000	
--reduced to worth at year zero	1,399,800						
b) maintenance and operating costs							
--yearly rate for 55 years(4%xX)					12,000	36,000	60,000
--reduced to worth at year zero	892,789				(11,320)	(32,040)	(849,420)
3. <u>Wells tapping the watertable</u>							
a) --total investment	320,000	160,000	160,000				
b) --maintenance and operating					16,000	16,000	16,000
--yearly for 55 years(5%x320.0)							
--reduced to worth at year zero	255,856				16,000		
4. <u>Main Access Roads and Bridges</u>							
a) --total investment	600,000			300,000	300,000		
--reduced to worth at year zero	549,900						
b) maintenance and operating costs					15,000	30,000	30,000
--yearly for 55 years(5%xX)							
--reduced to worth at year zero	465,565				(14,151)	(451,414)	
<u>TOTALS</u>							
a) --total investments	7,895,000	760,000	2,660,000	2,975,000	900,000	600,000	
--reduced to worth at year zero	7,744,700						
b) maintenance and operating costs							
--yearly for 55 years					78,700	117,700	141,700
--reduced to worth at year zero	2,185,088						

Source: Italconsult, "Land and Water Surveys on the Wadi Jizan," Vol. 1, Rome, 1965, p. 73.

project is outlined in Tables 16 and 17. The items involved in the cost are related to irrigation works, main access roads and bridges, demonstrational farms, and extension services. From the tables, it is observed that the direct costs amount to 44.7 million riyals or 10 million U.S. dollars. In terms, the direct benefits attributable to the project, the reduced worth of the increase in the net production in irrigated agriculture for the 55 years of the useful life of the project amounts to 75.2 million riyals, as outlined in Table 18. From this value, the associated additional costs have been subtracted, in order to obtain the direct benefits which can be attributed to the project, which amount to 59,976.8 riyals (Table 19).

In relating the items calculated previously, the benefit/cost ratio is obtained from two hypotheses (Table 20). If the costs of demonstration activities and extension services were included, hypothesis one, the benefit/cost ratio is 1.34. Excluding the above factors, the ratio is 1.55, the second hypothesis. According to the basis adopted and the various assumptions made by Italconsult, the project seems viable and profitable even on the basis of the first hypothesis.¹⁴

¹⁴See FAO, "Land and Water Surveys in the Wadi Jizan, Saudi Arabia," General Report, Vol. 1, Rome, 1966, p. 58.

TABLE 17

OVERALL COSTS OF PROJECT DEMONSTRATION AND EXTENSION SERVICES,
 BROKEN DOWN INTO INVESTMENTS AND ANNUAL COSTS, DURING THE
 LIFE OF THE PROJECT, REDUCED TO WORTH AT YEAR ZERO
 (in US\$ and thousands of Rials)

Description	Year				
	3(1969)	4(1970)	5	6	7
		1	2	3	4
1. Demonstration farm (US\$)					
--installation costs	42,000				
--annual operating costs		58,000	58,000	58,000	27,000
2. Extension service (US\$)					
--in stallation costs	41,700				
--annual operating costs		160,000	160,000	160,000	75,000
3. Totals (US\$)					
--installation costs	83,600				
--annual operating costs for 55 years		218,000	218,000	218,000	102,000
Totals (in 1,000's of Rials)					
--installation costs	376.2				
--operating costs reduced to worth at year zero	8,769.7				

SOURCE: Italconsult, "Land and Water Surveys on the Wadi Jizan,"
 Vol. 1, Rome, 1965, p. 94.

TABLE 18

NET WORTH OF IRRIGATED AGRICULTURE, INCREMENT IN NET PRODUCT AND YEARLY VALUES REDUCED TO WORTH, DURING THE USEFUL LIFE OF THE PROJECT
(in 1,000's of Rials)

Years	Net Product (in 1,000's of Rials)	Increase in Net Product (in 1,000's of Rials)	Reduction Factor (6% at x years)	Value Reduced to worth at year zero
1(1970)	4,795.0	139.8	0.9434	131.9
2	5,082.0	426.8	0.8900	379.9
3	5,489.0	833.8	0.8396	700.1
4	6,038.0	1,382.8	0.7921	1,095.3
5	6,642.0	1,986.8	0.7473	1,484.7
6	7,699.2	3,044.0	0.7050	2,146.0
7	8,354.0	3,698.8	0.6651	2,460.1
8	9,064.0	4,408.8	0.6274	2,766.1
9	9,834.0	5,178.8	0.5919	3,065.3
10	10,677.4	6,022.2	0.5584	3,362.8
11	10,718.0	6,062.8	0.5268	3,193.9
12	10,762.0	6,106.8	0.4970	3,035.1
13	10,809.0	6,153.8	0.4688	2,884.9
14	10,860.0	6,204.8	0.4423	2,744.3
15	10,914.0	6,528.8	0.4173	2,724.5
16	10,972.0	6,316.8	0.3936	2,486.3
17	11,032.0	6,376.8	0.3714	2,368.2
18	11,100.0	6,444.8	0.3503	2,257.6
19	11,172.0	6,516.8	0.3305	2,153.8
20(1990)	11,248.4	6,593.2	(14.498)	31,716.1
Total				75,212.7

Source: Italconsult, "Land and Water Surveys on the Wadi Jizan," Vol. 1, Rome, 1965, p. 79.



TABLE 19

DIRECT BENEFITS ATTRIBUTABLE TO THE PROJECT
(in 1,000's of riyals)

Description	Value (1,000's of riyals)
Reduced worth of net product (1)	<u>75,212.7</u>
Additional associated costs: (2)	<u>15,235.9</u>
1) Improvement and extension of farm installations (including land-leveling)	4,143.0
2) Improvement of farm installations for utilization of ground water--citrus culture (including land-leveling)	1,947.0
3) Demonstration farm and extension services	9,145.9
Direct benefits	<u>59,976.8</u>

(1) See Table 18.

(2) See Table 16.

Source: Italconsult, "Land and Water Surveys on the Wadi Jizan,"
Vol. 1, Rome, 1965, p. 81.

TABLE 20

BENEFIT-COST RATIOS ACCORDING TO TWO HYPOTHESES
OF ASSOCIATED COSTS
(in thousands of riyals)

Description	1st Hypothesis	2nd Hypothesis
1. Total direct costs reduced to worth at year zero	44,684.0	44,684.0
2. Net product reduced to worth at year zero	75,212.7	75,212.7
3. Additional associated costs	15,235.9	6,090.0
4. Direct benefits reduced to worth at year zero	59,976.8	69,122.7
5. Benefits-costs	1.34	1.55

Source: Italconsult, "Land and Water Surveys on the Wadi Jizan,"
Vol. 1, Rome, 1965, p. 82.

Components of the Project

From the studies and surveys conducted in Wadi Jizan, it was determined that there was promising agricultural and water potential in the area. Later, with suggestions made by FAO between 1951 and 1955, from Italconsult in 1965, and from Sir William Halcrow and Partners in 1972, a full-scale development plan evolved, which was composed of three major stanchions. The first and most basic component of the project was the building of the Malaki Dam, to facilitate the storing of potential irrigation water. A fundamental principle behind the dam construction is the building and development of an irrigation network system, including tube wells, to best utilize the available water and see that it is distributed in a manner most beneficial to the agricultural development of Wadi Jizan. The third main component is the building of an agricultural experiment station, which would perform two main functions: the training of Wadi farmers in agricultural methods and crop sciences; and the testing and development of crops for potential farming in the Wadi Jizan area. In addition, both the transportation and marketing systems will need to be further developed for maximum agricultural efficiency. It should be emphasized, however, that none of these components working alone will suffice. Only by harmonious intermixing of these factors can the agricultural level of Wadi Jizan be lifted from a subsistence level

to a commercial one. The following sections will discuss the components in detail, as well as the attempts to correlate them into a plan with significant implications for development in Wadi Jizan.

Malaki Dam

The Wadi Jizan rises in the Asir Mountains at an elevation of about 2500 meters. Its long path cuts through a belt of lava in an erosion gorge near Malaki Village (Figure 21). The catchment basin, which is subtended by Malaki Gorge at an elevation of about 135 meters, covers an area of some 1,100 square kilometers. Surveyors in Wadi Jizan found the Malaki Gorge well-suited for the reservoir site of the dam.

Based on hydrological information taken at Malaki Village for the years 1959 to 1963, it was discovered that flows reached a maximum of 136.7×10^6 cu. meters and a minimum of 32×10^6 cu. meters, the average being about 90×10^6 cu. meters. The studies also found that although the flood distribution does not follow an even pattern, flows are most frequent in July and August. For these two months, overall flows for the observed years, fluctuated between as much as 107 million and as little as 27 million cubic meters. For intensive study, two periods of about 50 cubic meters in July, August, and in

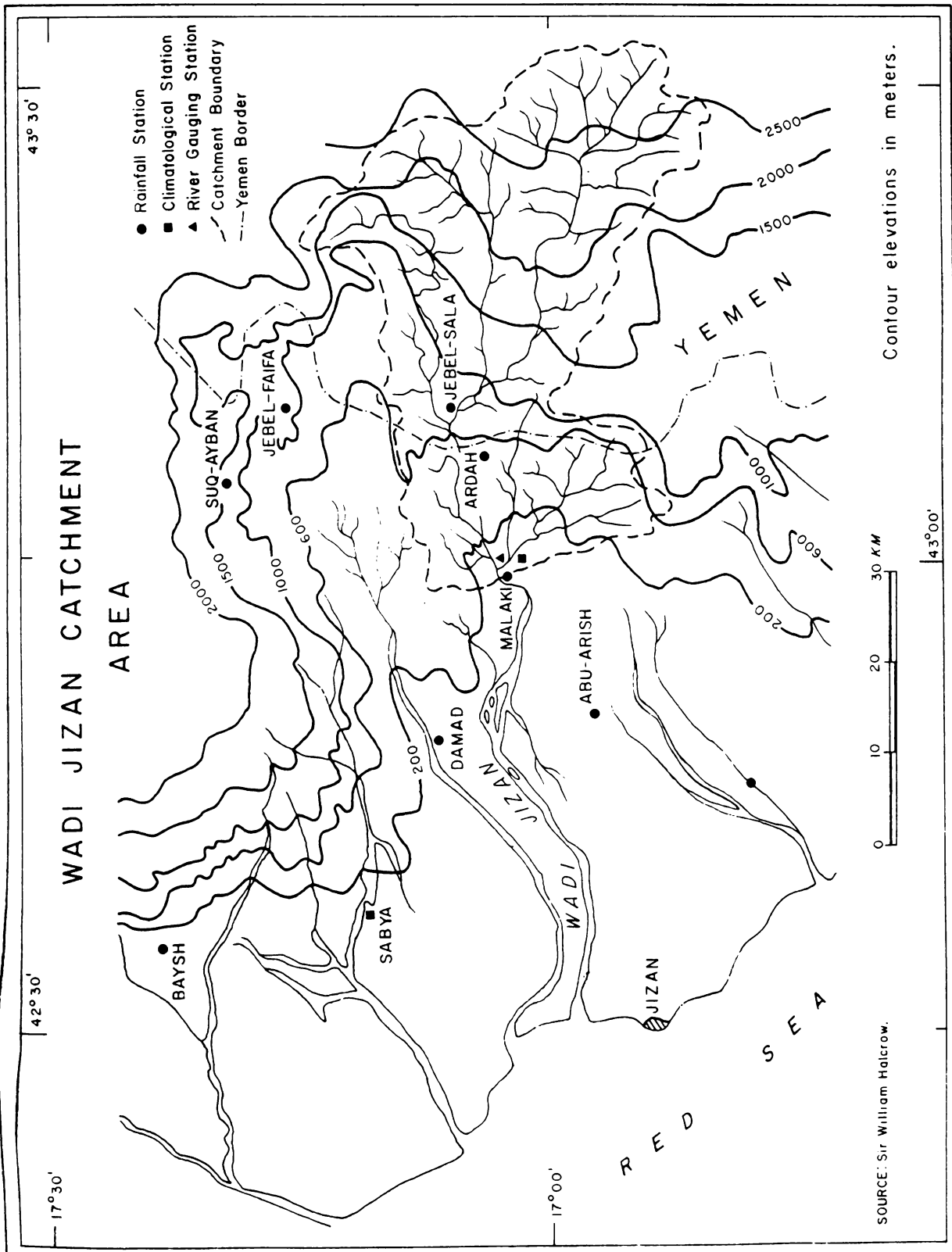


Figure 21

January-February were considered. A total of 71 cu. hm. was essential in terms of volume necessary to be stored. Hydrological data such as this was essential to the decision to construct the dam.

A geological survey was also conducted in the area, focusing on the formation of the reservoir basin as well as the dam site. It was found that the rock outcropping in the reservoir area consists of olvine basalts, diabases, quartzites, and crystalline metamorphics. From a water-tightness perspective, conditions of the reservoir area were satisfactory, for the most part. Choosing the type of dam to be constructed was based on geological, morphological, and hydrological set-up of the Malaki dam is summarized as follows:¹⁵

catchment area at the Dam site	1,100 sq. km.
river bed elevation	130 m.a.s.l.
maximum discharge	3,100 m ³ /sec.
minimum discharge	23 m ³ /sec.
average annual flow with 80% frequency	83 m ³ /sec.
200 year frequency	2,850 m ³ /sec.

After the detailed studies and surveys had been completed, dam construction began in February of 1967, and was completed in August of 1970. The dam is made of solid concrete with the following physical characteristics:

total length	316 m
total height	41.6 m
top width	3.6 m

¹⁵ Italconsult, "Wadi Jizan Development Project, Malaki Dam," General Report, Rome, 1966, pp. 8-14.

height of spillway	5.44 m
diameter of outlets (two)	1.7 m each
maximum storage capacity	71 mcm
water available for irrigation	51 mcm

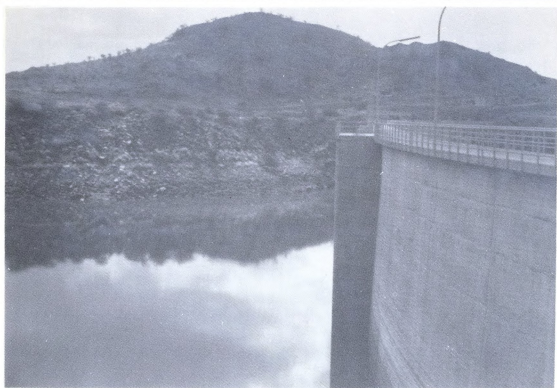
See Figure 22.

The Malaki Dam is a multi-purpose type. Its functions are:

- 1) to regulate the flow of Wadi Jizan and to protect the lands downstream from damage during the monsoon months.
- 2) to enable further expansion of the agricultural areas through release of the stored water for controlled irrigation in accordance with need, and at an opportune time.¹⁶

As stated above, the maximum volume of water that can be retained is 71×10^6 cu. meters, giving a maximum water surface area of 1409 hectares and a maximum depth of 25 meters. For the majority of the year, the lake is at much lower levels with a maximum capacity of about 23.5×10^6 cu. meters. The design of the dam is such that maximum volume of the water remains at 5×10^6 cu. meters with a maximum depth of 5 meters. Water is discharged from the reservoir through two outlet pipes of 1.7 meters diameter at an average rate of 25 cu. m/sec. for each pipe. Two periods for irrigation are considered: at the end of August as a major irrigation period; and at the end of February as a minor one. The reservoir life has been

¹⁶ Abdel Basset El-Khatib, "Seven Green Spikes," Dar al-Qulam Press Co., Beirut, Lebanon, 1974, p. 167.



UPPER PHOTOGRAPH SHOWS THE MALAKI DAM.
LOWER PHOTOGRAPH SHOWS THE DAM'S RESERVOIR.



Figure 22

calculated as the average volume of sedimentation annually deposited in the reservoir was estimated at 500,000 cubic meters. Thus, the average life of the reservoir will be 91 years.¹⁷

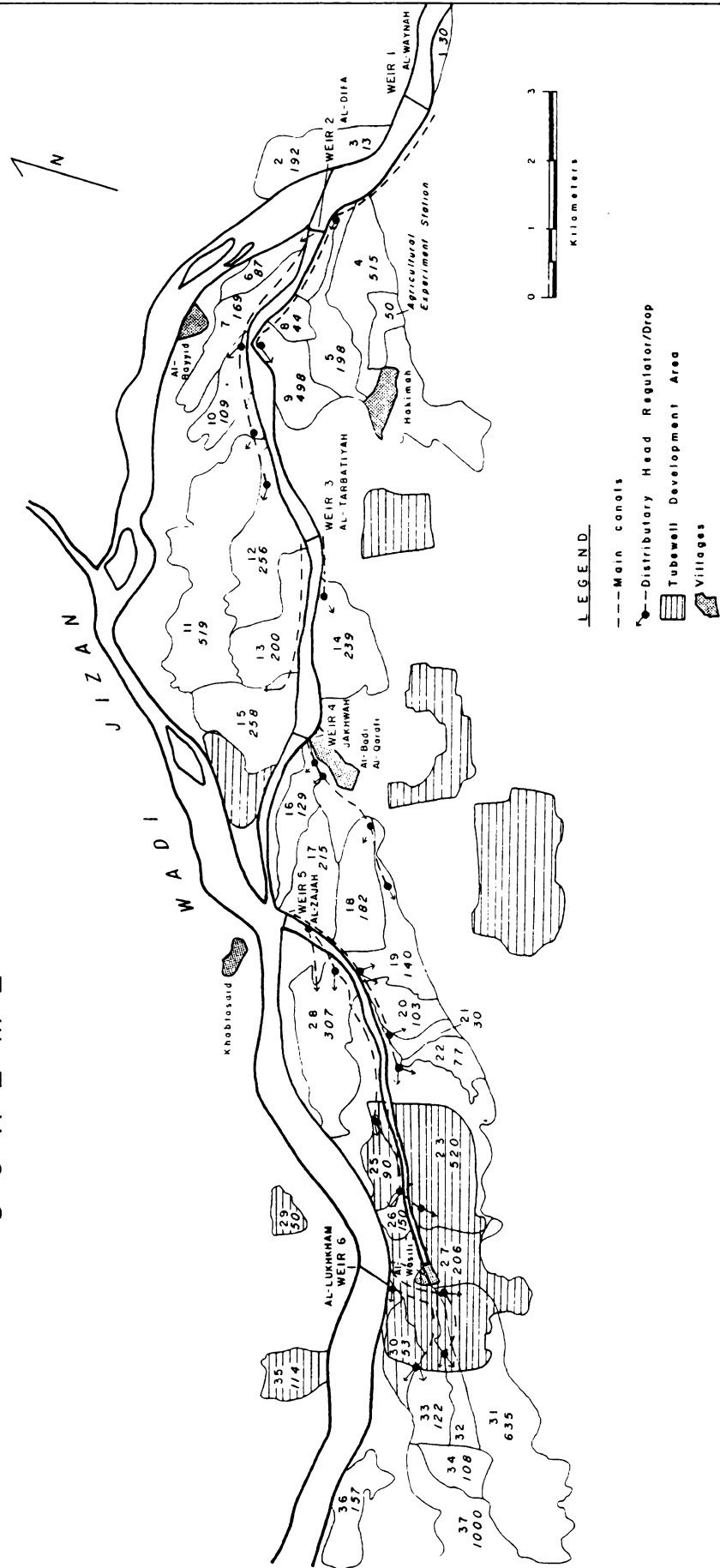
Irrigation Network Scheme and Tube Wells Development

A new project for better utilization of irrigation water is presently under construction. The new project coincides with the policy for more agricultural lands and a greater variety of crops by maximizing utilization of available surface and ground waters.

Floods are now controlled and stored behind the Malaki Dam. A network of diversion weirs and canals was proposed. The new irrigation network is not a complex system, but is based on a slightly modified version of the traditional method. The physical feature of the new system consists of six diversion weirs and head regulators which will be distributed along the Wadi Jizan bed (see Figures 23 and 24). In addition, there are ten main canals and several minor ones. These proposed diversion weirs and canals are designed to regulate the necessary volume of water for irrigation to be distributed among the agricultural fields. For example, diversion

¹⁷ Italconsult, "Land and Water Surveys on the Wadi Jizan," Vol. II, Rome, 1965, p. 15.

PROPOSED IRRIGATION NETWORK SCHEME



SOURCE: Sir William Halcrow, 1972.

Figure 23



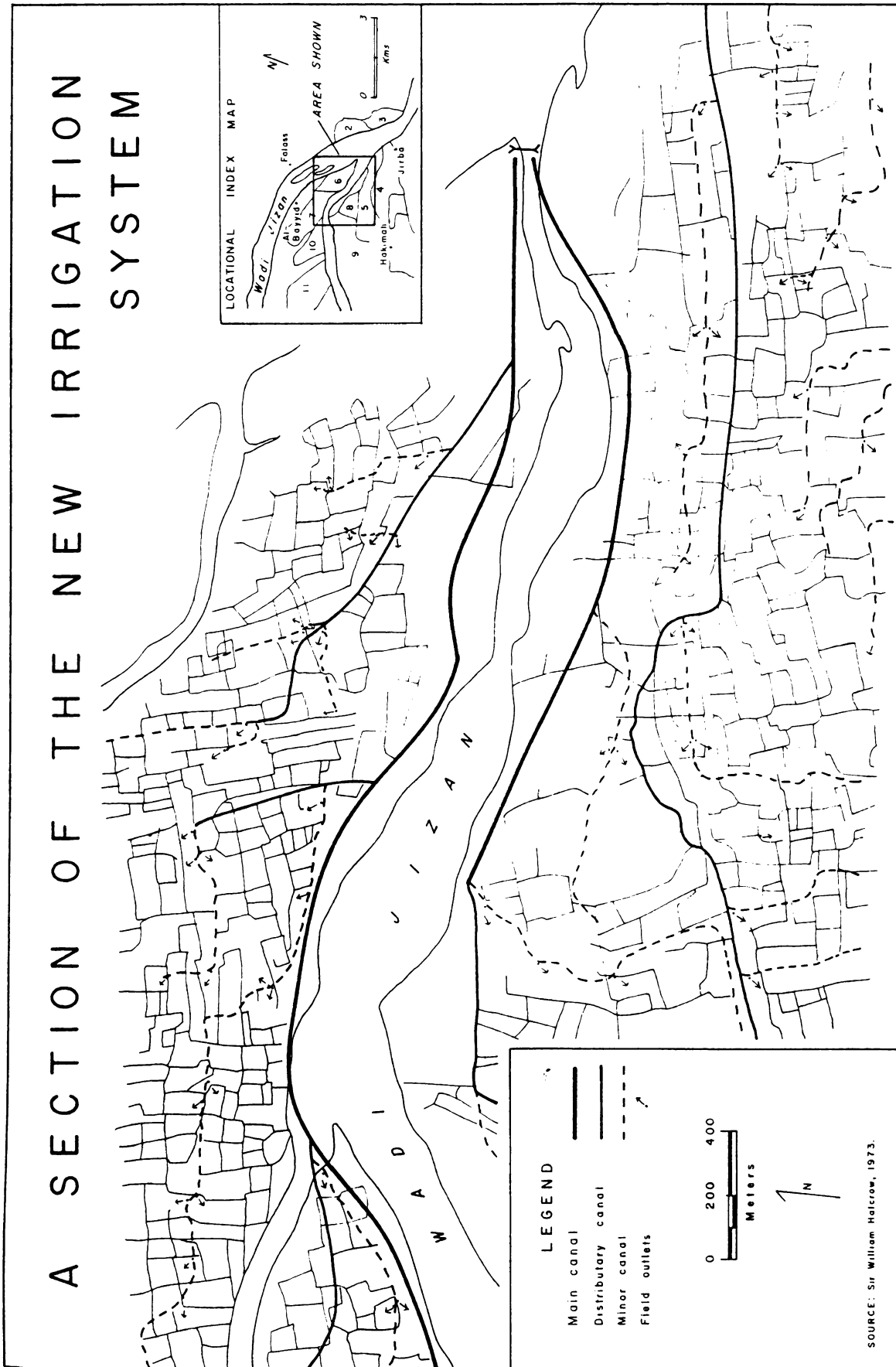


Figure 24

weir No. 1, at Al-Waynah, would be designed with canal head regulators and would pass floods of 2000 cu. m/sec.; while weir No. 2 would pass a flood of 200 cu. m/sec. The discharge progressively decreases for subsequent weirs, as shown in Table 21.

It is estimated that the ten main canals have a total length of about 60.1 kilometers with a total of about 139 offtakes, while minor canals and distributaries total about 117.3 kilometers with about 862 field outlets, all of which serve approximately 6,000 hectares (see Table 22). Each field outlet is in turn supplied by one tube well with a diesel-driven pump of 100 cum/hr capacity. Subsequently, a total of 43 tube wells was proposed which would cover an area of about 1075 hectares (see Figure 24). The plans for the tube wells propose dividing each land unit (25 ha) into nine to twelve plots of two to three hectares each. Every plot would be supplied from an outlet in the main supply pipe.

The development of the proposed tube wells has not started yet, and the construction of the diversion weirs and the main canals as well as minor and distributary canals just beginning. Thus far, only those parts of the Upper Wadi Jizan, at Al-Mujassass and Al-Jarah have been instigated. Subsequently, since the construction has proceeded slowly and behind schedule, the proposed 1980 date for greatly increased agricultural development will undoubtedly have to be postponed.

TABLE 21
DETAILS OF DIVERSION WEIRS AND IRRIGATION HEADWORKS

Weir Number and Proposed Site	Diversion Weir		Canal Head		Regulators	
	Design Discharge (cumecs)	Length (M)	Right Bank		Left Bank	
			Design Discharges (cumecs)	Gate Opening (M)	Design Discharges (cumecs)	Gate Opening (M)
1. Al-Waynah	2000	250	10	10	25	20
2. Al-Difa	200	80	25	20	15	15
3. Al-Tarbatiyah	200	75	15	15	10	10
4. Jakhwar	200	75	-	-	15	15
5. Al-Zajah	200	60	-	-	25	20
6. Al-Lukhkhah	200	40	10	10	15	15
Main Spillway						
Al-Difa	1800	300	-	-	-	-

Source: Sir William Halcrow, "Irrigation Development in the Wadi Jizan, Saudi Arabia," Annex I, London, 1972, p. ii.

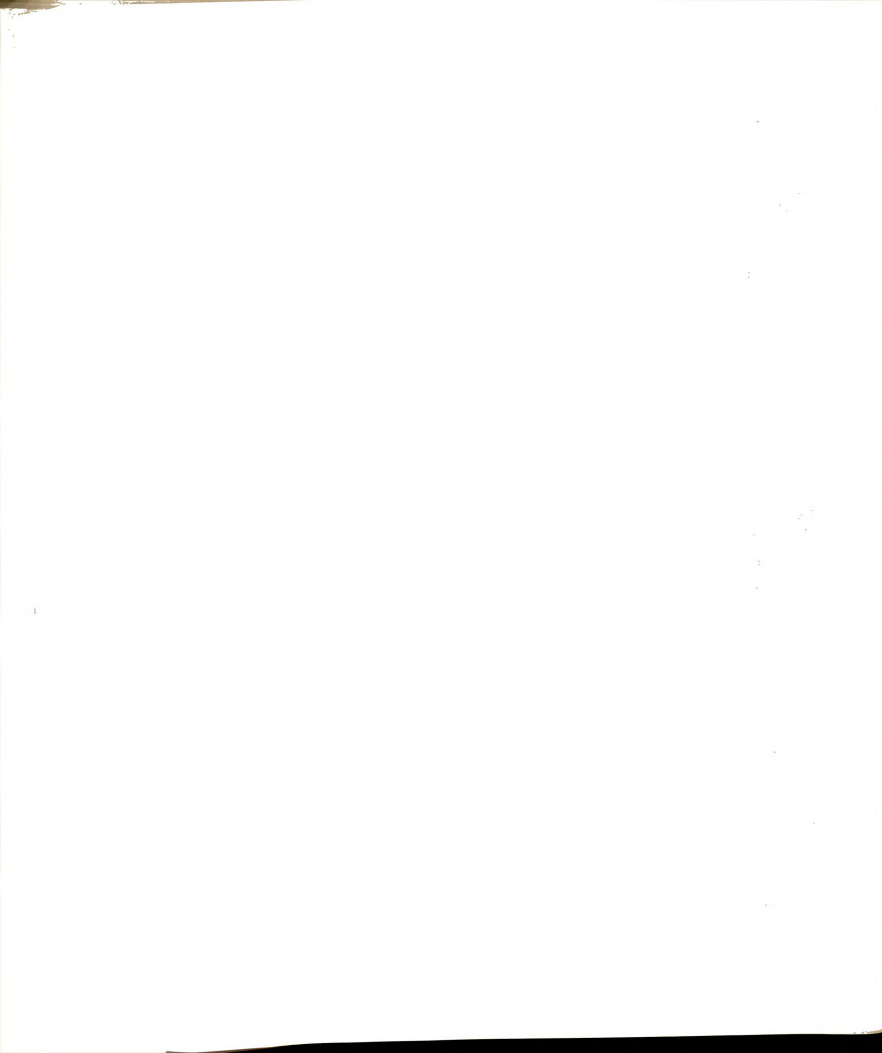
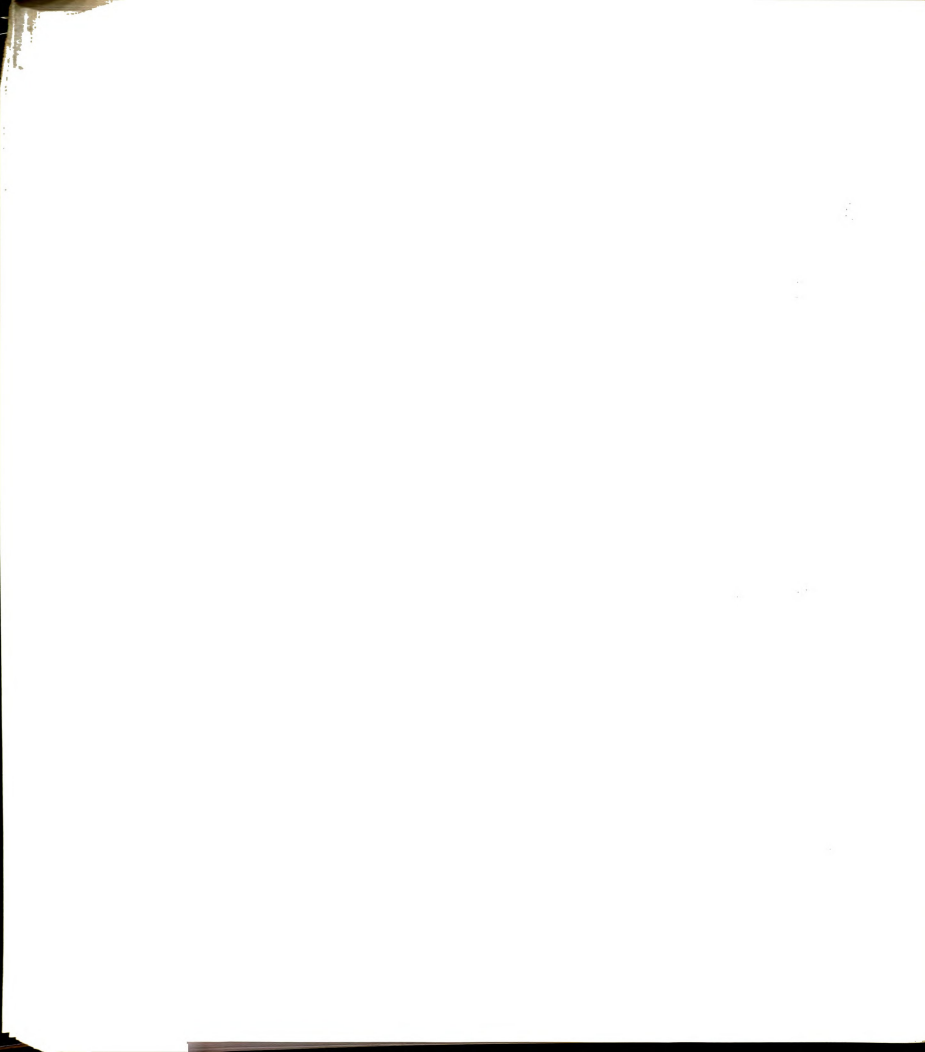


TABLE 22

PROPOSED SCHEDULE FOR DISTRIBUTARIES AND MINOR CANALS

Diversion System	Irrigable Area (ha)	Distributary Canals		Minor Canals	
		Length (km)	Check/ Offtakes	Length (km)	Field Outlets
1. Al-Waynah	828	11.4	21	20.7	82
2. Al-Difa	1480	24.5	24	29.9	131
3. Al-Tarbatiyah	648	5.5	7	12.6	64
4. Jakhwar	646	3.0	4	11.5	41
5. Al-Zajah	1091	8.6	10	24.2	79
6. Al-Lukhkhani	1307	7.1	73	18.4	465
Total	6000	60.1	139	117.3	862

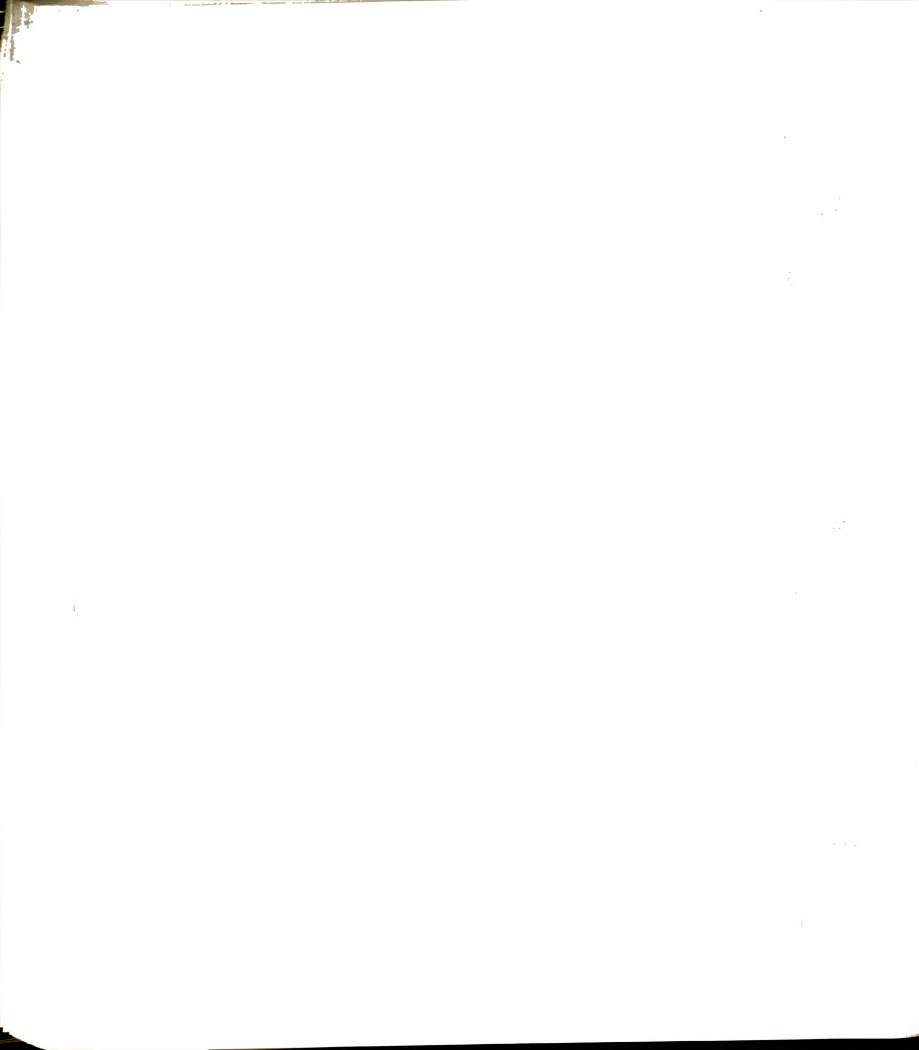
Source: Sir William Halcrow, "Irrigation Development in the Wadi Jizan, Saudi Arabia," Annex I, London, 1972, p. iii.



The Agricultural Experiment Station

The establishment of an agricultural experiment station is essential for developing new methods of irrigation and for introducing new crops to the Wadi Jizan area. In addition, such a station will instigate the use of mechanization in farming. As mentioned in Chapter Three, the agricultural potential of Wadi Jizan has been stifled to a great extent because of the farmers' traditional methods. It is hoped that such a station will provide information as well as practical demonstrations in modern farming methods and new crops.

Through a cooperative effort between the Ministry of Agriculture and Water and the FAO, an agricultural experiment station was established at Hakimah in September of 1972. The station incorporates fifty hectares of land, about half of which will be cultivated under spate irrigation practices; the other half will depend on three wells which supply underground water. The project aims at providing the research necessary to spur agricultural development in Wadi Jizan, as well as other wadies. The actual work done includes testing field crops, vegetables and fruit trees and determining the optimum methods of husbandry, irrigation, crop protection, processing and marketing. Economic appraisal of various crops is another essential factor in formulating proposals for irrigated agriculture. The major aims of the program are outlined as follows:



- 1) To screen and record first-hand information about the behavior of different crops, especially those most abundant in Wadi Jizan.
- 2) To study the problems faced with the growing of crops.
- 3) To study the behavior of possible new crops which are believed to be of economic importance to the region if introduced.
- 4) To become familiar with the water requirements of the various crops and means of improving water use and production; and to investigate means of improved management of the soil and water available.
- 5) To establish methods and procedures and train local staff on long-term record-keeping; and to find a logical approach to solving the problems of area farmers.
- 6) To demonstrate to the local farmer improved methods of crop production, and water management, as well as to introduce new crops.

It has been planned that studies on specific crops will initially be based on the following lines:¹⁸

Many varieties, both old and new, have been under intensive study. Sorghum, the most common crop in the area, is of major interest, as it provides the only feed for their weak stock. As it will be years before this fact is modified, the studies are extremely viable. The program at the present is mainly concerned with local farming practices, known varieties of sorghum, seasonal effects,

¹⁸ Ministry of Agriculture and Water, Department of Research and Development, "First Agronomy--Report of the Hakimah Experiment Station--1972/1973," Hakimah, 1973, pp. 12-20.



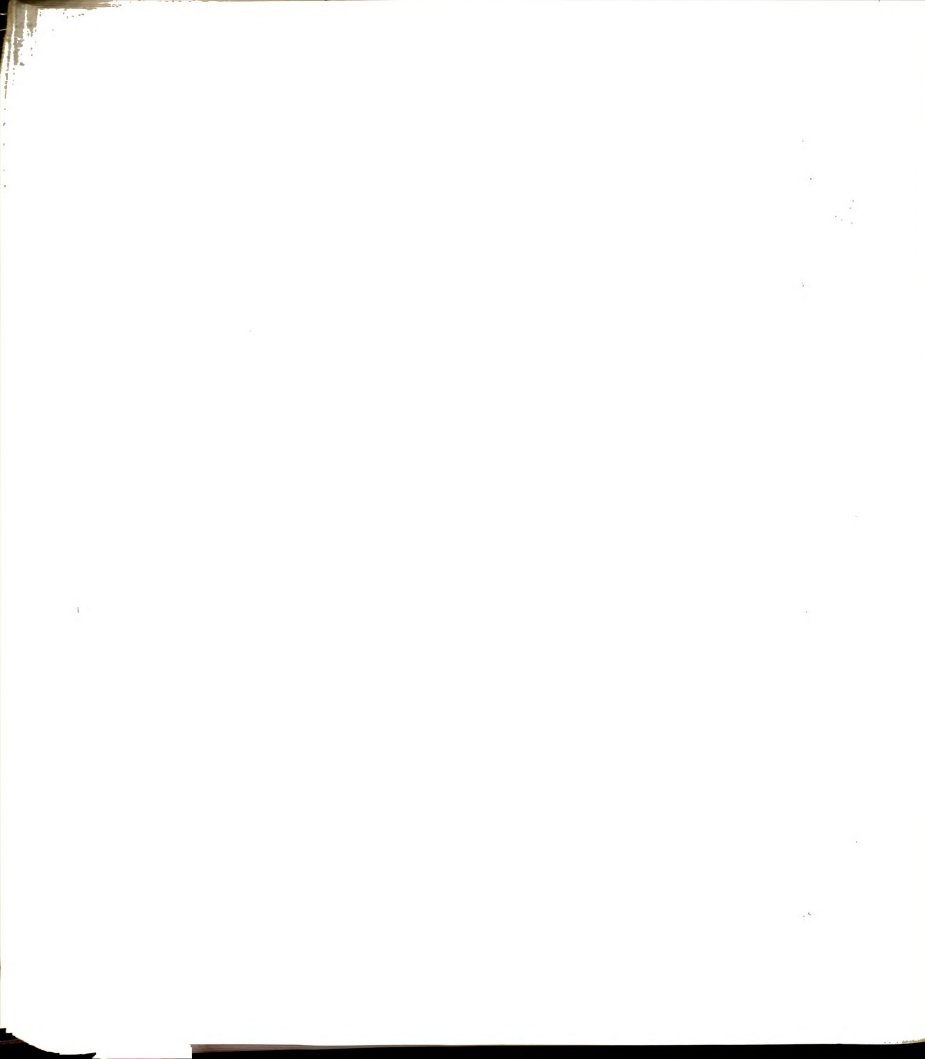
problems with harvesting, and potential as well as present yields, as no accurate record of these factors exists.

Cotton is a promising industrial crop in Wadi Jizan. It has been successfully grown in similar areas and under similar irrigation practices. The program for cotton in principal deals with testing of several varieties of and experiments with planting time and water use.

There are several crops currently being tested in different strains. Maize is one such crop, as well as vegetables such as tomatoes, onions, and potatoes. Also under testing at present are fodder crops, like alfalfa, barseem, and Sudan grass, which have been sown in observation plots. Observation plots have also been started which include: sugar beets, sesame and groundnuts and fruit trees such as papaya and banana.

Such experimental work on different species is detailed in the final annual reports, two of which (1974-75 and 1975-76) are currently available.¹⁹ It should be stated here, however, that the project is still in its early stages, and is not yet complete. However, the results, even this early, are promising.

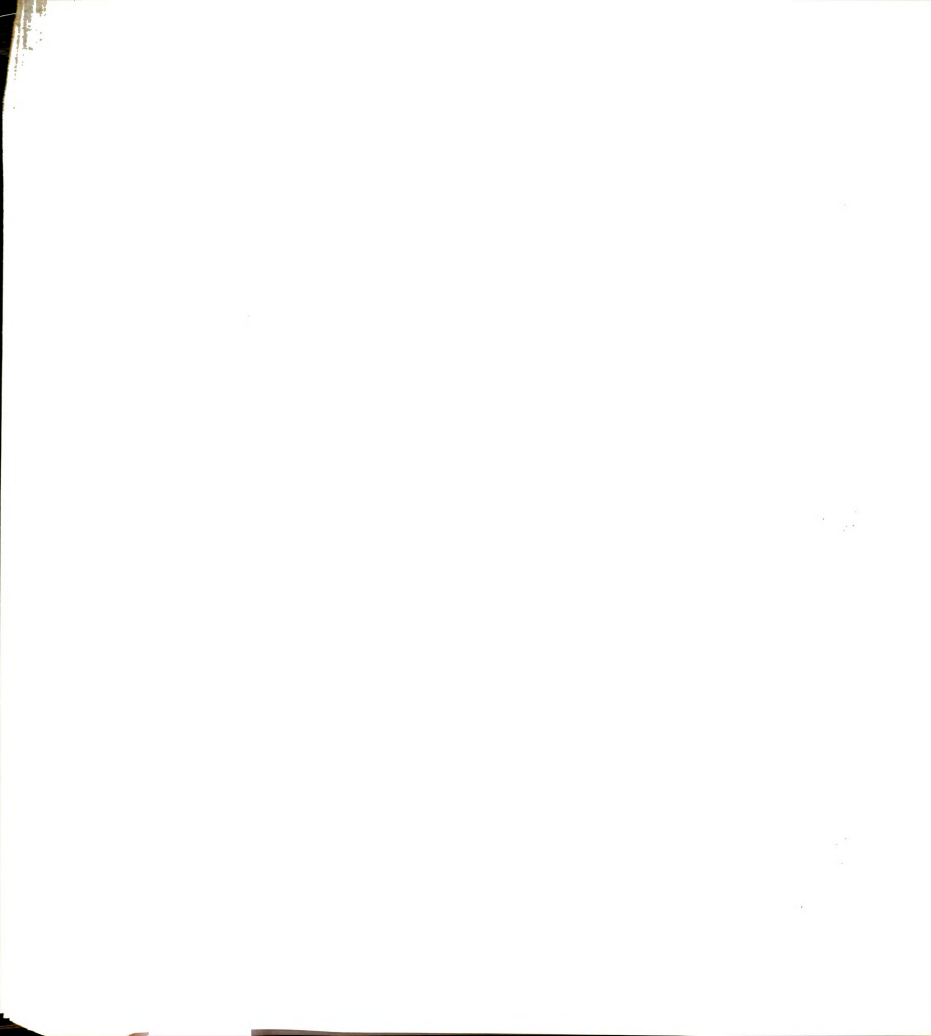
¹⁹Kingdom of Saudi Arabia, Hakimah Research Station, Wadi Jizan Agricultural Development Project, "Annual Report of Experimental Work, Season 1974-75 and 1975-76," Ministry of Agriculture and Water and FAO, December 1976, pp. 8-50.



Sorghum from Egypt has been found to give the highest yield, about 1624 kg grain/ha. No serious pests or diseases were reported. In the case of maize, the possibility of growing four out of a possible 23 varieties (yielding about 3000 kg. grains/ha) is indicated. A slight attack by termites was reported at the end of a growing season, however.

With respect to cotton, 20 varieties were laid out in a randomized block. Seeds were sown on September 16, and harvestings took place at 130, 144, 158, and 172 days. Two distinct varieties of cotton seem especially promising, *barbadense* and *hirsutum*. *Hirsutum* varieties mature more quickly, while *barbadense* varieties are characterized by their long stalks, high number of bolls, per plant (although the individual bolls are smaller in comparison to bolls of *hirsutum*). Cotton yield is estimated to be between 1280 and 1600 kg/ha. Results thus far indicate that by sowing cotton as early as July, earlier maturity, low insect infestation, and higher yield will be possible.

In regard to sugar beets, results indicate the possibility of planting sugar beets in October and/or November, in which case it could be harvested as early as 90 days after sowing. Total yield of sugar beets roots was 55 tons/ha while total sugar yield reached about 6.75 tons/ha.



Experimentation with vegetable strains has found tomatoes, eggplant, peppers, onions, cucumbers, and several others to be successful or potentially successful in Wadi Jizan. At present, however, these crops have been adopted by relatively few farmers.

Experiments are not the only sort of work taking place at Hakimah. A training program has been instigated, started in 1974, and completed successfully in 1975. The program is expected to continue throughout the next few years and aims to train farmers in organized practical studies, with less emphasis on theoretical factors. Emphasis is placed upon development of new crops and agricultural methods in the area. Trainees are young farmers (18-30 years of age), with primary school backgrounds. The training program was conducted for a period of seven months, and expected enrollment was 20 farmers for each of the 1974-75 and 1975-76 periods.

It is clear through the examination of the history of the Wadi Jizan Project and its components, that efforts have been devoted to solving the problems of water scarcity and distribution by the construction of Malaki Dam and the new irrigation networks. Regardless of the completion of Malaki Dam construction, the new irrigation network has just been started. However, there has been some emphasis on the research necessary in the agricultural development in the area by testing some new field crops, vegetables, and fruit trees. Even this latter aspect of experimental design has been practiced on a

small portion of land. Accordingly, one can say that there are some things missing in this agricultural development. That is, the improvement of the land tenure system, and water rights, marketing system, and the agricultural transportation roads. Thus a researcher may ask if there has been any impact as a result of the construction of the dam or the agricultural experiment station on the general agricultural system in the Wadi Jizan area and what kind of change or changes that have taken place as a result. This impact is the focus of Chapter Five.

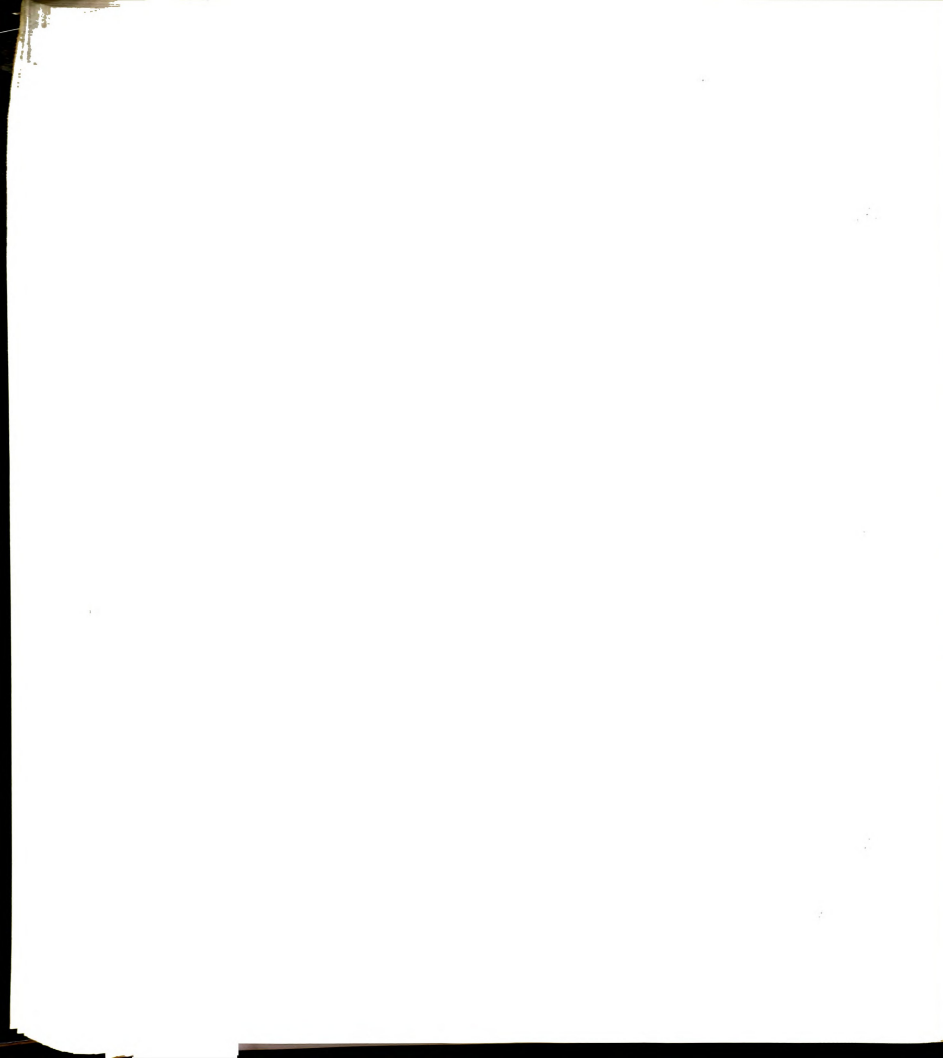


Chapter V

IMPACT OF THE MALAKI DAM ON THE AGRICULTURAL
SYSTEM IN THE WADI JIZAN AREA

Available land for agricultural use has never been scarce in Wadi Jizan, as there are large areas with potential for cultivation. Rather, Wadi Jizan farmers must always be concerned with the availability of water. One year they may be threatened by a water shortage resulting from lack of rainfall; and the next, an uncontrollable flood may occur, which can be equally devastating. Farmers have been longing for a solution to this dilemma, and their aid came with the construction of the Malaki Dam in 1970.

Although the construction of a dam usually implies protection from flood waters, this is only one of the purposes of the Malaki Dam. Not only does it protect the area from dangerous flooding; it is also part of a large-scale scheme for agricultural development in the Wadi Jizan area. A completely new irrigation system is in the works which will enable farmers to grow a variety of crops, rather than simply one or two staple crops. Such a system would lead to an increased amount of agricultural land, greater production, and larger crop



diversity. These factors, in turn, will have an impact upon the marketing and transportation systems, all of which will help to raise the standard of living in Wadi Jizan. Ultimately, agricultural advisors are attempting to transfer the present agricultural economy in Wadi Jizan from a subsistence level to a commercial one. In this plan, water availability is of tantamount importance, which signifies the great importance of the Malaki Dam, as well as the great impact it will have, whether directly or indirectly, on the agricultural system in Wadi Jizan. Through the following sections, this impact will be traced.

Land and Water Utilization

Before 1970, Wadi Jizan farmers were suffering heavily from flood damages. Their flood-control devices, UQUM, were insufficient, and not all of their lands could be irrigated. This fact is illustrated in the following table, compiled by Sir William Halcrow for the period from 1951-1962 and taken from concurrent zakat records and Wadi flow data. It should be kept in mind, while analyzing the table, that there are 8,000 hectares of irrigable lands in Wadi Jizan.

From Table 23, it is obvious that the entire 8,000 hectares have never been fully irrigated. The amount of land irrigated varied

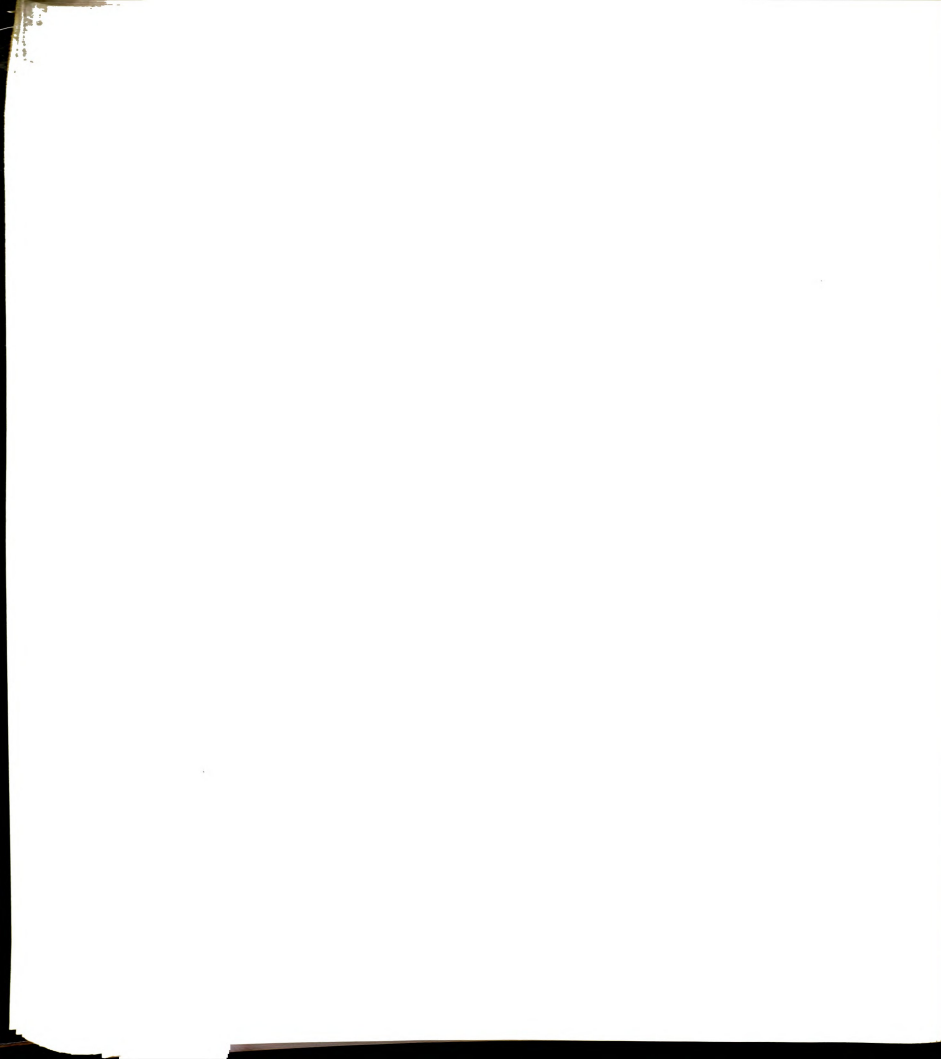
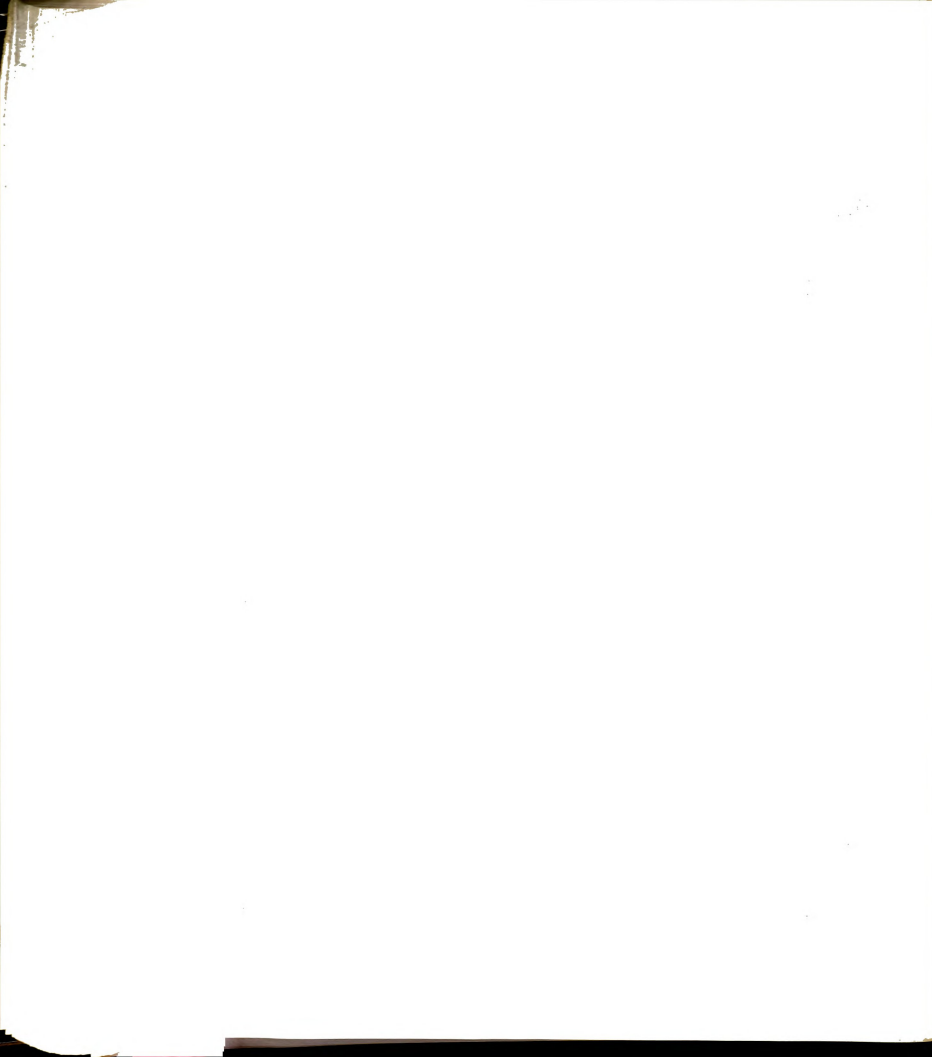


TABLE 23

ESTIMATED IRRIGATED AREAS AND VOLUMES OF WATER
IN THE WADI JIZAN FOR THE PERIOD
1951-1962

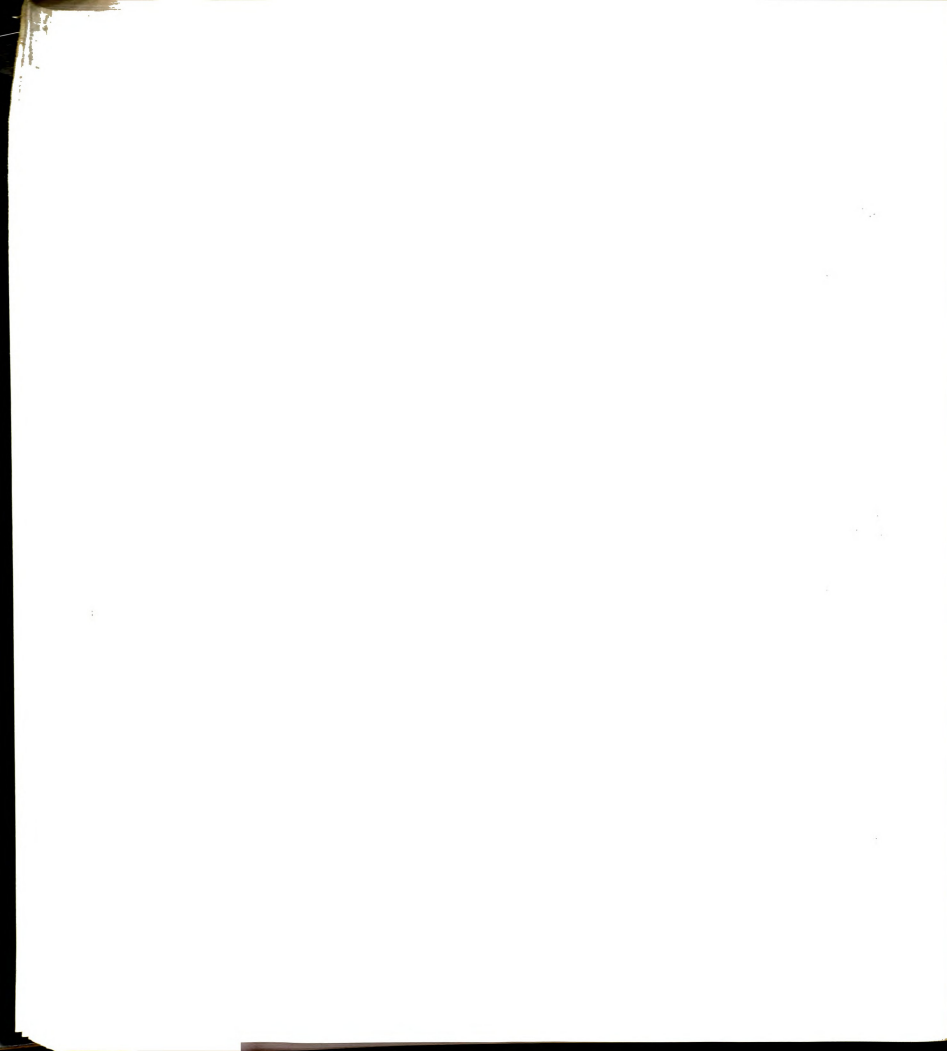
Year	Area (hectares)			Annual Wadi Flow MCM
	Lower Wadi	Upper Wadi	Total	
1951	1,736	2,868	4,606	
1952	2,520	2,803	5,323	
1953	1,496	3,177	4,673	122.5
1954	2,221	2,670	4,891	129.5
1955	50	1,470	1,520	55.0
1956	967	3,208	4,175	92.0
1957	498	2,170	2,668	68.0
1958	2,096	1,888	3,984	94.0
1959	2,439	3,187	5,626	73.4
1960	1,338	1,976	3,314	59.3
1961	1,100	1,961	3,061	136.7
1962	867	2,289	3,156	54.3
AVERAGE AREA:			3,672	

Source: Sir William Halcrow, "Irrigation Development in the Wadi Jizan, Saudi Arabia," Annex 4, London, 1972, p. 50.



from one year to the next, as did the amount in the Upper Wadi as compared to the Lower. At maximum, it amounted to 5,626 hectares, with an average total of 3,672 hectares--a figure less than one-half of the total irrigable area. As observed in the table, the amount of land irrigated in most cases is directly proportional to the water volume. However, there were several years in which large floods occurred, but the amount of irrigated land was small. This contradiction may be attributed to several factors. First of all, extremely high floods often breach UQUM and pass directly to the sea, thus leaving the land unirrigated. Secondly, there are often impoverished farmers who are unable to repair their UQUM, thus reducing their chances for successful and thorough irrigation. Water priority is a third factor which may have an effect. Upper Wadi lands receive water first, and there is no fixed scale for distribution; thus, some Upper Wadi farmers receive more than they need. In addition, lands are often watered more than once before the water is allowed to pass to the Lower Wadi, a problem which will hopefully be resolved by a more well-defined water distribution plan. A more efficient flood-control method would greatly improve all of the aforementioned problems.

With regard to the amount of land irrigated before 1970, Italconsult divided the Wadi Jizan irrigable lands into five classes



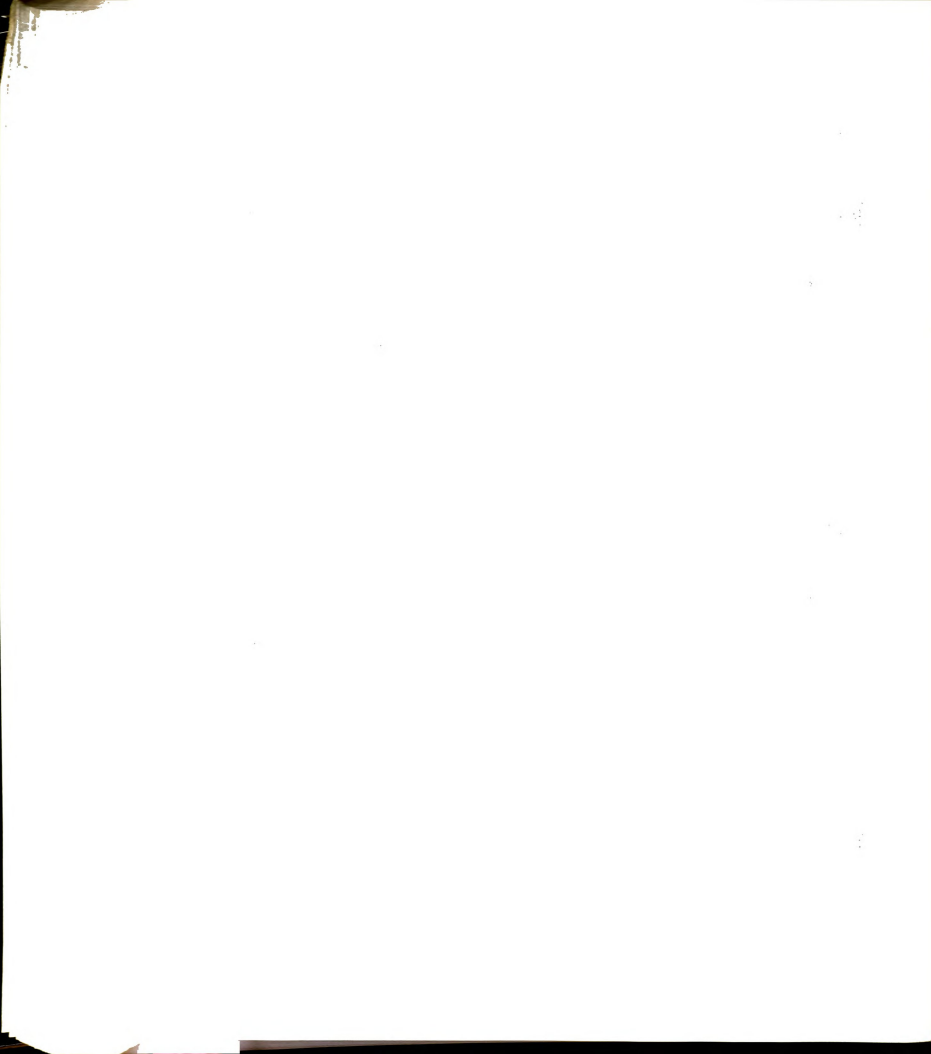
based on the frequency of irrigation, and summarized the data as follows in Table 24.

TABLE 24
DIVISION OF LANDS ACCORDING TO FREQUENCY
OF IRRIGATION

Class	Frequency of Irrigation	Irrigable Areas (hectares)	Average Area Irrigated in One Year (hectares)	
1st	Every year	1,900	1,900	100.0%
2nd	2 yrs. out of 3	1,500	1,000	66.7%
3rd	1 yr. out of 2	800	400	50.0%
4th	1 yr. out of 3	2,400	800	33.3%
5th	1 yr. out of 5	1,400	280	20.0%
TOTAL		8,000	4,380	54.7%

Source: Italconsult, "Land and Water Surveys on the Wadi Jizan," Vol. I, Rome, 1965, p. 14.

The absolute minimum amount of land irrigated out of the total irrigable lands is 1,900 hectares, with a normal minimum of 3,300 hectares. In the first class specifically, the total volume of water applied was estimated to be 9,000 cum/ha. for the first application, and 8,000 cum/ha. for the second application. Lands of the other



classes receive 7,500 cum/ha. for the first application only. Maximum utilization of lands was calculated to be 5,600 ha. with an application of 50,725,000 cum of water; and 4,350 ha. with an application of 42,925,000 cum. Minimum utilization was 3,300 ha. with an application of about 35,100,000 cum of water.¹ These figures again help to define the relationship between irrigated lands and water flows, as well as to explain the fact that farmers in the Lower Wadi receive less water and thus cultivate a smaller portion of land, while the Upper Wadi receives flood water from each flood which may be utilized two or three times, resulting in Upper Wadi farmers' larger cultivated areas.

The amount of water used for irrigation and the total areas irrigated during the five years prior to the construction of the dam are calculated in Table 25.

Information in the table is based on the assumption that 8,500 cum of water is sufficient for irrigating each hectare. Thus, it is evident that only a small amount of flow water was utilized during any given period, and that large percentages were lost. For example, in 1964, the flow amounted to 192 MCM, but the irrigated lands amounted to no more than 2,205 hectares (27.5%) of the total 8,000 ha. of irrigable lands. If the 2,205 ha. are multiplied by

¹ Italconsult, "Land and Water Surveys on the Wadi Jizan," Vol. 1 (Rome, 1965), pp. 14-16.



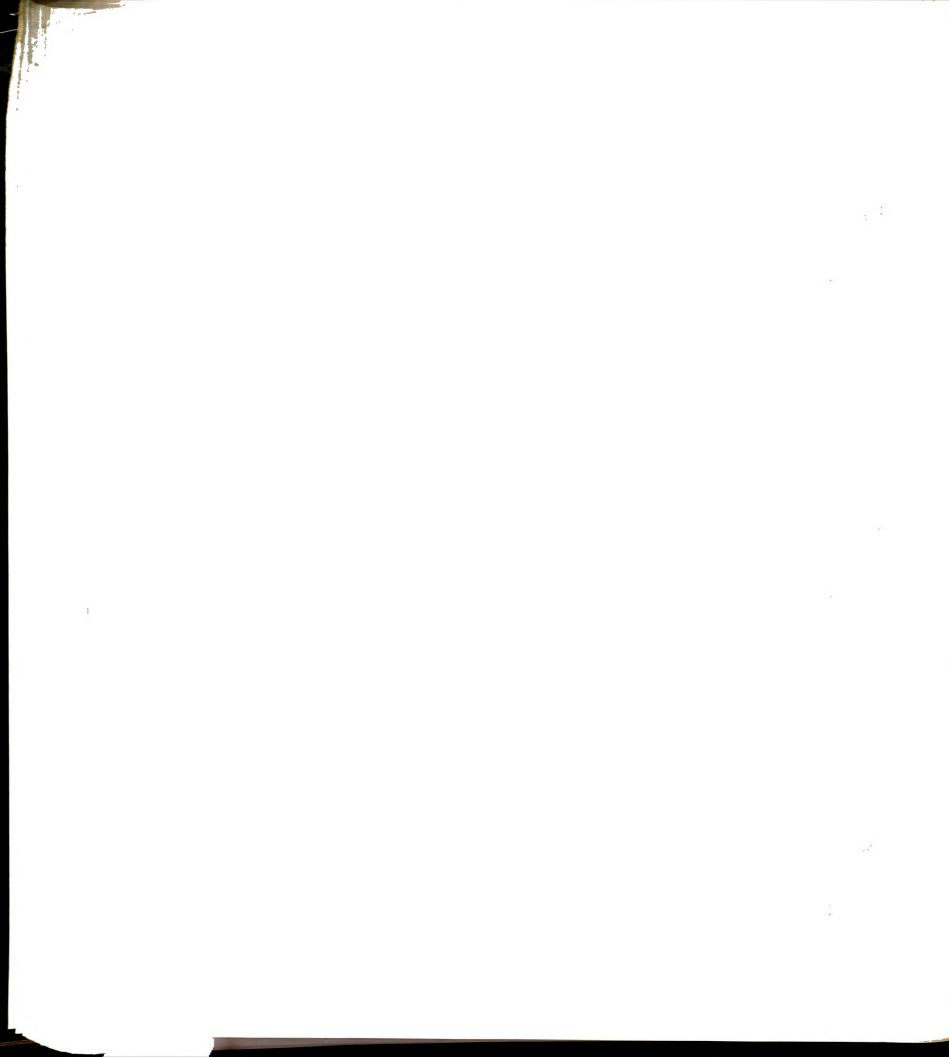
TABLE 25
LAND AND WATER UTILIZATION FROM 1964-1968

Total Irrigable lands in Wadi Jizan	Year	Total Irrigated Lands (hectares)	%	Wadi Flow (MCM Annually)	Net Water Utilized (MCM)	Losses (MCM)
8,000 ha.	1964	2,205	27.5	192.0	19	173
	1965	1,889	23.6	53.0	16	37
	1966	1,828	22.8	55.0	16	39
	1967	6,238	77.9	136.7	53	83.7
	1968	3,272	40.9	56.0	28	26

Source: Compiled from the Agriculture Experiment Station at Hakimah.

the amount of the average water applications (8,500 cum/ha.), the net amount utilized in 1964 is 19 MCM. This means a loss of about 173 MCM for the same year. The same pattern of calculation may be applied to subsequent years.

The purpose of the dam is to regulate water flow throughout the year, and to enable the farmers to apply water to lands if and when needed. The regulation of water facilitates the storage of irrigation waters in the reservoir for use during a specific period. The dam, which has been operating since 1970, released water during



the period from late August to October of 1970, irrigating an area of 3,964 hectares or 49.5% of the irrigable lands. However, the release of water was not completely controlled, as it was based on traditional irrigation methods. Not until the period 1971-1972 was the release controlled, although the amount of water stored was small during this season.

During this period, water was released four times; and, rather than being equally distributed, some areas received four waterings; others one, and the Lower Wadi lands received no water. Obviously, there was a serious lack of supervision and release-control. The farmers continued in their traditional mode of irrigation. Thus, little can be achieved until the farmers can be persuaded to adopt modern irrigation methods.

The impact of the dam upon land and water utilization is seen in the following Table 26 which compares utilization between the periods before and after the construction of the dam.

From this table, one can conclude that for the period 1964-1968, irrigated lands represented a small percentage of the total 8,000 hectares of irrigable lands. This fact remains true even during periods of high flooding, when large amounts of water were utilized. Such large utilization, irrigating such small amounts of land, is characteristic of the pre-dam period. The factors which are mainly

TABLE 26

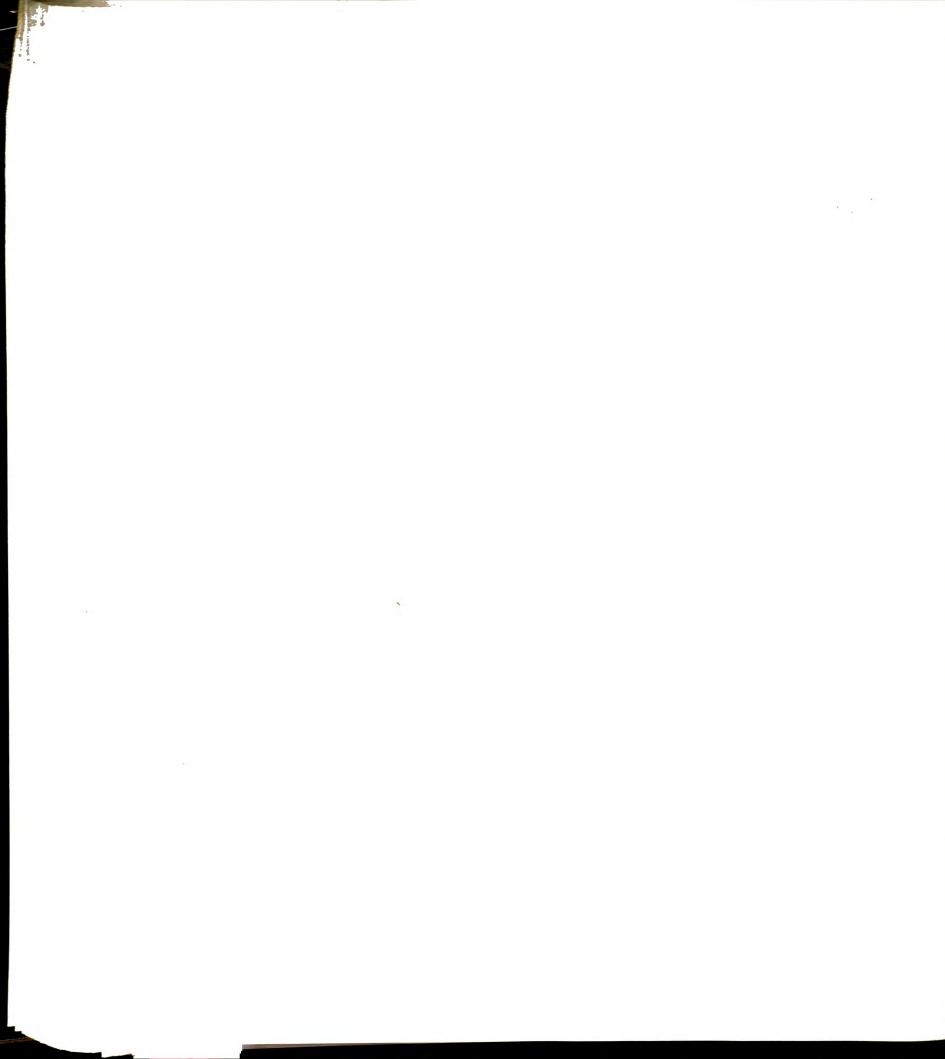
SIZE OF AREAS IRRIGATED BEFORE AND AFTER
OPENING THE DAM IN 1970

Year	Total of Irrigated Areas	%	Wadi Flow (MCM)	Water Utilized (MCM)	Losses (MCM)
1964	2,205	27.5	192.0	18	174
1965	1,889	23.6	53.0	16	37
1966	1,828	22.8	55.0	15	40
1967	6,238	77.9	136.7	53	82
1968	3,272	40.9	56.0	28	28
1970	3,962	49.5	34.5*		
1971	2,200	27.5	21.0		
1972	2,442	30.5	30.4		
1973	2,257	28.2	21.0		
1974	3,000	37.5	28.5		
1975	3,400	42.5	32.2		

*Figures indicate the net volumes of water released from the dam for the years 1970-75 and not the actual volumes stored in the reservoir.

Source: Compiled from the Agriculture Experiment Station at Hakimah.

responsible for this situation are the insufficient methods of flood control and the water priority system which permits several waterings

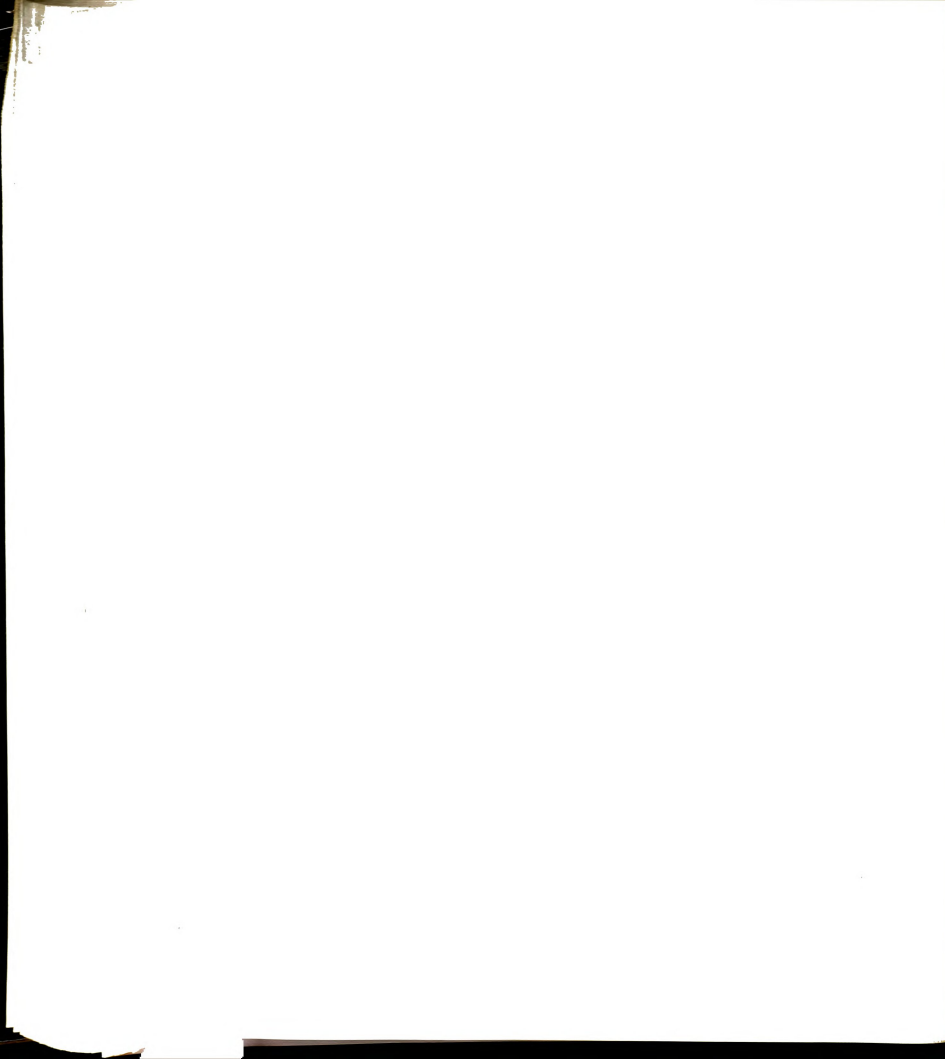


of the same area to occur. This makes the Upper Wadi a favorable agricultural area, while the Lower part suffers from water scarcity except during high flood periods.

The years 1970-1975 saw significant changes made. Floods were stored and the water released for irrigation. The dam facilities year-round storage, which eliminates loss of water to the sea. In comparing 1966 to 1972, several striking modifications can be seen. In 1966, the volume of flow was 55 MCM, while lands irrigated amounted to 1,828 ha. (22.8% of the total irrigable lands). The volume of water utilized in 1966 was 15 MCM, with a loss of 40 MCM.

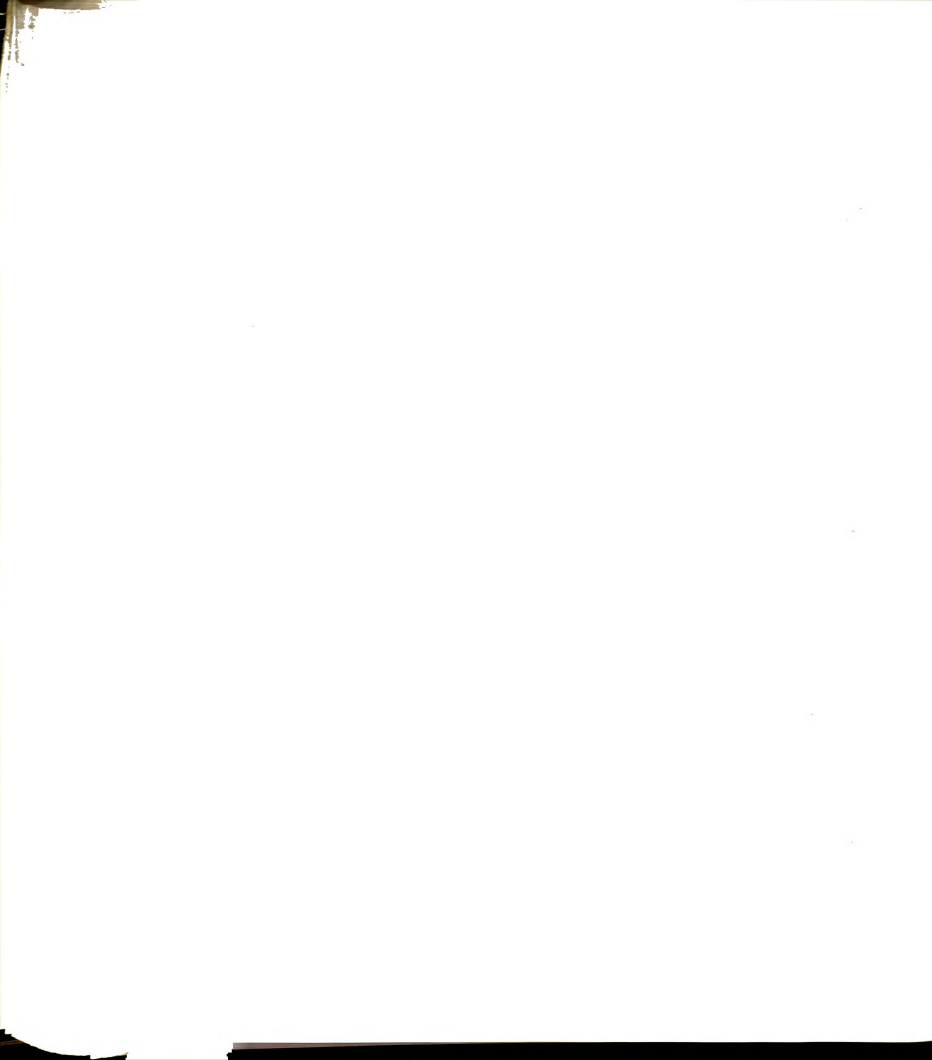
In 1972, the picture was noticeably different. A total of 2,422 hectares (30.5% of all irrigable lands) were watered. The net water released from the dam to irrigate was 30 MCM. In 1975, 42% of the total irrigable land was irrigated, with a net water release of 32 MCM--a drastic change when compared to 1965 when the flow was 53 MCM, but only 23.6% of the irrigable land was watered.

It can easily be observed that there are several large differences between pre- and post-dam statistics, due to the water loss, small total irrigated area, and significant variability, which were encountered before the dam, and severely reduced, if not eliminated, with the dam construction. The striking feature of years 1970-1975 is the graduation in size of the irrigated lands, which coincides with the volume of water released.

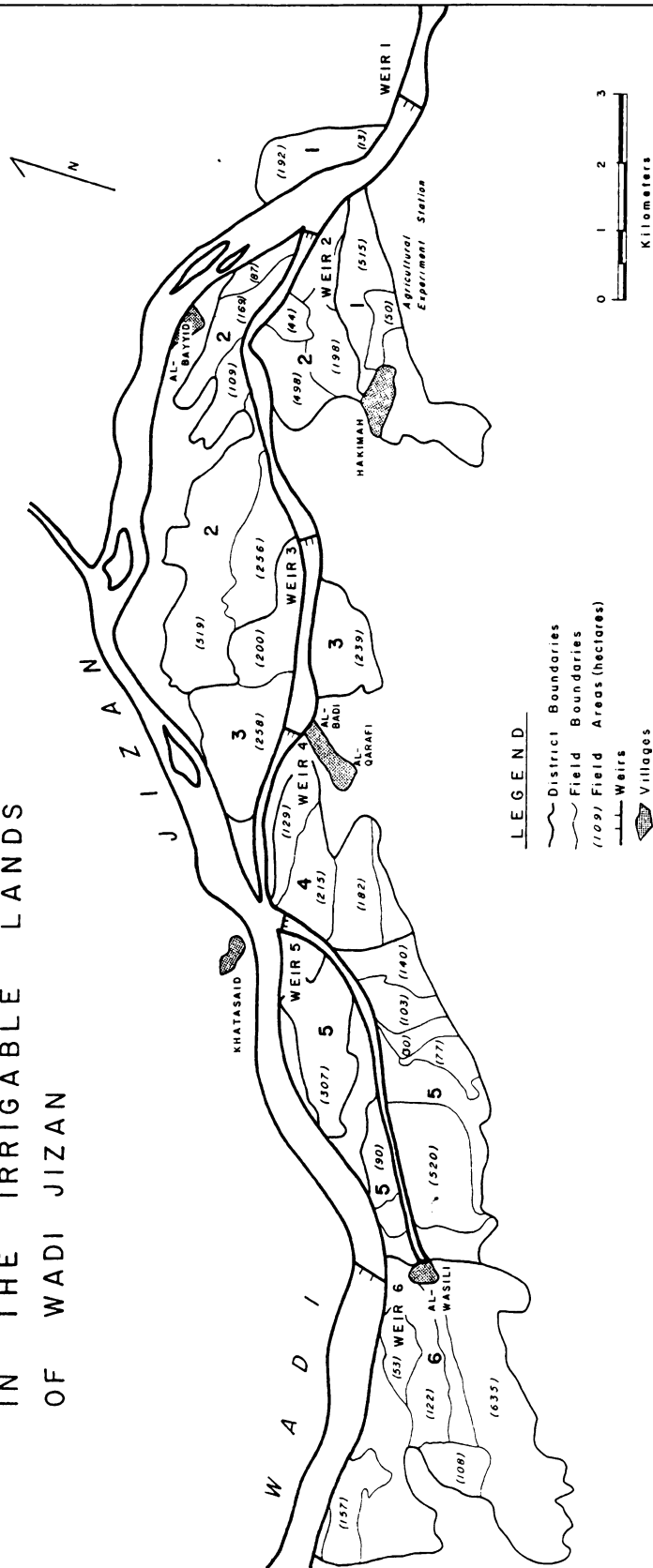


From the previous discussion, it can be deduced that while the dam has improved the problem of water scarcity, some flaws in the irrigation pattern still exist. The major facet which needs to be examined is water availability. Although the dam has the capacity to store water for irrigation use, its power is limited in two respects: The availability of water is a problem which basically is out of the realm of human control--that is, the amount of rainfall is at the discretion of nature. The other facet, however, is within human influence. The water distribution pattern can and must be changed in order to bring a successful irrigation system to Wadi Jizan. The major utilization problem stems from the fact that Wadi farmers do not share the water equally; rather, they tend to be greedy and to believe that the present priority system, developed through tradition, is the best method of water utilization.

To help establish a new distribution system, a new irrigation plan was formulated which calls for the building of small canals to help distribute water to the Upper and Lower Wadi in an even and fair manner. Unfortunately, progress on this new irrigation system has been extremely slow. Since work began in 1974, the construction has not moved out of the Al-Jarah district, a small part of the Upper Wadi. This plan divides the total irrigable land in the Wadi into six districts, as shown in Figure 25. The new irrigation system, when completed, will cover all six districts.



THE SIX NEW IRRIGATION DISTRICTS NUMBERS IDENTIFY DISTRICTS IN THE IRRIGABLE LANDS OF WADI JIZAN

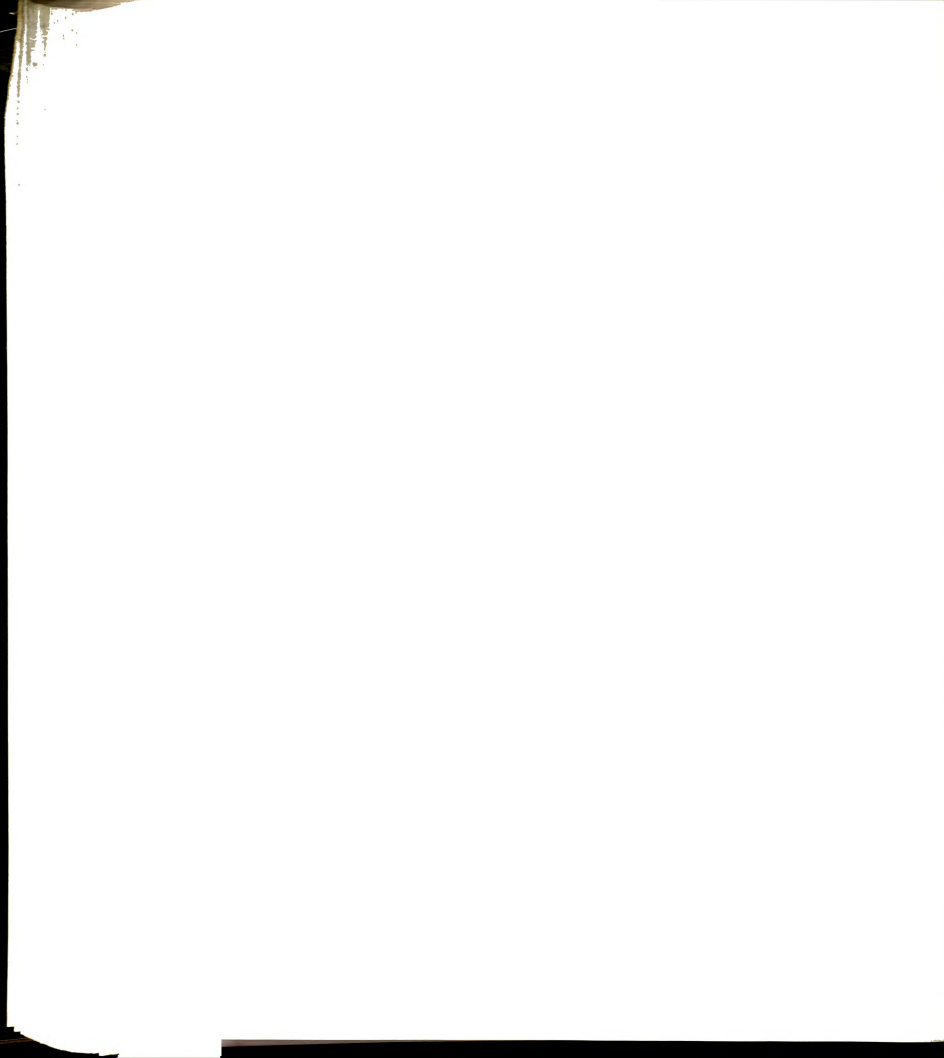


LEGEND

- District Boundaries
- Field Boundaries
- (109) Field Areas (hectares)
- Weirs
- Villages

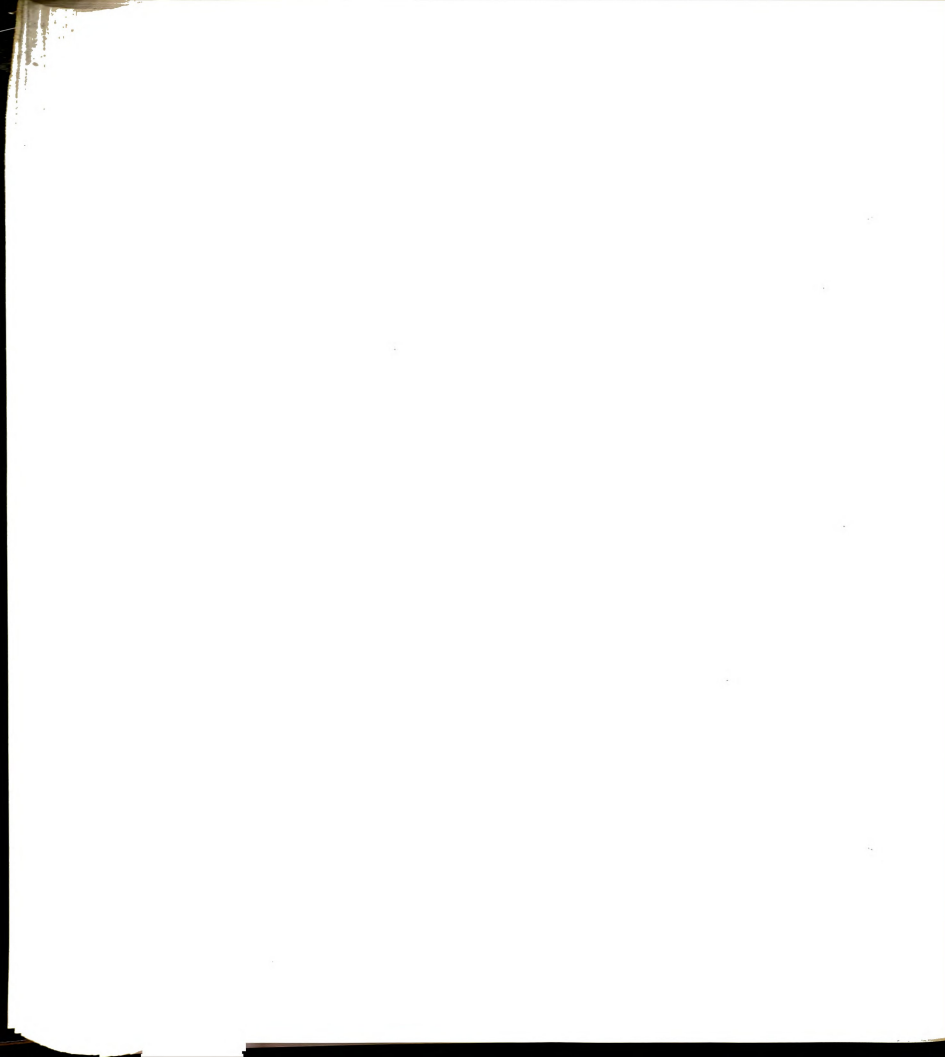
SOURCE: Sir William Helcrow, 1972.

Figure 25



The main element which continues to plague the development project is the dissatisfaction among Wadi farmers. When surveyed, 90% of the interviewed farmers in the Lower Wadi said that their problems with water scarcity and distribution were still unresolved. Undoubtedly, this largely was due to the minimal and slow work being done on the canals. While fewer Upper Wadi farmers were as concerned with such problems, they also expressed dissatisfaction with the slow progress on the canal system. Judging by this mass concern, it can be concluded that most farmers feel the dam to be an important and potentially helpful construct. However, until the farmers have concrete proof of such improvement, the stumbling block of public skepticism will hinder agricultural development and progress.

Finally, to complete the progress in land and water utilization, a system of precise measurement must be set up to determine the volume of water needed for each hectare, how much water should be released, which lands are irrigable, and which kinds of crops can be most successfully planted and irrigated. Thus it could be concluded that since the construction of the Malaki Dam there has been no significant change in the areas of lands cultivated and water utilized due to the fact that there has been no policy set up to change the present traditional use of water and land tenure system prevailing in the area.



Agricultural Production and
Crop Diversification

The completion of the dam has increased the amount of water available for irrigation. Accordingly, it can be assumed that large plots of land will be made irrigable. The question immediately raised is one of the effect this increase will have on the amount of agricultural production and on crop diversification.

The following table shows the amount of durra production from 1965 to 1975, or the five years prior to the dam, and the five years after the dam was constructed.

From the table it can be observed that while there is great diversity in Sa'a produced before 1970, the figures are more clustered after 1970. This is probably due to the fact that the amount of water utilized became more stable because of the decrease in the amount of water loss which occurred with the construction of the dam.

One important factor which limits the impact of the figures in determining agricultural production is the fact that although the table shows irrigated areas, it does not show actual cultivated areas. It is hard to determine the amount of production per hectare, since often lands were irrigated, but no crops were actually cultivated upon them. For example, in 1965, the total irrigated lands were 1,889 hectares, and the total production was 283,560 Sa'a or 3,260 tons;

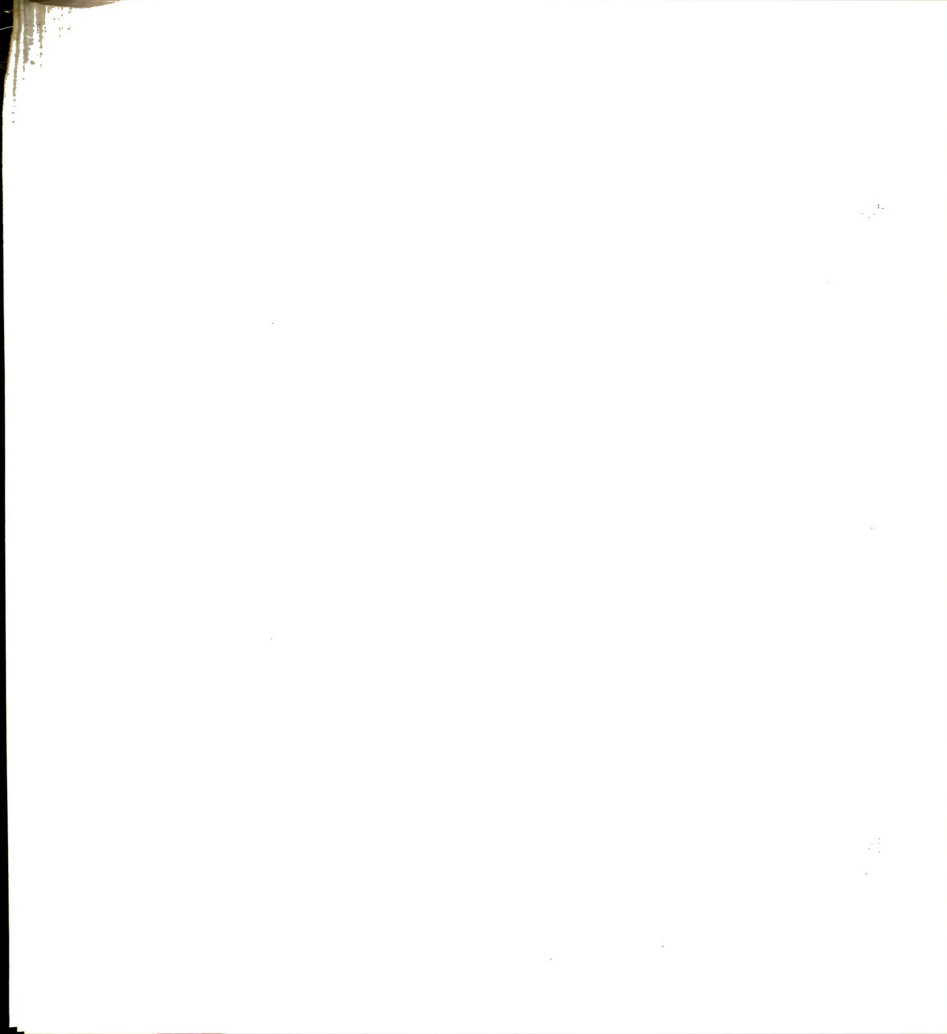


TABLE 27

AMOUNT OF PRODUCTION FROM DURRA AND AMOUNT OF AREA
IRRIGATED IN WADI JIZAN FROM 1965-1975

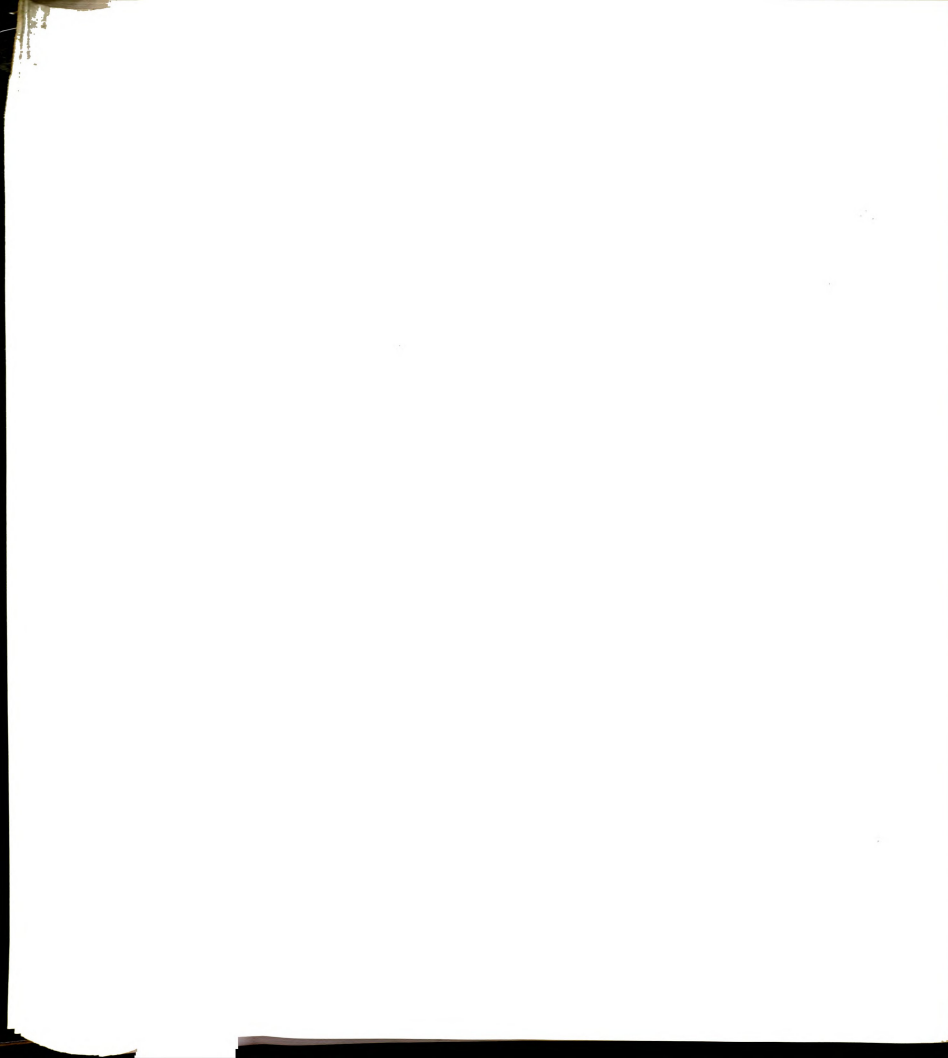
Year	Water Flow (MCM)	Water Utilized (MCM)	Areas Irrigated (Ha.)	SA'A ³
1965 ¹	53.0	16.0	1,889	28,350
1966	55.0	16.0	1,828	37,560
1967	136.7	53.0	6,238	142,280
1968	56.6	28.0	3,272	2,600
1969	-	-	- ⁴	2,080
1970 ²	-	34.5	3,962	60,910
1971	-	21.0	2,200	50,160
1972	-	30.4	2,442	37,606
1973	-	21.0	2,257	34,757
1974	-	28.5	3,000	68,400
1975	-	32.2	3,400	52,360

¹ Statistical information on water flow, areas irrigated and production size from 1965-1968 was obtained from the Sir William Halcrow and Partners report, "Irrigation Development in the Wadi Jizan, Saudi Arabia," Annex 4, p. 50.

² Information for the period 1970-1975 was obtained from the Agricultural Experiment Station at Hakimah.

³ One Sa'a = 11.5 Kg.

⁴ No statistics available for 1969.



while in 1968, the land irrigated was 3,272 hectares, and total production was only 2,680 Sa'a or 30.82 tons, a comparison which would seem highly unlikely if the total irrigated area was also the total cultivated area.

It can be obviously assumed that larger production is due to increased water availability (water flow). Water flow is, of course, an independent factor, as it relies upon the abundance or scarcity of rainfall.

With regard to the size of cultivated lands, it can be observed that there are great differences between the Upper and Lower Wadi (Table 28). The Upper Wadi had always been either one-half cultivated (64.4% of the interviewed farmers), or three-fourths cultivated (35.6% of the interviewed farmers) before the dam was constructed. After the dam, however, 9.6% of the interviewed farmers increased their lands under cultivation from one-half to three-fourths of their total lands, while 2.7% of the respondents cultivated all of their land (mostly of small size) for the first time.

The picture in the Lower Wadi is drastically different. Before the dam, 33.3% of the farmers interviewed cultivated none of their land, 21.8% cultivated one-fourth, and 36.3% of the interviewed farmers had cultivated one-half of their lands. As of 1970, only 8.9% of the interviewed farmers had cultivated three-fourths of their land. After 1970, a decrease in the amount of cultivated lands is seen in the Lower

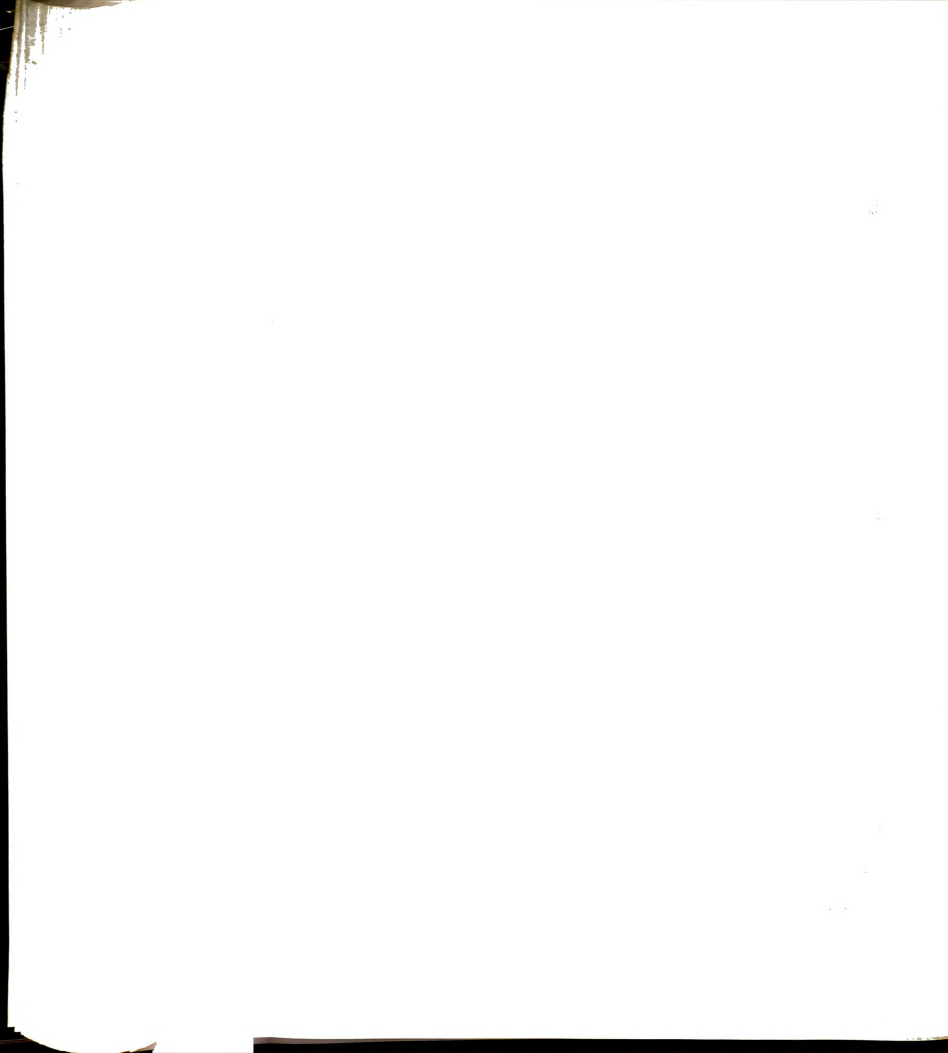


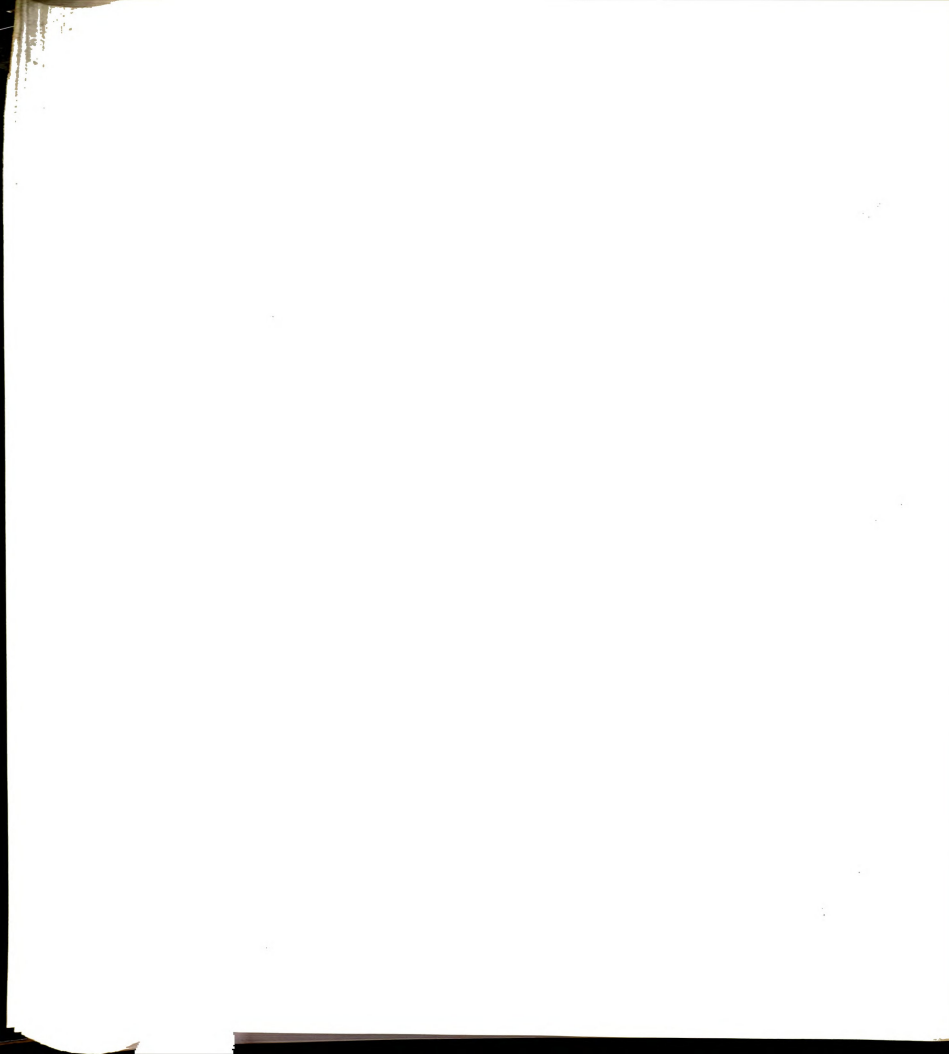
TABLE 28

INCREASE IN CULTIVATED LANDS FOR INTERVIEWED FARMERS IN THE WADI JIZAN AREA
(PERCENTAGES)

Size of Farm ¹	Small 10-59					Medium 60-109					Large--More than 110				
	None	1/4	1/2	3/4	All	None	1/4	1/2	3/4	All	None	1/4	1/2	3/4	All
Prior to 1970			26	6.8				15.0	8.2				23.3	20.5	
After 1970			16.4	13.7	2.7			12.3	10.9				32.8	10.9	
Prior to 1970	11.5	19.2	15.8			21.8	14.1	3.8			2.6	6.4	5.1		
After 1970		37.1	8.9			28.2	7.7	3.8			7.7	3.8	2.6		

¹Farm size is given in local Wadi measurement known as MA'AD. One MA'AD = .36 ha.

Source: Data collected during field work of the author in the Wadi Jizan area, Saudi Arabia, November 15, 1976 through March 15, 1977.



Wadi. The percentage of farmers who did not cultivate any of their land rose to 35.9%, the figure went to 11.5% for one-half of the cultivated farms, and 48.7% declared they now cultivate only one-fourth of their lands.

In comparing these figures to Table 29, some interesting interpretations can be made.

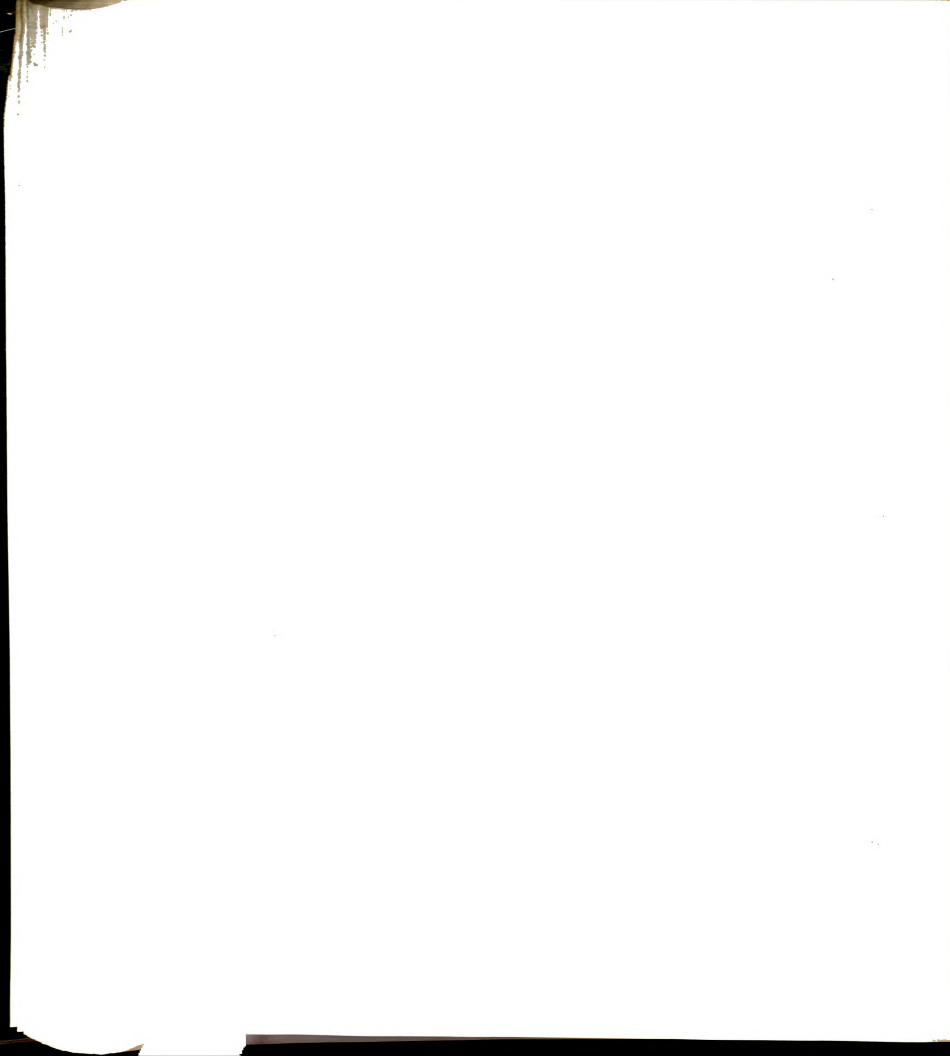
TABLE 29
INCREASE IN DURRA PRODUCTION FOR THE
INTERVIEWED FARMERS (PERCENTAGES)

Division	UPPER WADI		LOWER WADI	
Period Categories ¹	Prior to the Dam	After the Dam	Prior to the Dam	After the Dam
Grow nothing				65.4
20-29 ²	4.1		75.6	33.3
30-39	95.9	2.7	24.4	1.3
40-49		45.2		
More than 50		52.1		
TOTAL	100	100	100	100

¹Size of durra production is given in SA'A/MA'AD. One SA'A = 11.5 Kg.

²The average size of production is calculated to be 35 SA'A/MA'AD or 1,116 Kg/ha.

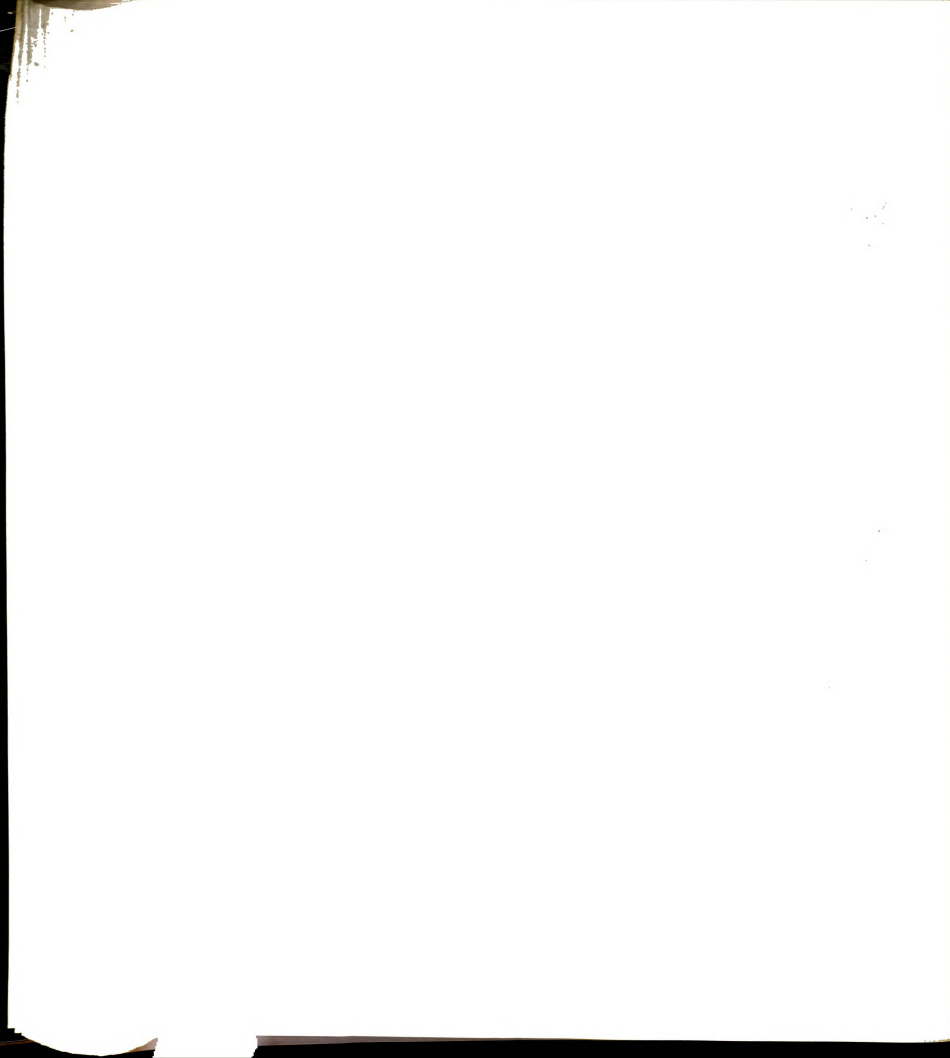
Source: Data collected during field work of the author in the Wadi Jizan area, Saudi Arabia, November 15, 1976 through March 15, 1977.



First of all, 95.9% of the interviewed farmers in the Upper Wadi produced less than 39 SA'A/MA'AD or 1,245 Kg/hectare for the pre-dam period. This implies the local durra yields an average of about 1,245 Kg/hectare. This also reinforces the assumption that farmers did not cultivate all of their irrigated lands. In the Lower Wadi, 75.6% of the interviewed farmers obtained only 30 SA'A/MA'AD or 958 kg/hectare for the pre-dam period. These results, as well as those of the Upper Wadi, correspond to the size of the cultivated lands before the dam.

For the post-dam period, however, there are some discrepancies. An increase in production was realized in the Upper Wadi, while the Lower experienced a decrease. In the Upper Wadi, 97.3% of the interviewed farmers increased production from 35 SA'A/MA'AD to about 50 SA'A/MA'AD or an average of 1,357 kg/hectare. This increase would seem to come from the larger amount of cultivated areas. In the Lower Wadi, 65.4% of the questioned farmers grew nothing after the dam construction, and those who did cultivate compiled an average of 30 SA'A/MA'AD. Here again, this decrease is probably due to the decrease in the size of cultivated lands.

It is obvious from the above discussion that much could be done to enhance the effects of the dam on agricultural production, particularly in the Lower Wadi. There are two major reasons why the picture has not brightened for the Lower Wadi farmers. First, the



traditional water priority system is still being followed by Wadi farmers, thus, the Lower Wadi farmers do not always receive irrigation water. Although the dam helps to store more water, its efficiency can also hinder the farmers of the Lower Wadi, for they do not receive the "surplus" water after a large flood, as often happened with their less-efficient UQUM. Second, as the canal system is not yet completed, it is more difficult to see that the water is evenly distributed between Upper and Lower Wadi farmers.

The agricultural production as a whole has not improved as much as expected. The Agricultural Experiment Station at Hakimah has been able to cultivate durra and obtain a yield of 2,500 kg/hectare, but as observed earlier, the average production at present is drastically lower, due to several factors. First, and most importantly, the farmers in the Wadi still practice their traditional methods. Technical impact has not reached the Wadi Jizan area, and modern agricultural equipment is not yet employed for the most part, as it is at the Experiment Station. Crop rotation is not practiced, and the use of fertilizer has not been introduced except in the experimental station. All of these factors intermingled have hindered the advance of agricultural production.

Crop diversity has also been severely hindered, and has not come close to meeting expectations. Durra is still the only widely-grown crop, and the agricultural economy remains at a subsistence



level. Part of this problem stems from the unwillingness of the farmers to experiment. Until the farmers see that the present reforms taking place in Wadi Jizan will work for their benefit and increased well-being, they will most likely shy away from experimentation. Thus one can say, in terms of time since the dam was built in 1970, that the agricultural system in the Wadi Jizan area has remained unchanged as far as any increase in the amount of production and crop diversification are concerned.

Socio-Economic Patterns

Not surprisingly, there has never been an accurate estimate of agricultural production or of the annual income of farmers in the Wadi Jizan. However, it is possible to give some idea. As stated previously, durra is the monoculture of the Wadi, and thus forms the staple cereal diet as well as being the main cash crop. Hence, by roughly estimating the cost of production, the average yield, and the average selling price of durra, one can get a somewhat accurate measurement of income.

Such an attempt was made by Sir William Halcrow in 1972. Calculating the cost of durra production and then figuring out the net return, he obtained the following results (Table 30).

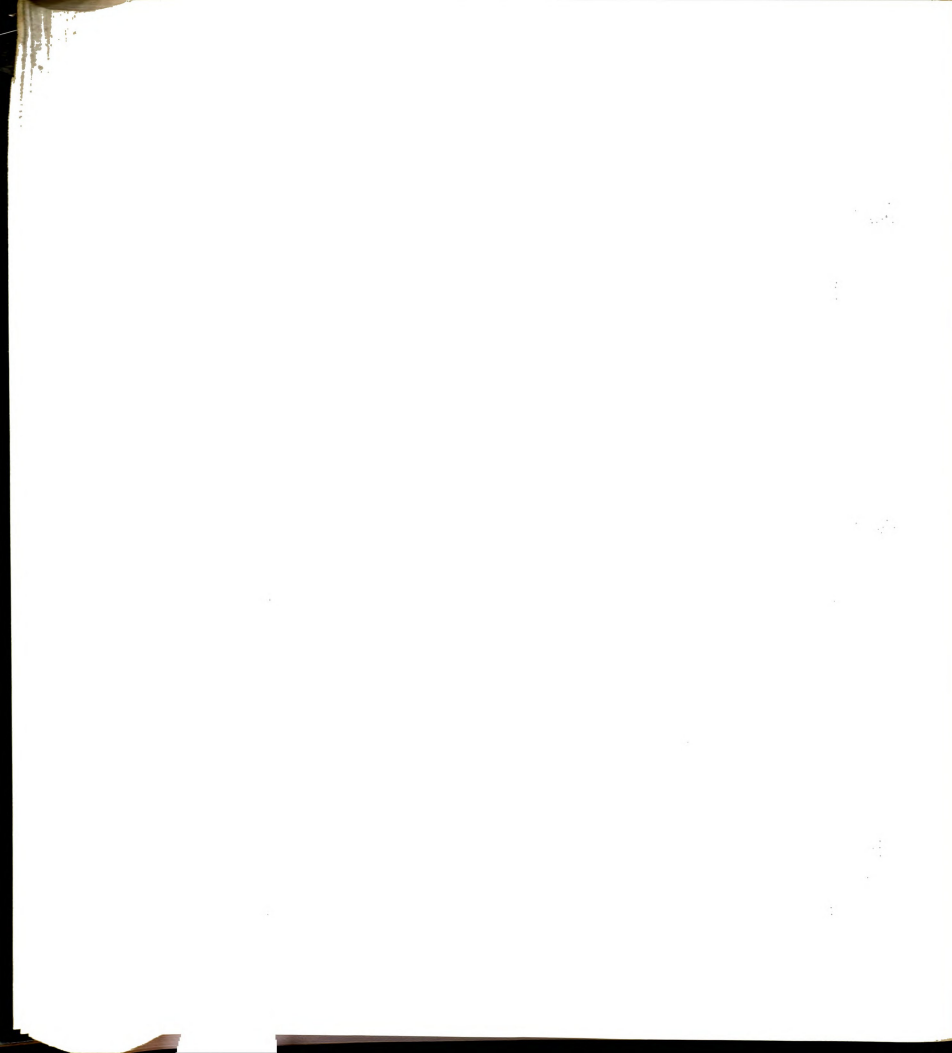


TABLE 30
COST OF DURRA PRODUCTION PER HECTARE

Item	Durra kg/hectare
Seed	12
Land Preparation	90
Plow	74
Sow	60
Weed	85
Harvest	88
Thresh and Clean	50
Sacks	18
Transport	18
TOTAL	495

Source: Sir William Halcrow, "Irrigation Development in the Wadi Jizan, Saudi Arabia," Annex I, London, 1972, p. 16.

The net return was calculated with the assumption that durra would yield 1,000 kg/ha, and in 1972, the average selling price for



durra was .40 riyals. Hence, the net return of 505 kilograms of durra would be 202 riyals.²

At the time of the fieldwork, however, production costs had increased, and laborers were no longer willing to be paid in kind, but rather, demanded cash payment. The selling price of durra, however, had risen to 1.5³ riyals per kilogram. Using the 1,000 kg yield of Halcrow, this indicates a net return of 757.5 riyals. By March of 1977, an increase of 555.5 riyals per hectare was in effect. However, it must be kept in mind that this indicates price increases only, and is not reflective of production. Also, these prices were the ones quoted at market, and since only 25.83% of the questioned farmers sell even one-fourth of their cultivated durra, the figures do not necessarily indicate a sharp increase in income or standard of living. As a matter of fact, there have been few changes in the economic situation of Wadi Jizan farmers thus far.

A good indicator of the impact of the Malaki Dam can be traced through migratory statistics (Table 31).

It is obvious that migration has always existed in the Wadi Jizan area, but outward migration has lessened since the dam was

²Sir William Halcrow and Partners, "Irrigation Development in the Wadi Jizan, Saudi Arabia," Annex V, London, 1972, p. 16.

³One U.S. dollar = 3.5 Saudi riyals.

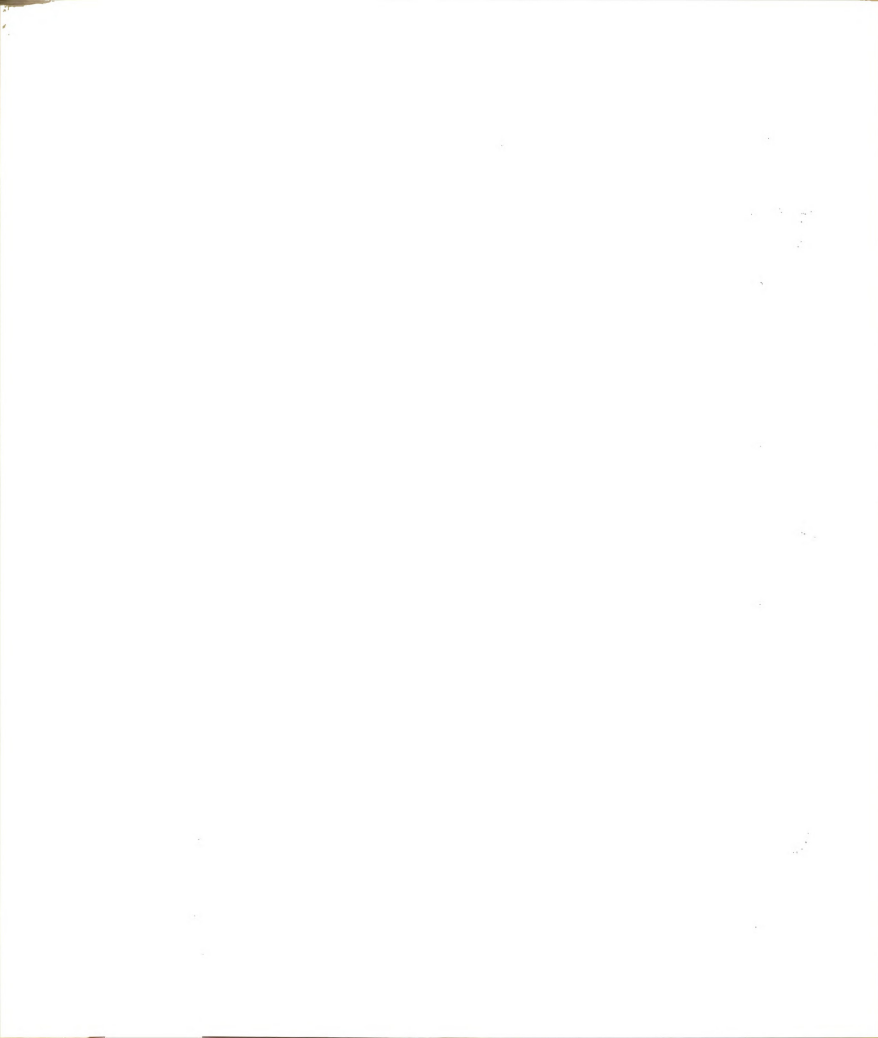


TABLE 31
MOVEMENT OF FARMERS IN THE WADI JIZAN
(IN PERCENTAGES)

Categories	Prior to the Dam	After the Dam	Total
Upper Wadi	17.8	12.3	30.1
Lower Wadi	37.29	16.7	53.8
Overall Average	27.8	14.6	42.4

Source: Data collected during field work of the author in the Wadi Jizan area, Saudi Arabia, November 15, 1976 through March 15, 1977.

constructed. Lower Wadi figures are substantially higher both before and after the dam than those of the Upper. The reasons given for migration may shed some light on this phenomenon (Table 32).

The most common reason given for migration was water scarcity (26.5% of the responses). None of the remaining responses seem very significant.

It is interesting to note that a higher percentage of Lower Wadi farmers (39.7% of respondents) named water scarcity as the major reason than Upper Wadi farmers. This would seem to be due to the fact that Lower Wadi farmers receive little water, if any, while Upper Wadi farmers are often able to irrigate more than once.

TABLE 32
REASONS FOR MOVEMENT (IN PERCENTAGES)

No.	Reason	Upper Wadi	Lower Wadi	Overall Average
1	Scarcity of water	12.3	39.7	26.5
2	To find a school for children	-	-	-
3	Searching for higher income job	13.7	8.9	11.3
4	Too many members in household to support	4.1	5.1	4.6
TOTAL		30.1	53.8	42.4

Source: Data collected during field work of the author in the Wadi Jizan area, Saudi Arabia, November 15, 1976 through March 15, 1977.

For Upper Wadi farmers, water scarcity seemed to be somewhat less of a problem, and searching for higher-income jobs was given most frequently as the reason for moving from Wadi Jizan. One factor which affects this figure is the fact that sharecropping is quite popular with Upper Wadi farmers, and many of the landowners are engaged in business.

When tracing the factors which account for a reversal in outward migration, some useful facts can be obtained (Table 33).

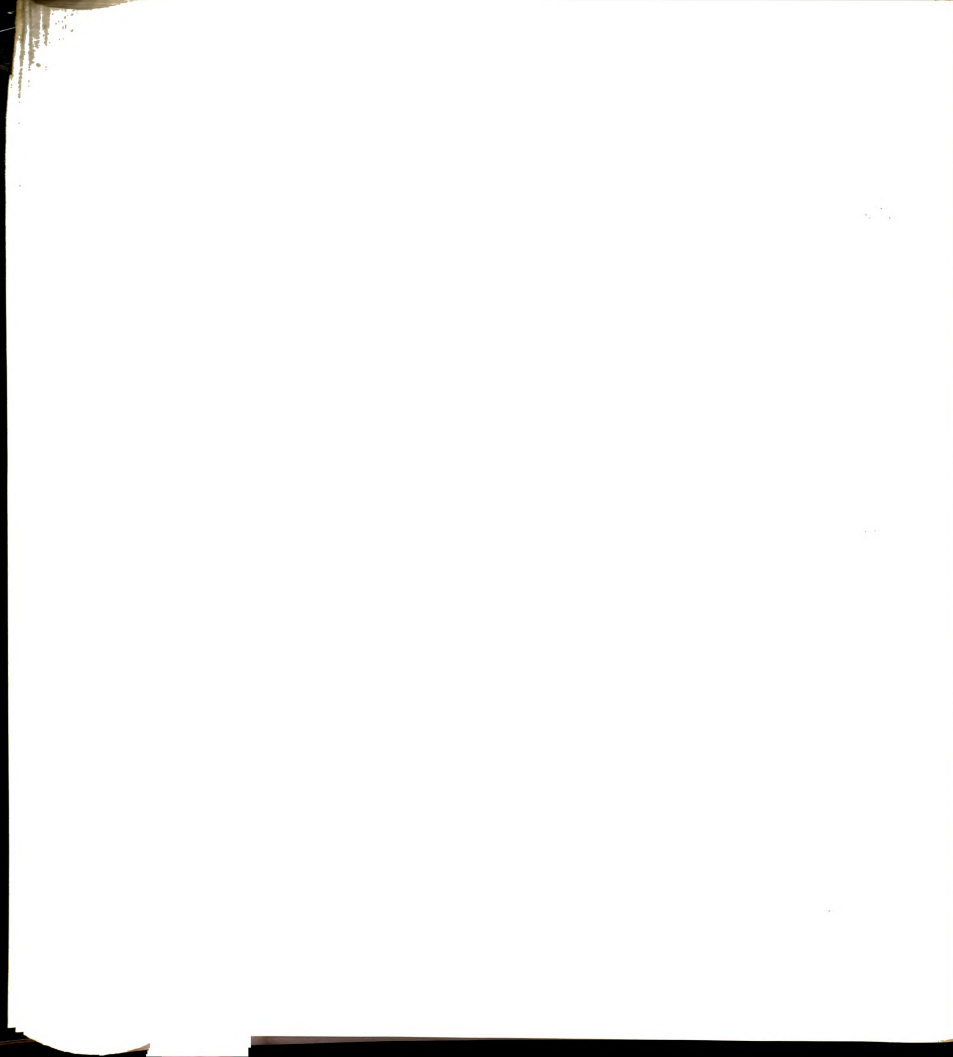


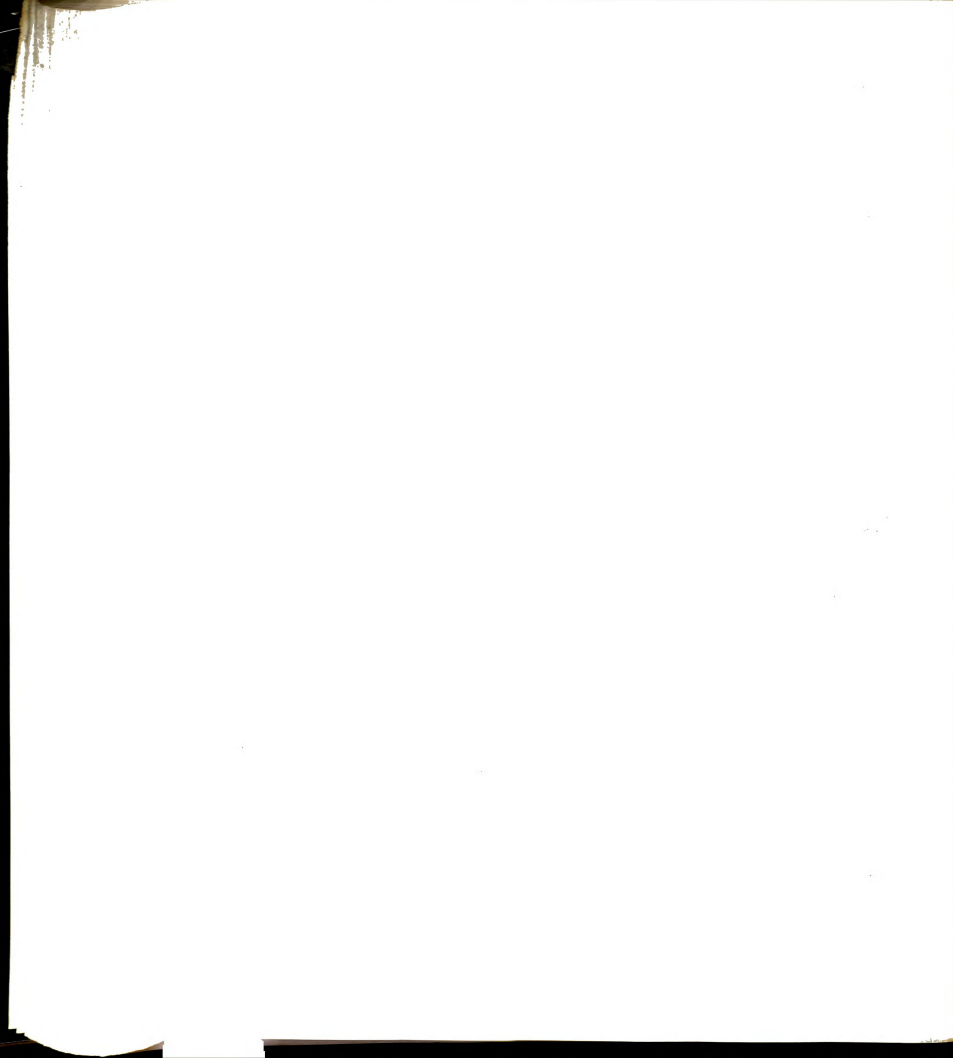
TABLE 33
REASONS FOR RETURNING TO WADI JIZAN
(PERCENTAGES)

No.	Reason	Upper Wadi	Lower Wadi	Average
1	Availability of water	30.1	7.9	24.9
2	Availability of useful Public Services		3.3	1.9
3	Presence of Agricul- tural Extension Services	30.1	4.6	26.6
4	Job Opportunities	30.1	11.9	33.9
	TOTAL			42.4

Source: Data collected during field work of the author in the Wadi Jizan area, Saudi Arabia, November 15, 1976 through March 15, 1977.

Upper Wadi farmers show an even distribution for three responses: water availability, agricultural extension services, and job opportunities, while Lower Wadi farmers gave increased job opportunities as their reason by a wide margin. Water availability since the dam construction has not been a major attraction for Lower Wadi farmers.

The building of the dam, the construction of the canal networks, and the improvement in the road systems, towns, villages, and



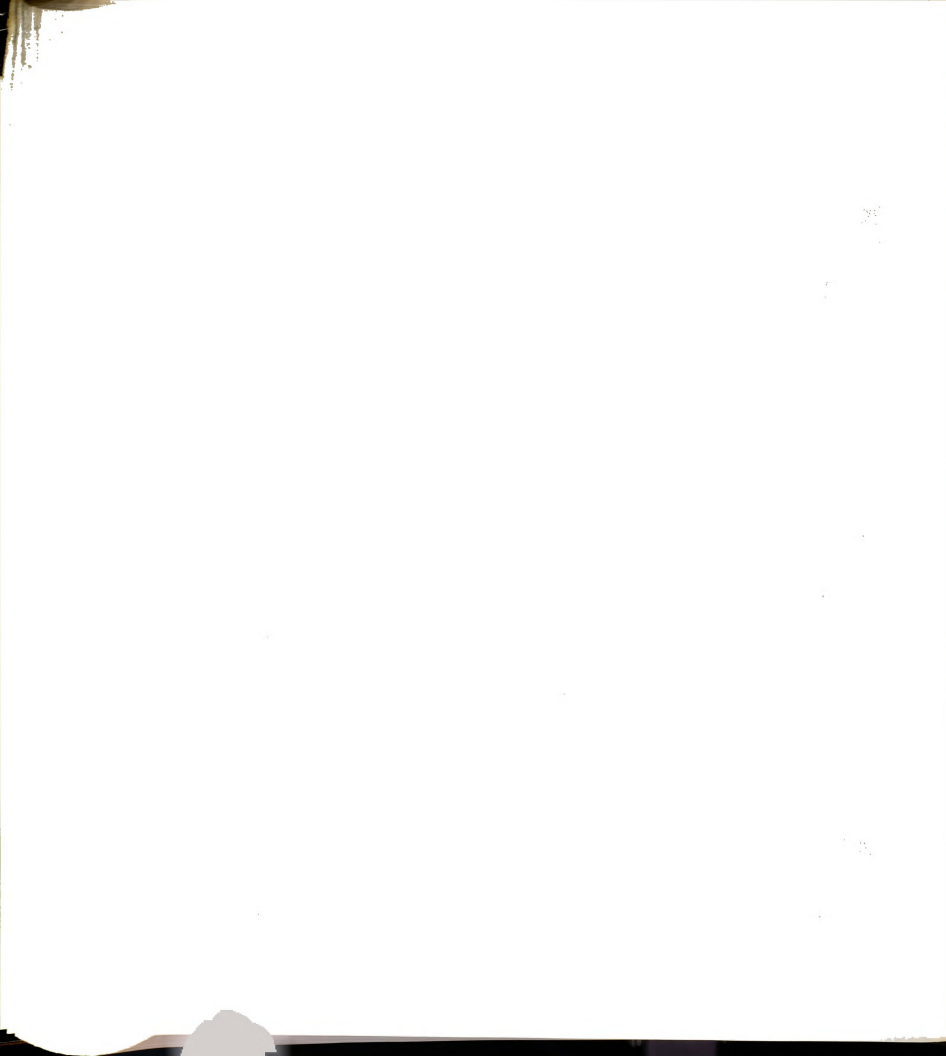
cities have been accompanied by increased job opportunities in the Wadi, as well as higher wages for such jobs. Several companies have been encouraged by the development taking place in the Wadi; there are government jobs available; and trade has become a thriving business in the area. A large percentage, 53.6%, of the respondents have jobs other than farming as seen in Table 34.

TABLE 34
FARMERS WHO HAVE JOBS BESIDES THEIR FARMS
(PERCENTAGES)

Category	Overall Average	Location of Job			Type of Job		
		Jizan City	Abu Arish	Wadi Jizan	Govern- ment	Trade	Companies
Upper Wadi	36.9	7.4	48.1	44.5	14.8	29.6	55.6
Lower Wadi	69.2	33.3	7.4	59.3	11.1	20.4	68.5
Overall Average	53.6	13.2	11.3	29.1	6.6	12.6	34.4

Source: Data collected during field work of the author in the Wadi Jizan area, Saudi Arabia, November 15, 1976 through March 15, 1977.

It is interesting to note that 59.3% of the respondents in the Lower Wadi and 44.5% of those in the Upper Wadi have jobs in the Wadi Jizan area. This attraction is due to the increased presence of



companies and businesses in the Wadi. For 34.4% of the respondents; companies have made it possible for the local citizens to stay near their villages and yet receive higher wages. Abu Arish seems to be especially popular for Upper Wadi farmers, and trade seems to be the main occupation. Lower Wadi farmers seem to favor Jizan City as a job location.

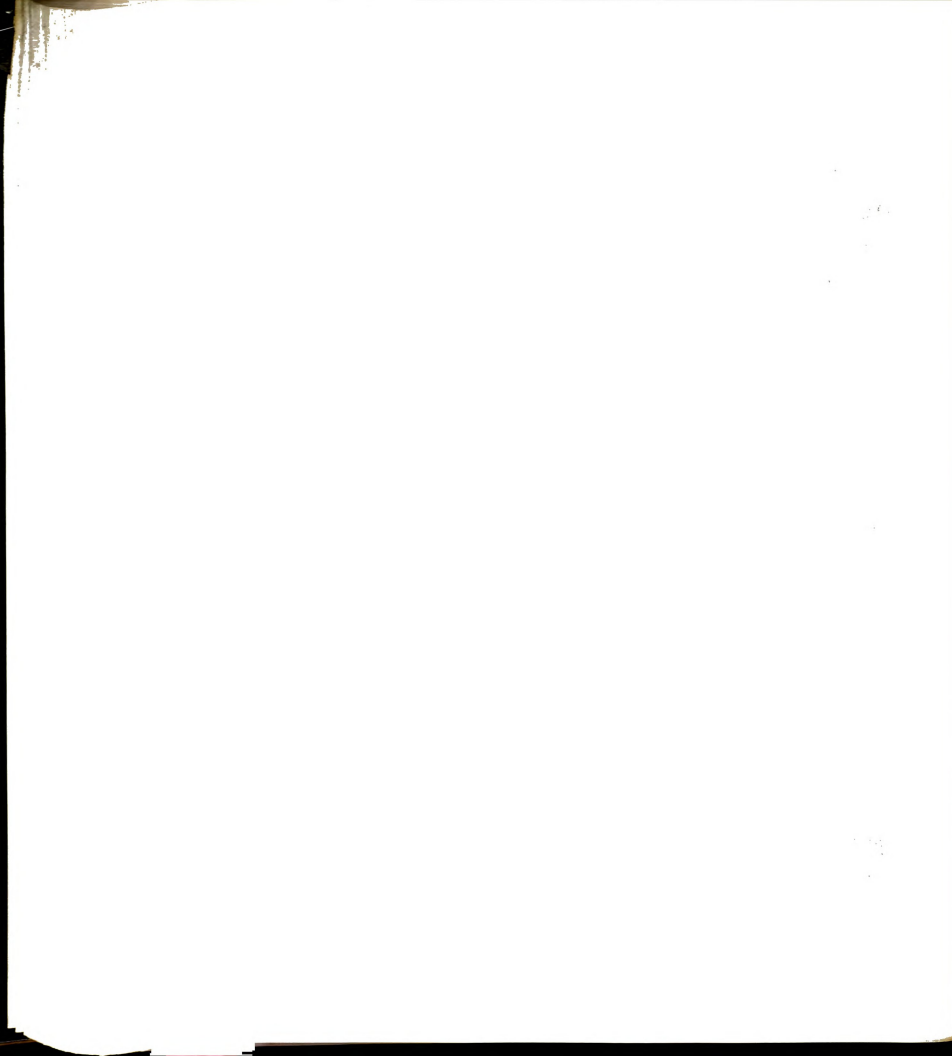
In effect, the abundance of jobs is drawing many farmers away from their traditional farming occupations. Of those people who did not leave the Wadi, 18.5% have other jobs in addition to farming, and 17.2% (mostly in the Upper Wadi), stated that their water supply was sufficient.

The increased presence of companies; the improved road system between Abu Arish, Jizan City, and Sabya; and the agricultural extension services, all of which accompanies the dam construction, have had quite a significant impact on the citizens of Wadi Jizan. Although this is encouraging in some respects, it also seems to be stifling the presence of agriculture as a major occupation. Many farmers, especially those in the Lower Wadi, are being increasingly drawn to the cities because of the better wages offered there. They have become cynical of the prospect of successful farming, since the canals have yet to be constructed, and the dam itself has had little impact so far on agricultural production. Unless these factors are



improved soon, agriculture will cease to be a lucrative and popular profession in the Wadi Jizan, and the development measures will have been taken in vain.

It should be noted that a fair evaluation of the success of agricultural development cannot be made at this time. Only after a sufficient time has passed, and the project has been given a fair chance for good results can rating of the development in the area be justified. This study is merely the beginning of a thorough evaluation of the success of the Wadi Jizan Development Project and it is hoped that this work will serve as a reference in further research.



Chapter VI

CONCLUSIONS AND RECOMMENDATIONS

This study concerning the agricultural development in the Wadi Jizan was conducted from November 15, 1976 through March 15, 1977. During this period I had the opportunity to investigate and study at a close range the present agriculture as well as the progress and effects of the recent agricultural development in Wadi Jizan. This period also gave me the chance to interview 151 farmers in the Upper and Lower parts of the Wadi, and discuss directly their impressions of the development as well as analyze their agricultural problems. As a result of this investigation, the following conclusions and recommendations have been reached.

Conclusions

There have been great changes in the agricultural sector of Saudi Arabia during the last few decades. These changes involve attempts to increase the amount of cultivated land and agricultural production through various programs for water resource development



and land improvement. The main goals behind such measures were to raise the standard of living in the rural areas and to render the country self-sufficient in agricultural products.

Due to the fact that Saudi Arabia is a large mass of land, most of which is desert, several agricultural projects were designed in hopes of developing the potential agricultural land which does exist. One of the most important of these projects is the Wadi Jizan Development Plan. The core of this project is essentially the development of agriculture in the area through wise control and effective use of flood waters, a new irrigation system, modern cultivation techniques, greater crop diversity, and increased land use. Two main themes are apparent in the Wadi Jizan agricultural development project. The first and most important is that the project is considered an essential step toward comprehensive agricultural development for the South Tihama region as a whole. The second is that the Wadi Jizan area is intended to be a prototype for other wadies.

Studies and surveys carried out in the South Tihama region have justified the selection of Wadi Jizan as a test area for potential agricultural development. As the Wadi Jizan is medium-sized as compared to the other wadies of South Tihama, the results attained there are easily applied to similar wadies. The Wadi Jizan contains plenty of land with agricultural potential. The population is quite

of 1901.

heavily concentrated, and for the most part, agriculturally oriented. Physical and climatic conditions in the area are favorable for agriculture. In addition to the available surface water, an aquifer was discovered in Wadi Jizan; thus, ground water can also be utilized. Moreover, the presence of such cities as Jizan City on the Red Sea, and Abu Arish, both of which have potential for growth and expansion, presents areas for marketing centers. Such towns would also help consume the increased agricultural production from Wadi Jizan. Finally, such a move for development would, in time, reduce the serious destruction of houses and lands which occur in Wadi Jizan from high flood water. For these aforementioned reasons, Wadi Jizan was given priority in the South Tihama region's agricultural development.

The development plan itself consists of three main fundamentals: the construction of the Malaki Dam, the establishment of an agricultural experiment at Hikimah, and the construction of new irrigation network canals. Corrolaries to these main factors were the development of marketing and transportation systems. When following the actual history of the project, it is obvious that the development plans have been very slowly executed, and often not synchronized. For instance, the Malaki Dam was completed in 1970, while the canal network is just getting underway. The Hakimah experiment station was completed in 1972 and is carrying out its research on only fifty

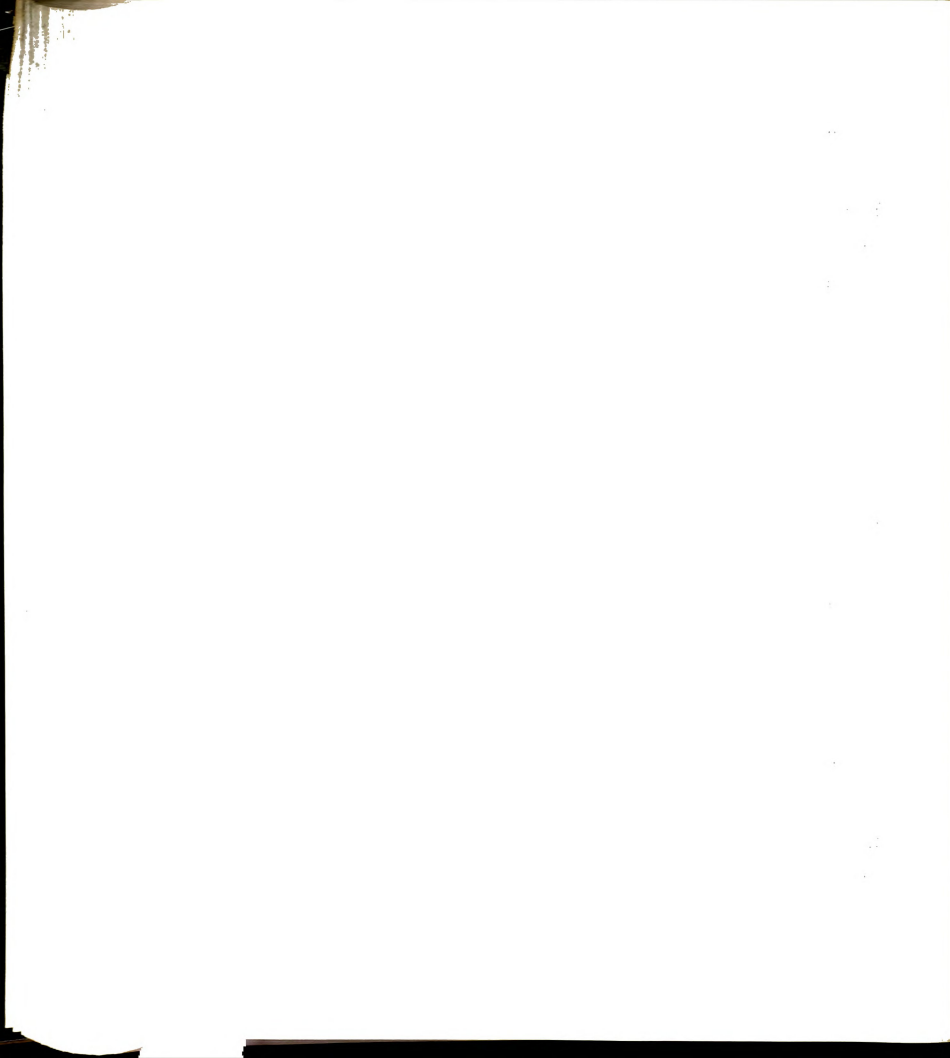


hectares of land. Nevertheless, when all aspects are completed, it is assumed that they will increase cultivated lands, crop diversity, and agricultural production.

The main advantage realized from the dam thus far has been the decreased amount of damage to homes and land from flood waters, and preventing water loss to the sea. As far as irrigation goes, an increase in the amount of irrigated land can be seen. For instance, in 1972, 30.5% of the irrigable lands were irrigated, while the figure rose to 42% of the irrigable lands by 1975.

Although the dam has improved the water scarcity problem somewhat, the expectations for the amount of cultivated lands and agricultural production have not been met. There are several factors which are hindering the meeting of such expectations. First, as the available surface water is dependent upon rainfall, it varies from year to year. Obviously, the dam is only responsible for storing water, not creating it. Secondly, Lower Wadi farmers, in particular, are growing skeptical about the project, since the canal network which will distribute water to their plots of land has been progressing slowly. Thirdly, as the traditional water distribution system is still in effect, Upper Wadi farmers often irrigate more than once, while Lower Wadi farmers often receive none, which adds to their skepticism.

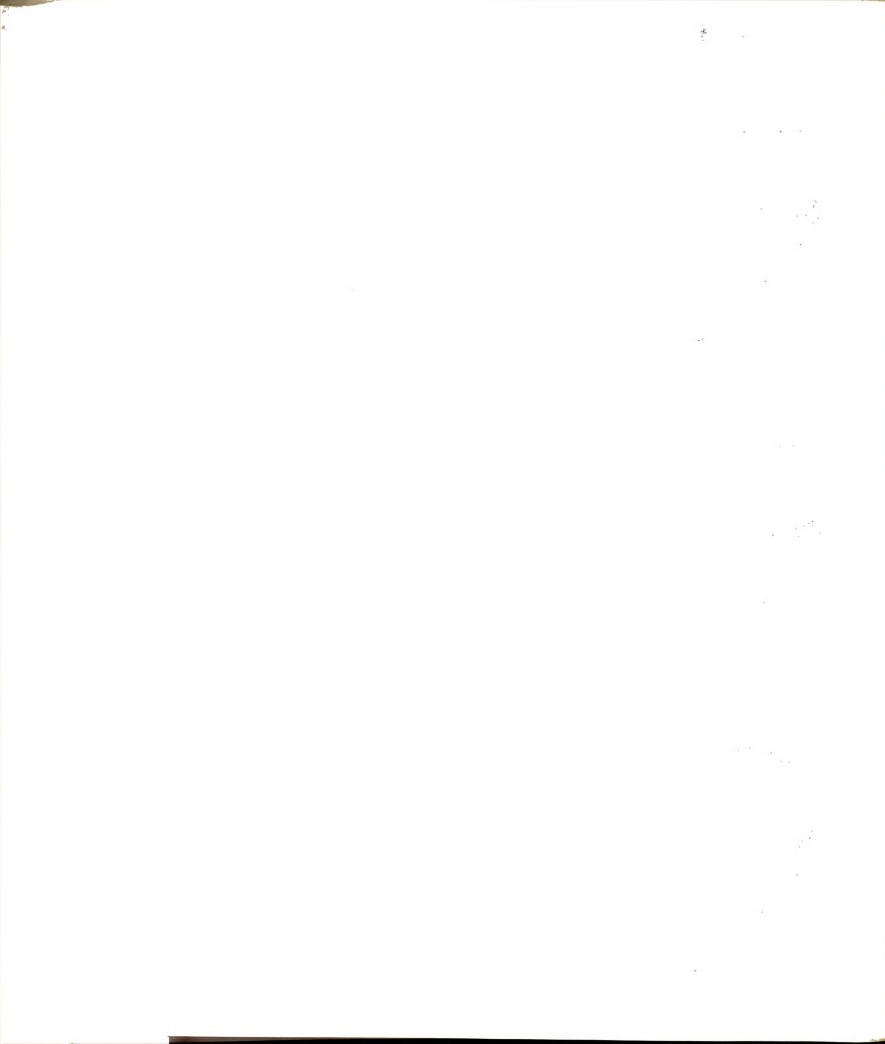
With respect to the minimal and often negligible increases in cultivated lands and agricultural production, the deficiency is due



to the lack of modern cultivation and agricultural knowledge of the Wadi Jizan farmers. No fertilizers are employed, crop rotation is not practiced, there is inadequate irrigation, and the lack of proper cultivation techniques is a major problem. These factors not only make agricultural production small, but force the farm economy to remain at a subsistence level, dependent upon only one widespread crop, sorghum.

Differences exist between the Upper and Lower Wadi in terms of cultivated land and amount of production. Small plots of land and a low level of production characterize the Lower Wadi, in particular. Such differences are explained by the amounts of water availability and irrigated areas, both of which are higher in the Upper Wadi.

Results formulated at the agricultural experiment station indicate a potential for growing a variety of new crops in the area, such as cotton, groundnuts, maize, vegetables, and fruits like papayas and bananas. However, except for small plots near Abu Arish which have begun to grow vegetables, none of these crops have been cultivated in the area. There are several possible reasons for this failure to experiment. Water availability is still a problem, especially in the Lower Wadi. In addition to the cultivation problems mentioned earlier, the land tenure system adds to the difficulties, as it creates land fragmentation, thus making the already small plots



of land even smaller. The small size of farms as well as the inaccessibility and unlevelled fields hinder the use of modern machinery and implements. In addition, insufficient transportation methods and primitive marketing systems hinder the growth and development of new crops. Very importantly, there has been little change in education of the farmer or in his economic set-up, which creates a reluctance to experiment. The outward migration of farmers and laborers to the factories and businesses in the area (53.6% of respondents) where wages are high, has put a damper on agricultural improvement and created a severe labor shortage.

Unless the aforementioned problems can be resolved, it seems highly unlikely that further advances in an agricultural development can be made. Even though the dam was a major step in development, if it is not accompanied by positive action in these problem areas, little improvement will be seen.

Recommendations

Complete and successful agricultural development will not be achieved in the Wadi Jizan without the resolution of several pressing problems. Although there are no quick and simple answers, for such resolutions, this study attempts to suggest possible solutions to aid

agricultural development, not only in Wadi Jizan, but in other wadies as well.

Most prevalent is the problem of water scarcity. The present water distribution system borders on the archaic, and is simply not practical. Such a system needs to be completely revised, and a more even distribution pattern should be developed. In addition, further exploitation of ground water is recommended in order to lessen the dependence on rainfall in the area. The dam, although greatly improving the amount of water stored and decreasing the amount of water lost, can do nothing to increase the amount of surface water available. This is especially true in the Lower Wadi, where the dam has not been able to provide water for complete irrigation. Only by stepping-up ground water extraction can the growing irrigation needs be met.

A mass education system should be set up to increase the agricultural and practical knowledge of the farmer. At present, the average farmer is illiterate and totally ignorant of modern cultivation techniques. As a result, any technology, or modern cultivation methods have relied upon imported skills. By instigating mass education for farmers of the present, and especially for future farmers, the path will be opened for modern technology and thus for increased yield and economic status.

The introduction of new crops in the area is essential for changing the agricultural economy from a subsistence level to a



productive one. Crops such as groundnuts, cotton, and maize should be introduced in the area, since they have been successfully grown at the agricultural experiment station, and could help establish the agricultural importance of the area as well as the country.

At present, the road system of the Wadi Jizan area is very deficient, and inside the agricultural lands almost nonexistent, which stifles the incentive for producing greater and varied crops. Agricultural production cannot improve unless farmers have safer, easier, and better planned routes by which to transport their crops to market.

The market system also needs vast remodeling. If the farmers could get greater cash values for their crops, as well as better circulation of goods, the incentive to grow more and varied cash crops would be established. The present marketing system is primitive and does not encourage expansion, as prices are low and contacts are very limited.

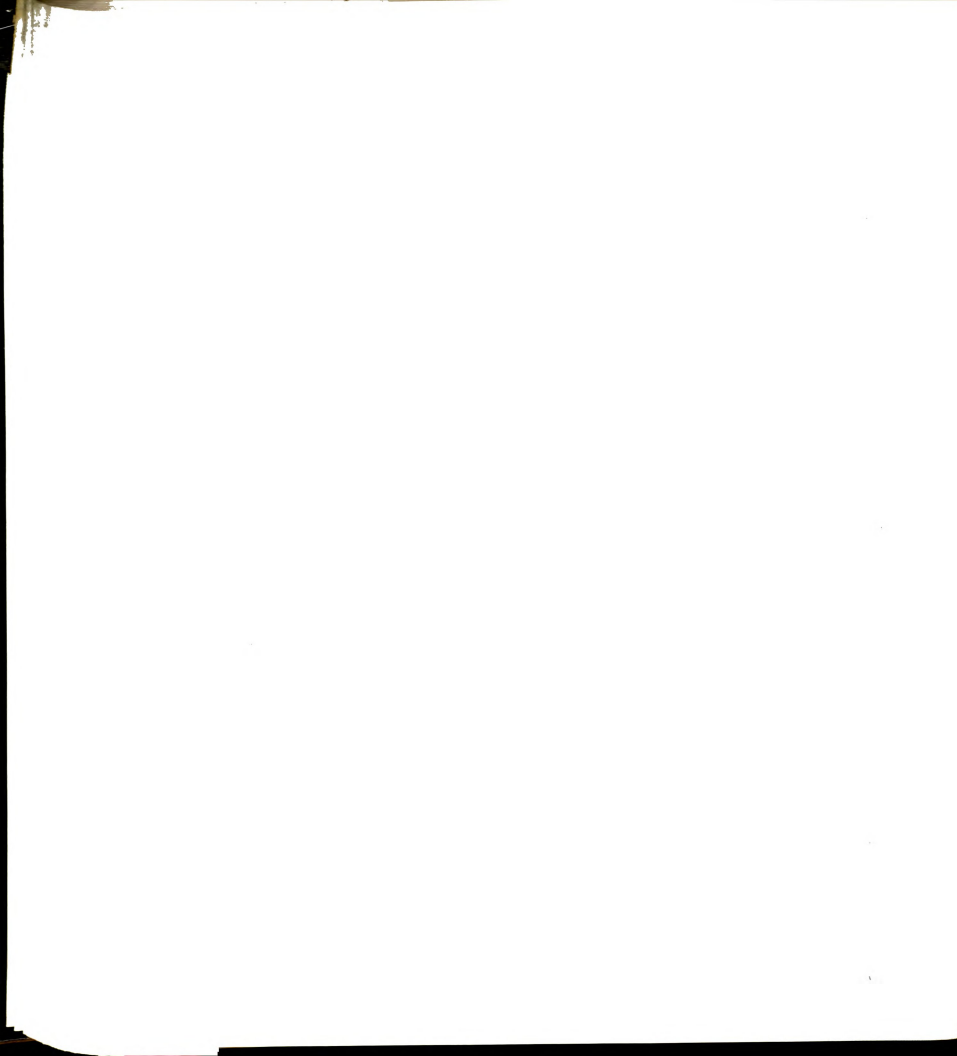
An extensive plan for cooperatives is suggested--one in which larger plots of land are cultivated by groups of farmers. At present, farms are extremely fragmented, due to the traditional land tenure system. This limits cultivation to small plots and stifles the successful use of modern machinery and techniques. A cooperative organization, composed of farmers and aided by government agricultural experts, would serve several functions. It would make greater use of the available land, since modern technology could be introduced, as



well as new cultivation methods. It would also help solve the problem of the labor shortage. Not only would the use of machinery cut down on the amount of needed manpower; but larger groups of farmers cooperatively working to cultivate a large area would accomplish much more than would isolated farmers each trying to cultivate their own small plots. Production would increase since fragmentation would be less prevalent and thus more efficient cultivation and irrigation would take place. Government subsidized financial aid would also be put to better use and the results would be much more encouraging. A cooperative effort would be much more economical than giving a small sum to each farmer for use on his private plot. By pouring larger amounts of money into a bigger operation, the aid will be more effective in increasing production and spurring further development. Instigation of such a cooperative system would take time, of course, and would undoubtedly be met with some opposition. However, if a group of farmers could be encouraged to set up a cooperative to act as an example for other farmers, the increased production and efficiency of such organizations would surely spur further participation.

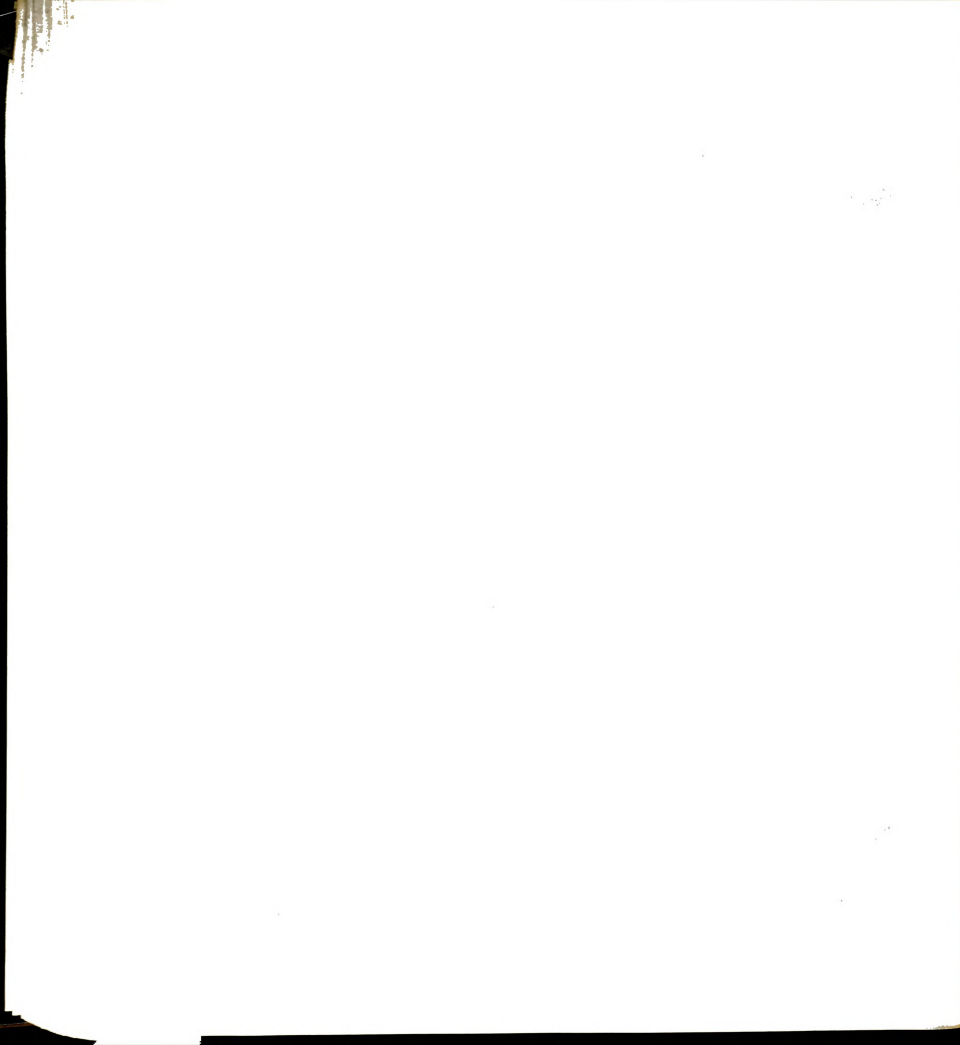
Finally, there must be a more immediate method of development. At present, farmers in the other wadies are becoming discouraged with the low yield of their farms and their poor economic status. The Wadi Jizan Project alone has been well over twenty years in the

making, and is not yet completed. Unless the development efforts are further spread into other areas of the country there will be an even greater shift in the work force from agriculture to business. If the government continues to hold back further development efforts until seeing the results of the Wadi Jizan Project, there will be no need for further agricultural development, as agriculture as a profession will have vanished in favor of jobs in business and factories. Obviously, development projects like that of the Wadi Jizan are not carried out overnight, but smaller-scale development such as education, better agricultural methods, and crop diversity should be instigated soon, before agricultural development is no longer a necessity.



APPENDIX

- A. QUESTIONNAIRES FOR SAMPLE OF FARMERS IN WADI JIZAN
- B. HOUSING AND POPULATION CENSUS



APPENDIX A

QUESTIONNAIRES FOR SAMPLE OF FARMERS IN WADI JIZAN

Name of the village _____

1. How old are you?

- a. less than 20 years
- b. 20-35 years
- c. 36-50 years
- d. over 50 years

2. How long have you been living in this village?

- a. less than 5 years
- b. 5-10 years
- c. more than 10 years

3. Do you read and write? a. yes _____ b. no _____

4. How many members are in your family?

Male _____ Female _____

5. How long have you been farming in the Wadi?

- a. less than 5 years
- b. 5-10 years
- c. more than 10 years

6. Are you employed in work other than farming? a. yes ____ b. no ____

If so, where? _____

7. Have you ever moved to another place? a. yes ____ b. no ____

If yes, answer questions 8-11, but not 12.

If no, proceed to question 12.

8. When did you move?

- a. less than 4 years ago
- b. 4-6 years ago
- c. 6-10 years ago
- d. longer than 10 years ago

9. To where did you move?

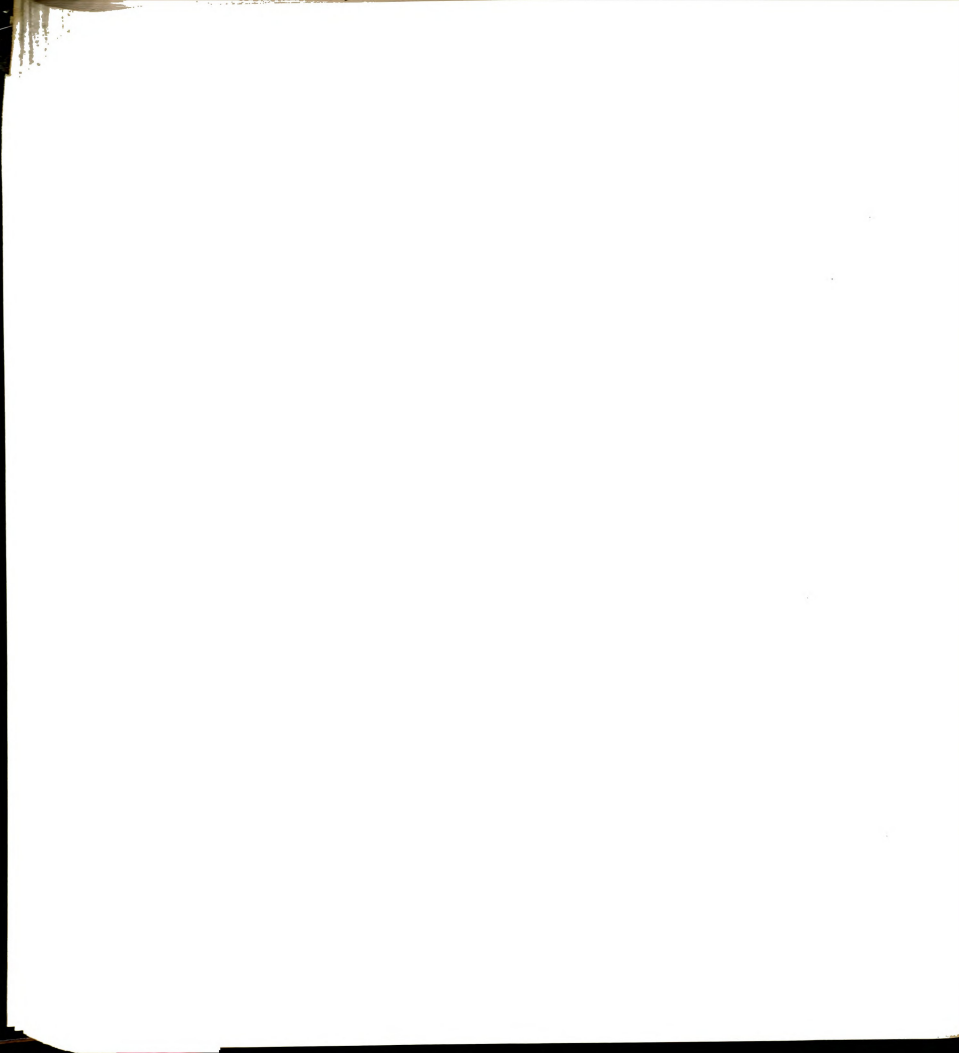
- a. with Jizan area
- b. somewhere along the valley
- c. somewhere in the Kingdom (specify)

10. Why did you move?

- a. Because farming failure due to scarcity of water.
- b. To find a school for my children.
- c. Looking for a higher income job.
- d. Because of too many laborers in the household for our holding.

11. Why did you come back?

- a. Because of the availability of water.
- b. Because it is now easy to live with the useful public services.



- c. The presence of agricultural extensions and services.
- d. I could not get along in other areas.
- e. Job opportunities.

12. Why didn't you move?

- a. I have always had enough water for my farm.
- b. My farm work keeps me busy.
- c. My farm production satisfied my needs.
- d. I do not want to move, I have lived here all my life.
- e. I have a job besides my farm.

13. How many workers do you have on your farm? _____

14. Are they all from your household?

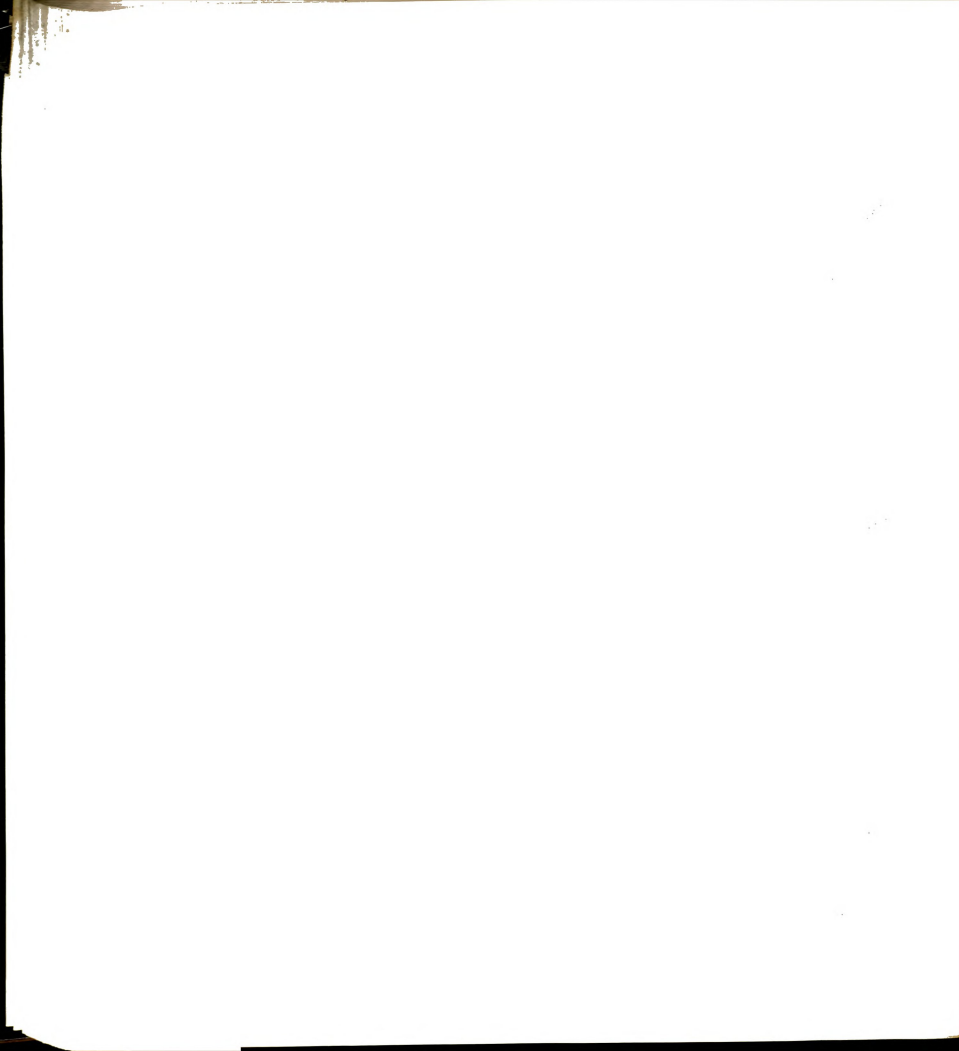
- a. all
- b. some How many? _____
- c. none

15. If you have some employees on your farm other than your household members, where are they from?

- a. Wadi Jizan
- b. Jizan province
- c. from far away areas (specify)

16. How big is your farm? _____

- 1. between 10-59 ma'ad
- 2. between 60-109 ma'ad
- 3. between 110-159 ma'ad



4. between 160-209 ma'ad

5. between more than 210 ma'ad

17. How much of your farm was in cultivation ten years ago?

a. all of it

b. 3/4 of it

c. 1/2 of it

d. 1/4 of it

e. none

18. How much of your farm is in cultivation now?

a. all of it

b. 3/4 of it

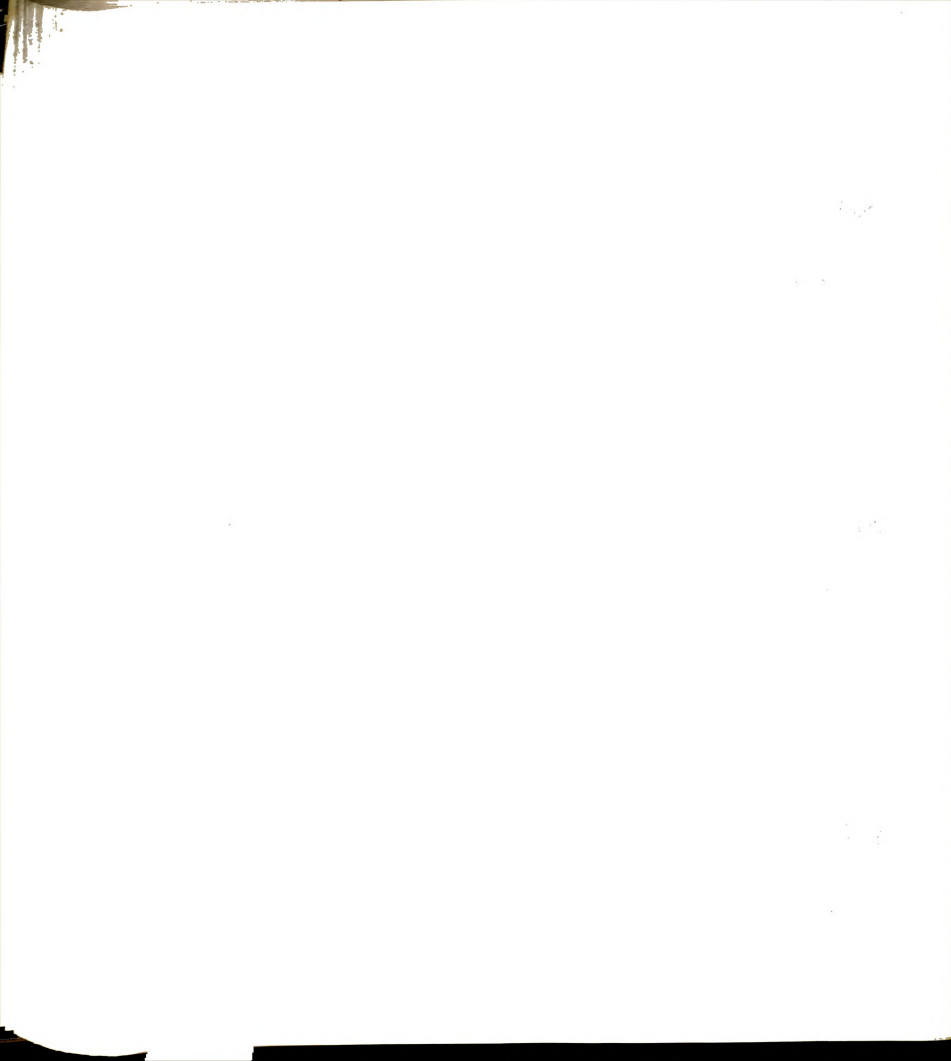
c. 1/2 of it

d. 1/4 of it

e. none

19. What do you grow?

	<u>Ten Years Ago</u>	<u>Now</u>
a. Fruits	_____	_____
b. Vegetables	_____	_____
c. Grains	_____	_____
d. Cotton	_____	_____
e. Others	_____	_____



20. How much was/is your farm income?

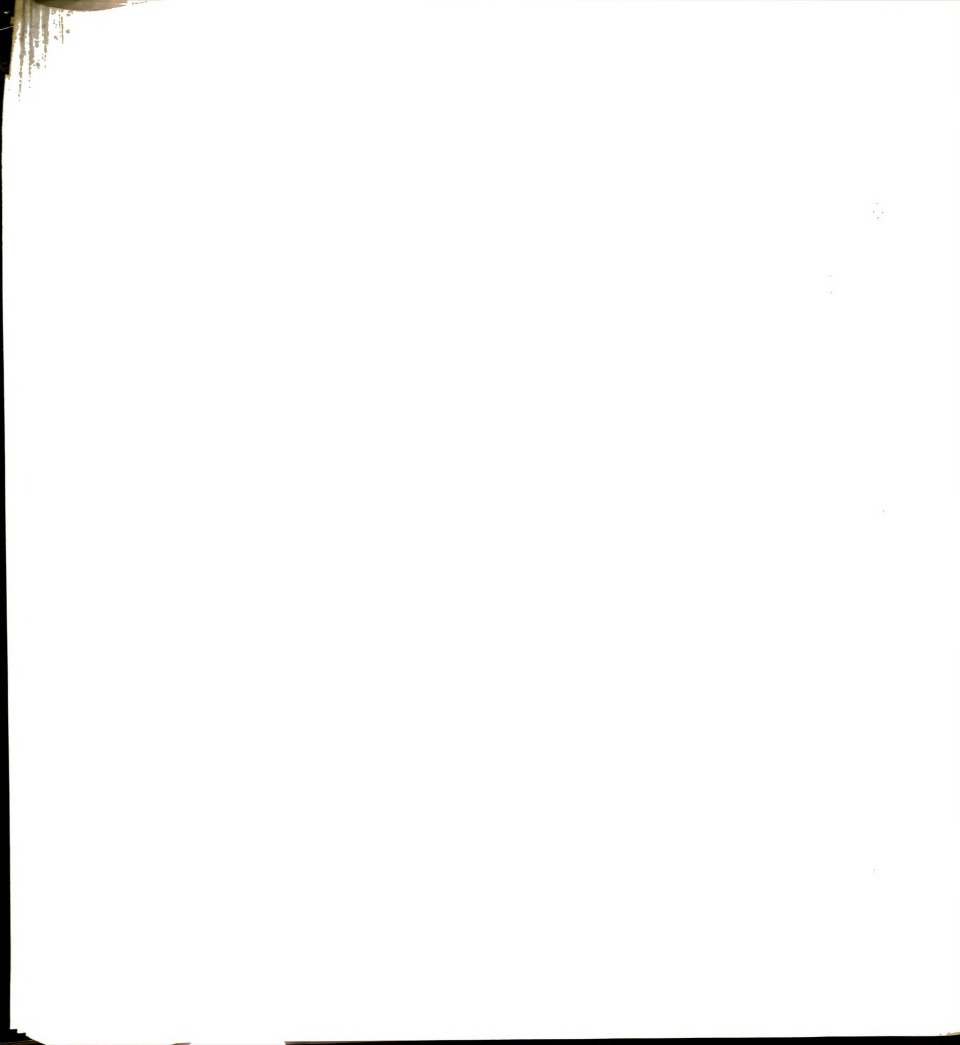
- a. ten years ago
 - 1. don't grow anything
 - 2. between 20-29 (SAA)
 - 3. between 30-39 (SAA)
 - 4. between 40-49 (SAA)
 - 5. more than 50 (SAA)
- b. now
 - 1. between 20-29 (SAA)
 - 2. between 30-39 (SAA)
 - 3. between 40-49 (SAA)
 - 4. more than 50 (SAA)
 - 5. don't grow anything

21. After household consumption, how much of your product do you sell?

- a. all of it
- b. 3/4 of it
- c. 1/2 of it
- d. 1/4 of it
- e. none

22. How do you transport your farm products to the market?

- a. by foot
- b. animals



c. professional truckers

d. my own vehicle

23. Where do you sell your farm products?

a. Jizan City

b. Abu Arish

c. Sabya

d. other places (specify)

24. How many animals do you keep on your farm?

a. sheep _____

b. cattle _____

c. goats _____

d. donkeys _____

25. What is the most serious problem you face in farming?

a. Water scarcity.

b. Water drainage.

c. Transport facilities.

d. Diseases and insects.

e. Lack of agricultural knowledge.

f. Shortage of labor.

g. Long distance to market.

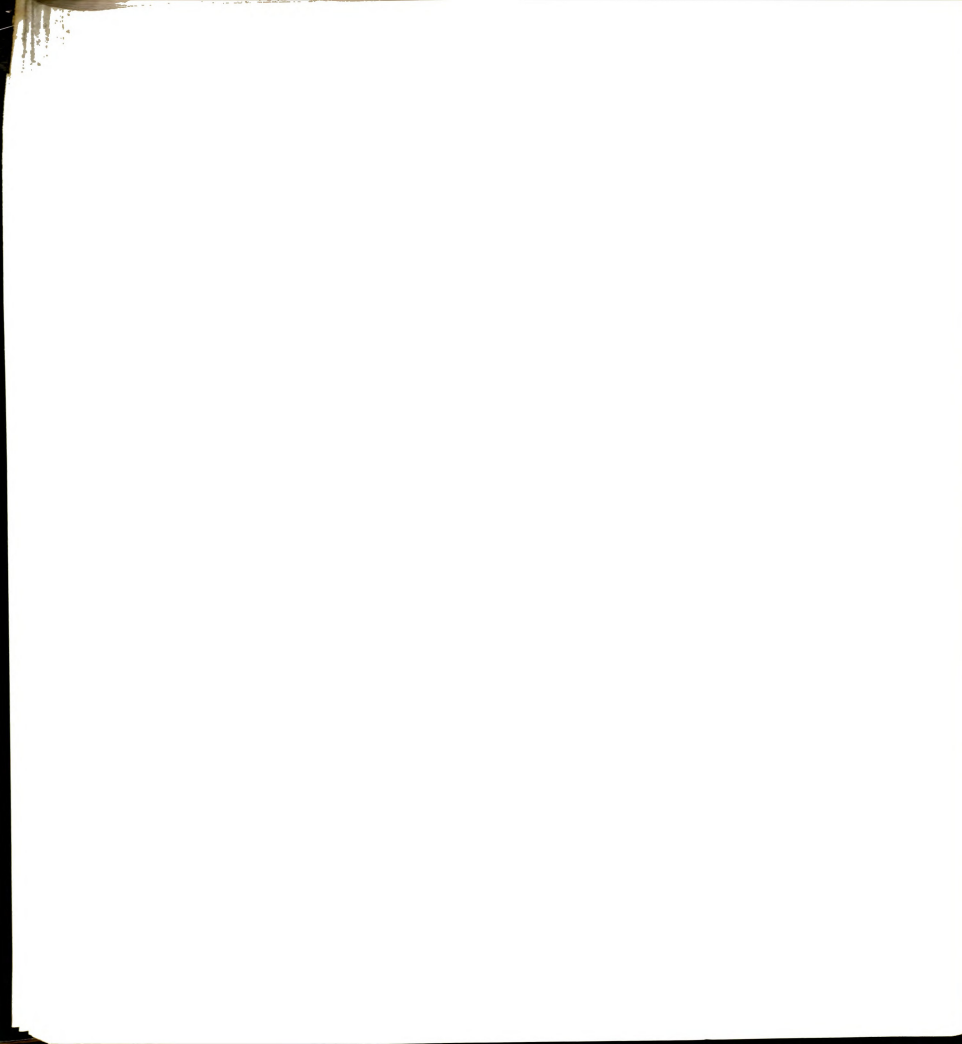


APPENDIX B
HOUSING AND POPULATION CENSUS

Ser. No.	Name of Village	No. of huts in each village pounds	No. of house-holds (family com- in each village pounds)	No. of persons in each village pounds	Av. No. of persons per house-hold	Av. No. of persons per house-hold	Popn. in Wadi Jizan	Popn. in Wadi Jizan	Popn. in Wadi Jizan
1	AL-'UDDAH	96	88	393	4.1	1.1	4.2	393	
2	QAMIRAH	132	96	443	3.4	1.4	4.6	443	
3	AL-QUMAY' IYAH	103	87	436	4.2	1.1	4.7	436	
4	AL-SALMAH	135	78	415	3.1	1.7	5.3	415	526
5	AL-GHURAYYIB	136	107	526	3.9	1.3	4.9		219
6	AL-MATIRI	70	45	219	3.1	1.5	4.9		
7	AL-KHASHABIYAH	122	91	475	3.9	1.3	5.2	475	
8	AL-WASILI	334	242	873	2.6	1.4	3.6	873	
9	AL-FUQAH	125	89	449	3.5	1.4	5.0	449	682
10	AL-MABUJ--AL-MAKINAH	261	167	682	2.6	1.5	4.1	682	193
11	BAKHSIAH SHAM. & YEM.	49	40	193	3.9	1.2	4.8	208	
12	BAHRAH	61	37	208	3.4	1.6	5.6	199	
13	QANBURAH	46	40	199	4.3	1.2	5.0		
14	AL-GHASHAMIYAH	771	50	193	2.7	1.4	3.9	193	567
15	AL-KARBUS	150	140	567	3.8	1.1	4.1		
16	TAL'AH	7	7	22	3.1	1.0	3.1	22	
17	AL-'USAYLIYAH	46	30	142	3.1	1.5	4.7	142	
18	AL-RAHAH (AL MTHDAS)	51	30	179	3.5	1.7	6.0	179	
19	HAKIMAH	712	591	2,646	3.7	1.2	4.5	2,646	
20	AL-BAYYID	200	169	670	3.4	1.2	4.0	670	

21	AL-KHADRA AL-JANUBIYAH	424	308	1,377	3.2	1.4	4.5	1,377
22	AL-MURAYKHIYAH	48	28	186	3.9	1.7	6.6	186
23	FALASS	186	168	770	4.1	1.1	4.6	770
24	AL-MUJASSAS	207	155	643	3.1	1.3	4.1	643
25	ABU AL-NURAH	122	152	507	4.2	1.2	5.0	507
27	AL-WASIT	58	57	258	4.4	1.0	4.5	258(3)
28	AL-MAHALLAH	141	116	650	4.6	1.2	5.6	650(3)
29	KHABTA SAID	155	87	378	2.4	1.6	4.0	378
30	AL-RAYYAN	252	148	686	2.7	1.7	4.6	686
31	AL-KAWAMILAH	70	46	224	3.2	1.5	4.9	224
32	AL-'USHWAH	124	95	484	3.9	1.3	5.1	484
33	AL-KHASAWIYAH SHAM.	38	31	142	3.7	1.2	4.6	142
34	AL-KHASAWIYAH YEM.	152	110	548	3.6	1.4	5.0	548
35	AL-KHARADILAH	220	91	695	3.1	1.3	4.1	695
36	AL-UMAYRIYAH	138	89	419	3.3	1.5	4.7	419
37	AL-DUHAYQAH	87	62	245	2.8	1.4	3.9	245
38	AL-JIRBAH	16	15	78	4.9	1.1	5.2	78
39	AL-MIHSAM	93	65	324	3.5	1.4	5.0	188
40	AL-SHUMAYHAH	42	41	188	4.5	1.0	4.6	108
41	TEIHAN	25	25	108	4.3	1.0	4.3	44
42	AL-MUAHAFI	15	12	44	2.9	1.2	3.7	859
43	AL-QARAFI	269	181	859	3.2	1.5	4.7	1,026
44	AL-BADI'	382	233	1,026	2.7	1.6	4.4	10,853(1)
45	ABU ARISH	3,015	2,122	10,853	3.6	1.4	5.1	217
47	AL-KHUDAYRAH	70	48	217	3.1	1.4	4.5	193
48	AL-QA'ARIYAH	42	33	193	4.6	1.3	5.8	316
49	AL-'AJABIYAH EAST/WEST	67	61	316	4.7	1.1	5.2	134
50	AL-GHAZAWAH	24	22	134	5.6	1.1	6.1	350
51	AL-BUKHTAH EAST/WEST	89	78	350	3.9	1.1	4.5	99
52	RAH AL-'UQLAH	26	21	99	3.8	1.2	4.7	120
55	AL MOGAR	30	27	120	4.0	1.1	4.4	40
56	RAH AL TAWAHIRAH	13	9	40	3.1	1.1	4.4	73
57	SALAM EM TAWASHI	20	18	73	3.7	1.1	4.1	240
58	RAH EM MADARAH (MALAKI)	75	89	240	3.2	1.3	4.1	84
59	SA'BAH	21	19	84	4.0	1.1	4.4	144
60	AL MAJDARAH (AL JZOUR)	35	30	144	4.1	1.2	4.8	

Source: Sir W. Halcrow and Partners, "Irrigation Development in the Wadi Jizan," Saudi Arabia, Annex 4, London, 1972, pp. 204-206.



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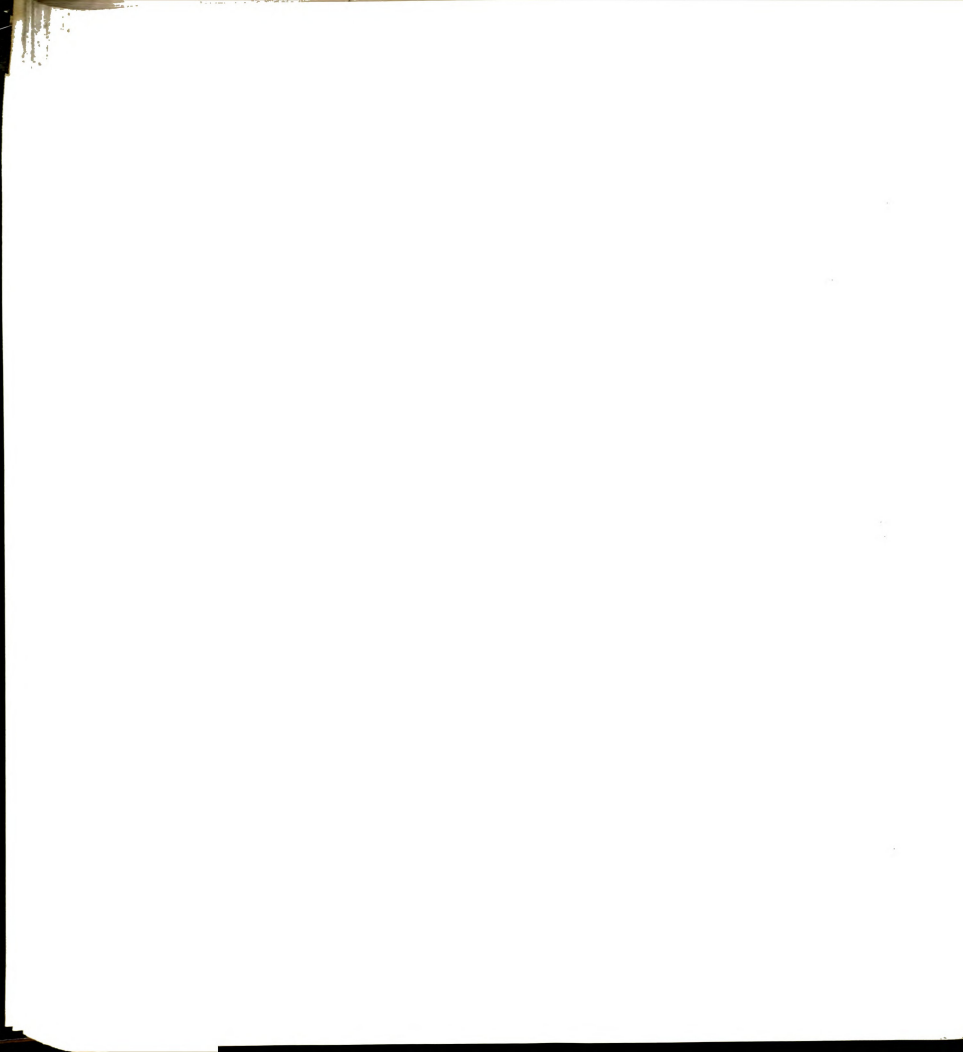
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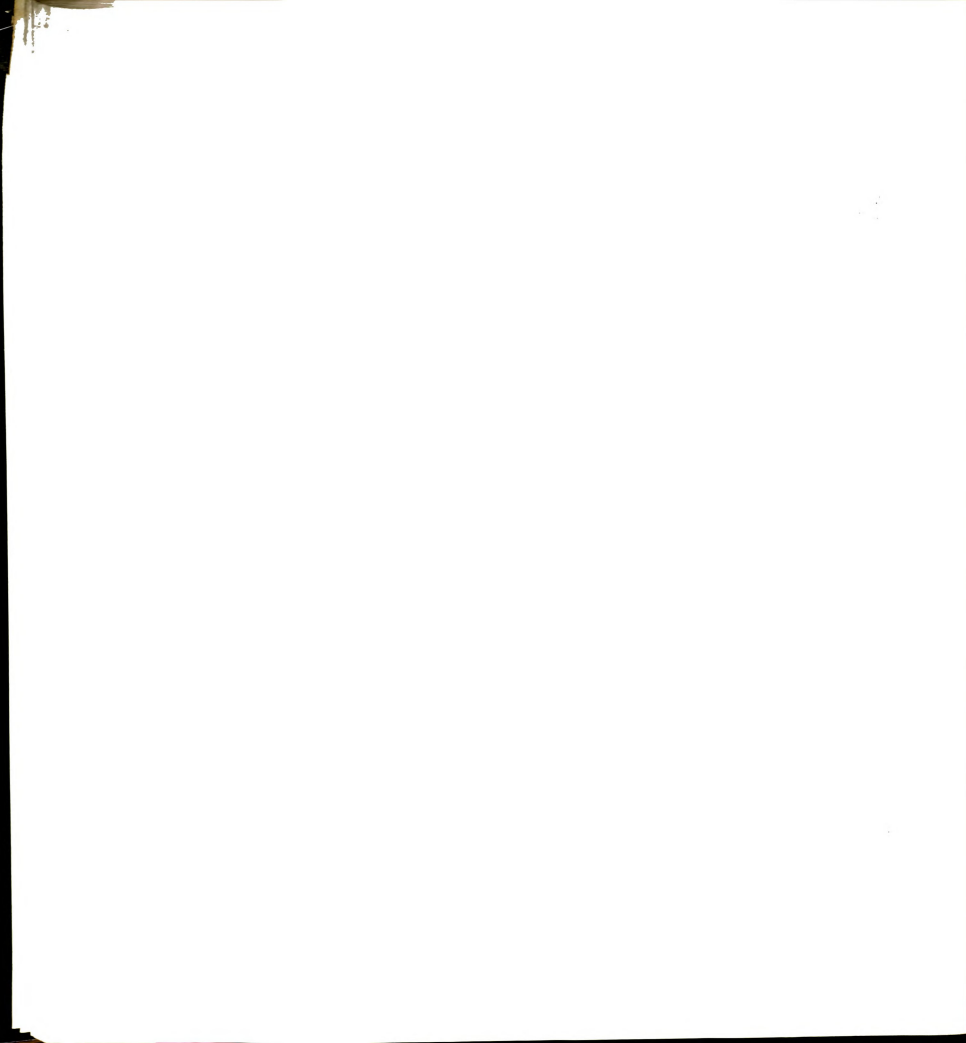


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