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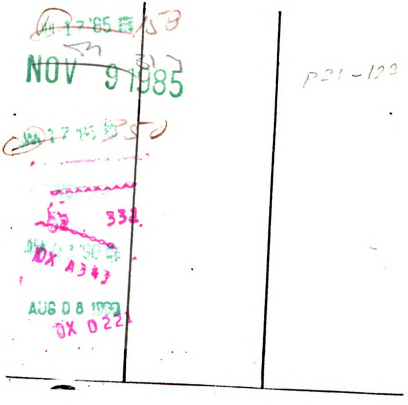

# A STUDY OF AGRICULTURAL DEVELOPMENT IN AL-KHARJ, SAUDI ARABIA

By

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ABSTRACT

A STUDY OF AGRICULTURAL DEVELOPMENT
IN AL-KHARJ, SAUDI ARABIA

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Since 1970, Saudi Arabia has undertaken great efforts to develop the natural resources of the Country. Agriculture is among the natural resources upon which the government has placed much attention. One governmental plan for the advancement of agriculture is development of the Al-Kharj agricultural region, which is the focus of this thesis.

The research methods employed in writing this thesis include the use of previously written materials and the taking of a survey, through which the origins, current status and future prospects of this area have been discussed.

Despite numerous difficulties encountered by the Al-Kharj farmers, two major factors contribute to the continuation of agricultural development. One factor relates to the availability of laborers, and the second relates to governmental subsidies to the farmers.

In the concluding chapter, a general finding concerning the questionnaire analysis is presented.

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# I. INTRODUCTION

The Kingdom of Saudi Arabia is located in the arid tropical zone, where climactic and physical characteristics are not favorable for agriculture. High temperatures average around 65°F to 120°F during the summer months, from May to October; and during the winter, temperatures seldom reach freezing.

Most of the country consists of bare ground, and the soil is of poor quality. Natural vegetation is sparse and limited to the dry bed valleys of the western region and to those oases which are scattered throughout the country where groundwater is readily available because it is close to the surface and can be reached easily by drilling wells. Rainfall is slight in the central and eastern regions, except for in the mountainous areas of the west region.

The population of Saudi Arabia has not been accurately determined, but estimates range between 4.1 and 9.5 million. Despite current efforts of the government, a great number of the population has minimal or no education, and many are illiterate. Nomads are common throughout the country as well; and the women of Saudi Arabia comprise only a small portion of the labor force.

The one outstanding feature of Saudi Arabia is, of course, its oil reservoirs and the resulting revenue. This revenue is a source by which the Saudi government is attempting to improve those aspects of the country which it is able to. Such efforts include the construction of roads and cities, increased availability of and encouragement for advanced education, and much more. Oil revenue is as limited as the oil resources, however, and thus this period of rapid advancement may some day end unless the country is able to advance itself to the point where it has other sources from which to sustain its population.

Given these characteristics, physical, social and economic, Saudi Arabia is not a place where agriculture has many advantages. The climate and soil, as well as the nomadic nature of the people and other characteristics, are not encouraging to those persons investing in the sector of agriculture; and at the present time, the great wealth of the country places little urgency on the importance of developing and improving agriculture in the country. However, a great deal of oil revenue is required to maintain efforts for agricultural advancement to prepare the country for the eminent future need for food for the people of Saudi Arabia.

One effort of the government in the furtherance of agricultural is an agricultural region located at Al-Kharj, a site chosen for its close proximity to the capital city of Riyadh and because of its groundwater sources, which

is maintained from relatively shallow aquifers. This area is the focus of this paper. Through research and personal study, the origins, current status and future prospects of this area have been discussed. It is this agricultural area at Al-Kharj, among other such areas, which must be further developed in order to increase Saudi Arabia's advancements in the field of agriculture--steps which will benefit the country both now and in the future.

## Statement of Problem

This study of agricultural geography is concerned with the potential for agricultural development at Al-Kharj, Saudi Arabia. The current status of agriculture at Al-Kharj must be explored, whereupon the potential of the area may be determined.

Al-Kharj as been the focus of agricultural advancement in Saudi Arabia since 1936. In 1942, the Saudi government, with the aid of oil company engineers and geologists, began an agricultural project here. This interest in Al-Kharj continues to this date with the cooperation of the government and private investors.

Governmental contributions to agricultural development are concentrated on recent surveys relative to groundwater locations at Al-Kharj. Additionally, the government has encouraged the farmers in the area themselves by providing assistance in the forms of purchasing and using new

technology in farming equipment, supplying cheap fertilizers and seeds, and providing free consultations.

This study also concentrated on the degree of participation by the farmers themselves in the development of their farms, with the use of private capital as well as governmental assistance. This shall be determined by way of a survey of the farmers of this area, conducted by this writer, which shall be analyzed in depth.

Through this study, the agricultural contributions of the government and individual farmers will be determined, thus allowing conclusions to be made relative to the current situation and potential for agriculture at Al-Kharj.

## Objectives

The objectives of this study are as follows:

1. To investigate the current agricultural status at Al-Kharj.
2. To provide evidence about the attitude of native farmers toward agricultural advancement at Al-Kharj.
3. To investigate the facilities and contributions of the Saudi Arabian government relative to agricultural development in the area.

## Methods of Research

Information used as a basis for this study was obtained through written material as well as a great deal of field research.

Field research was carried out by way of a survey. Distribution of questionnaires was based upon a random choice of farms in the twenty-four existing villages at Al-Kharj. Because Al-Kharj town was the core where agriculture first appeared in the area, this town was used as the focal point for the distribution of the questionnaire. Al-Kharj area is comprised of two emirates, Al-Kharj which is the focus of this study and has a total of 761 farms, and Al-Dilam emirate which has 522 farms.

This survey covered 150 farms, 20 percent of the total 761 farms of the Al-Kharj emirate. These 150 farms were randomly chosen as a sample of sufficient size to represent the current agricultural status in the area. However, the actual number of farms in each village was not available, so another random choice of farmers was taken by obtaining an estimated list of farms in each village. The total number of the population engaged in agriculture at Al-Kharj is about 6,170 persons. The random sample represents 2.4 percent of the total farmers. This method of research was followed to provide an equal chance for everyone in the area to be chosen.

A review of the combination of individual farmer and governmental efforts in agriculture will help show the potential of the area. The questionnaires have been used as the basis for the study of Al-Kharj agricultural geography.

The written material used in this study was obtained through books, articles and other documents obtained from a

variety of sources, such as the Saudi Arabian Ministry of Agriculture and Water, the Saudi Arabian Agricultural Bank in Riyadh, and the Saudi Arabian Agricultural Bank in Al-Kharj. Additional information was obtained through the Department of Geography at the University of Riyadh, and the Ministry of Finance and National Economy. This information was supplemented by personal interviews with officials at the Ministry of Agriculture and Water. A great deal of research was also done at the Michigan State University libraries.

## Analysis Procedure

Questionnaire responses are organized into five groups. Each group represents a specific category. These categories are as follows: Methods of farming, hazards and problems, governmental assistance, a private agricultural project and social status.

## II. AGRICULTURAL GEOGRAPHY: A REVIEW

Geographers have made a good deal of contributions to agricultural geography, with their initial interest being the classification of the agricultural regions of the world. Here geographers have divided into different schools of thought. Some base their classification upon climactic characteristics, others upon quantitative methods, and still others upon the forms of agricultural activity that appears to dominate every type of agriculture around the world. Many of these scholars have given their explanation of the procedures they have used. Many geographers agree with some of these methods, while they criticize others. However, a brief survey of these methods will be helpful in understanding each scholar's standpoint on these different methods. It should be noted here that geographers have sufficient information about agricultural geography, but the time has come to plot the information they have obtained on maps to be distributed to the agricultural regions of the world.

Wladimir Köppen used climate as the primary tool in determining the boundaries of the major vegetation types around the world.

> Köppen, in using this system, was not entirely successful; but his climate system has appealed to geographers because it is empirical and allows no room for subjective decisions.[1]

Griffith Taylor is another geographer who classified an area on the basis of climate, in this case Australia. He stated strong ideas about the effect of climatic conditions on settlements in Australia, and he discussed what problems they might encounter in future development because of the aridity of the country. Also, he indicated the problems in the development of northern Australia due to the climate factor.[2] Another obstacle faced in the settlement of Australia is the availability of water.

> The potential sources of water were in fact much more limited than was popularly believed. Taylor estimated that instead of providing a home for more than one hundred million people, the maximum population that could be supported with a high standard of living was perhaps less than thirty million.[3]

Taylor was accused of being a determinist spokesperson, and this standpoint led the public to attack him and reject his ideas. Australians' rejection of Taylor's ideas concerning the limit of nature's ability to support a great number of people had forced him to leave Australia, and he settled in Toronto, Canada. When Taylor reached the age of seventy, the people of Australia were finally beginning to accept and appreciate his ideas, and he returned to his homeland.

Instead of using climate as a basis for classifying agricultural regions, geographers needed a system that would enable them to establish the boundaries of agricultural regions. This was not possible due to the lack of

statistical data about many parts of the world. A notable work in the classification of agricultural regions of North America was done by Oliver E. Baker. Based upon the statistical data available relative to counties in the United States of America, Baker, in his series of articles published in economic geography between 1926 and 1928, was able to draw boundaries for the agricultural regions in North America. But his classification drew the attention of some geographers who criticized this system.

Derwent Whittlesey criticized this system as it lacks the possibility of being used to establish the agricultural regions of the world.[4] Another scholar of geography who, in fact, agreed with Whittlesey's criticisms of Baker's system but indicated that Baker's system will remain valuable to the students of agricultural geography, is R. Ogilvie Buchanan. Buchanan stated as follows:

> . . . Baker's method and his system of agricultural regions materially aided in appreciating the regional character of American agriculture it was of inestimable value to students of the subject. From the point of view of an economic geographer, however, there would seem to be some methodological weaknesses, or at any rate some lack of logical rigour in Baker's work. He is on quite firm ground in his delimitations where the problem is to find the outer boundaries beyond which a particular crop is not cultivated at all.[5]

In the field of agricultural geography, the most important study made was written by Derwent Whittlesey, which was published in the Annals of the Association of American Geographers in 1936. In this article Whittlesey used a more complex methodology than Baker to classify the

agricultural regions of the world. His methodology was based upon five criteria which he listed in his article. These five criteria appear or are dominant in all agricultural activity around the globe. However, Whittlesey indicated that his method is different because the classification he used is largely empirical and qualitative. It is the only system so far which is acceptably establishes the world's agricultural regions, since statistical data is not available for all parts of the world.

Many criticisms have been offered by geographers of Whittlesey's agricultural region classification. However, attempts have only been made to modify Whittlesey's classifications rather than devise new systems.[6] Although Whittlesey identified thirteen agricultural systems, recent developments have somewhat modified this early classification, and also reduced the validity of distinctive features.[7]

Geographers in general, in their studies of agricultural systems, have been giving less attention to the effect of social organization upon agriculture. R. O. Buchanan noticed this gap in agricultural geography, which is being filled by social anthropologists.[8] These social organization studies, such as religious beliefs and practices, customs and behavior, have also attracted the attention of geographers, but to a minor degree and with the association of the social anthropologists.

H. C. Brookfield is one of those geographers who has collaborated with anthropologists in his research about

the Chimbu agricultural system. Brookfield's agricultural studies are rather different than those of Baker and Whittlesey, as he is primarily concerned ". . . with the manner in which land resources are evaluated, used, and allocated in a densely peopled area in central New Guinea."[9] as he himself stated. He continues to describe his approach to the study of this kind of primitive agricultural system by stating as follows:

> . . . (T)he Chimbu agricultural system and the Chimbu political system are our main subjects. No single, simple question is asked but rather a group of inter-related problems is posed within the general field outlined. An attempt is made to combine a measure of generalization over a wider area with detailed material obtained from one locality and to draw out the wider significance of the local findings by means of comparative discussion of the literature.[10]

These approaches to the study of the agricultural systems of the world, and many others, have given the literature of geography a successful methodology to find a practical solution to agricultural problems. These approaches have given agricultural geography firm ground upon which to stand, equal to other sciences which have interest in studying the earth as the home and main resource of mankind.

## Geography and Development

When referring to development, there are a few questions which must be answered in order to understand the process of development, whether in countries which are economically advanced or those that are not. Some of these questions, but not all, are related to our study, such as:

"What is the purpose of development?" "How is development measured?" "What is the definition of the word development?" According to Dudley Seers, ". . . development means creating the condition for the realization of human personality. Its evaluation must therefore take into account three linked economic criteria: whether there has been a reduction in (1) poverty; (2) unemployment; (3) inequality."[11] Seers also showed that high income per capita is not a good indication of development if it does not include a reduction in the three criteria mentioned earlier.

However, Lester B. Pearson argues that development has an even broader definition. "It means participation of people in the determination of their environment. It means the opportunity for people to choose and to use their resources to the maximum capacity."[12] Because geography is the relationship between man and his environment, the geographer can give his broadest definition to the concept of development. Murray Chapman has stated this broad geographical definition as referring ". . . to the more optimal utilization of a country's and/or people's physical and human resources through concerted and often planned action."[13]

Chapman has realized that until recently geographers have made no theoretical contribution to the study of development. But because geographers have accumulated enormous amounts of data about many parts of the world through the years, they are in a position to contribute to

development studies. There are a number of articles written in geographical magazines which reveal the continuous interest in agricultural land use. Geographers have made a considerable number of empirical land studies which place them ". . . in a strong position to make a real contribution to the theory of development."[14]

In the literature of geography, the scholars have managed to explain the process of development and modernization according to their interest between man and his environment. The development process in underdeveloped countries is usually linked to and affected by the world economy; therefore, geographers should emphasize their research on the development problems that are faced by their countries.

Anthony R. de Souza and Philip W. Porter have stated that geography has a special opportunity to aid development in underdeveloped countries by conducting research concerning these three elements: man's environment, spatial organization, and inventorying and monitoring. Research done on these elements will help underdeveloped countries to avoid mistakes made by other countries in the past.[15] This geographical idea, as stated by de Souza, is very important due to the fact that many underdeveloped countries do not place emphasis on the value of geographical research which may reduce the time and capital consumed in their developmental plans.

In terms of the man-environment relationship, the major concern of the geographer is concentrated around four steps which will lead to the best geographical research. These steps concern soil survey, hydrological investigations, food crop characteristics, and research on farming systems. Also, the geographer is able to track any change on the surface of the earth. The analysis of these changes could lead geographers to reach conclusions about the nature of these changes. Here de Souza also explains the purpose of monitoring.

> . . . The purpose of monitoring research is to keep track of change, to find out whether damages are harmful to man, the resource base, or both, and whether goals of development and social betterment are being achieved.[16]

Geographers have been able to distinguish if a real development process has taken place. They are able to do so due to their understanding of the difference between economic development and growth. M. I. Logan argues as follows:

> . . . (D)evelopment does not simply mean to attain more of what some already possess, but that it involves a form of structural transformation in either the economic or social system or both. The possession of certain material goods, for example, is not necessarily an indicator of innovativeness in agriculture which is one of the more important agents of structural change.[17]

Here, also, Logan stressed his understanding relative to the difference between economic growth and modernization.

> Economic growth is the policies that are directed towards maximizing per capita incomes. While modernization is the process of economic and social change through which a less developed country acquires the characteristics of the so-called economically advanced nations.[18]

Thus, the building of hospitals, schools, etc., is an indication of modernization. But this does not necessarily mean a country is developed. Development constitutes a better standard of living for all people by the improvement of the economy through a high industrial advancement, improved agricultural technology and more. Developed countries are those which enjoy continuous economic and social growth.

## Geography and Environment

During the early part of this century, many geographers were influenced by the theory of determinism. This geographical view stresses the belief that "man is extensively influenced by his physical environment and, if taken to the extreme, that the cultural achievement of any group are controlled by factors such as climate and landform."[19] Determinism was discussed in the discipline of geography for a long time until it faded from academic geography in the 1920s.[20] The new generations of geographers have rejected the concept of environmental determinism because it ignores the fact that man has dramatically altered the face of the earth. Here, a new geographical theory has been developed to replace the rejected one. Geographers accept the concepts of the possibilism theory.

Science, technology and knowledge have enabled man to reshape his physical and cultural environment. This is a basic tenant of the possibilism theory. Unfortunately, man's interference with nature has had hazardous results

in addition to the benefits. The use of technology has caused man to create many problems easily and quickly. Forests have been cleared to expand agricultural land, dams have been built to control floods and increase irrigated acreage, and many diseases of plants, animals and humans have been brought under control. But geographers and other scientists have alerted the world of the consequences of massive use of technology.

> Many scientists claim that the use of technology promises a bright future, while others argue that our massive interference with nature has brought erosion of soils, depletion of groundwater, exhaustion of minerals, pollution of air and water and destruction of wildlife, all pointing up the lack of control over environment which, if continued may lead to catastrophe.[21]

The relationship between nature and man is one of the geographers' primary concerns. Geographers find themselves in a position to warn the public of the natural hazards that are created by technology and the growing population. Both geographers and laymen believe in the viewpoint that population control is imperative to prevent a catastrophe.

> Mankind in this twentieth century doubled in numbers by 1960, thereby passing the three billion mark. There is every sign that another three billion will be added within little more than thirty years. . . . If no efficient control is applied, which is the more likely alternative, this crucial century will see the world population zoom above eight billion, barring a major catastrophe.[22]

The environment of the Middle East, for example, has limited resources in terms of water and agricultural land, thus limiting the distribution of the population along

river banks, coastal lines and in oases. The remaining land of these countries is too arid for cultivation or to support the increasing population.

> Demographic characteristics of most of the countries in the arid lands of Africa and the Middle East give clear evidence of difficulties governments face in seeking to improve the quality of life and to meet the rising expectations of the people. The annual rate of increase of population for North African states averages about 3.1 percent while that of the arid Middle East falls just short of 3 percent. Such annual rates of increase mean that the population of these areas as a whole will double within about 23 years.[23]

Projections of population growth throughout the third world are similar to those of the Middle East region. The consequences of this growth affect the political organization, economy and environment of these countries.

In 1972, the Club of Rome concluded in its book entitled The Limits to Growth that there are five factors which determine the limits of growth on this planet--population, agricultural production, natural resources, industrial production and pollution. These limits, as the book has predicted, will cause mass starvation, political chaos and a general disaster by the middle of the next century.[24]

In response to population growth pressure, some communities may adopt some solutions in order to feed themselves. Massive emigration is among these solutions, and it was practiced from 1850 to 1950 when Europeans emigrated to North and South America. In these virgin lands the Europeans found the ultimate solution to their increasing

population. Since 1950, the third world has experienced a rapid increase in its population, but no additional virgin land was available on this earth.

> In modern times there have been few opportunities for emigration from the overpopulated areas of the Third World. Most of the empty areas of the world had been settled by the 1920's, and immigration policies began to restrict free movement.[25]

But even if the immigration doors were open, this policy will not solve the problem of overpopulated countries, as D. B. Grigg continues to explain. If overseas emigration was possible for the congested countries of the Third World, the absolute numbers who would have to move to make any difference would be vast.[26]

Here we must determine what the alternatives are for the developing or developed countries to feed the continually increasing population. The geographer D. B. Grigg recognized that Europe is still using immigration policies to solve this problem, but it is currently internal rather than external immigration. The industrial economy of many European countries has enabled the absorbtion of the excess labor force from agriculture. This solution, however, is not applicable in the Third World, because the natural rate of population increase in these countries is much higher than those experienced by the western hemisphere.[27]

Another scholar of geography has presented some evidence which illustrates how the developed countries are able to provide adequate food supplies for their population even though their agricultural land is not capable of doing

so. Many developed countries have managed to survive through importation and the use of ocean resources as two main bases for feeding people, as well as its livestock. Japan, for example, imports agricultural products equivalent to 1.82 times its present tilled land, while fisheries furnish about 3.8 times as much as the present tilled land.[28] Japan is not the only country which depends on these two sources for food, but increasing numbers of European countries import hugh amounts of foodstuffs and raw materials as well. The striking fact is that most of the food imported is used as animal feed.

> More than half of the U. S. cereal export is for purposes of feeding domestic animals. . . . Wheat of which one-third goes to the well-to-do countries and is even used for stock feed.[29]

However, only a few countries of the Third World depend on food importation, such as parts of the Middle East and North Africa.[30]

Man has not yet exhausted all the possibilities for providing food and suitable shelter for millions of people. Some ideas fail, but others succeed. The proportion of failures to successes leans dangerously toward failure, as many technological projects have disadvantages which disturb the environment.

An example of man's failure to create more arable land is described by Georg Borgstrom, who states that:

> Making deserts bloom is one of technology's masterpieces. Yet at the same time man has created five times as large an acreage of deserts as existed

> heretofore, or some 1.2 thousand million ha now in all whether through negligence, ignorance or sheer pressure of numbers in man and livestock.[31]

Geographers and other scholars have exhibited what man has done to his environment. They now place their efforts on finding a strategy which would be adoptable in many countries and would provide food to meet the demands of populations during the next century. This strategy is the one presented by Georg Borgstrom, which he called the "Hexagon of Survival." It states that food supplies and population must be brought into balance through coordinated efforts. Food production must be accompanied by population control, better storage and utilization (both for human and animal food), stronger nutritional requirements, disease control, and resource appraisal (water, energy, land and animals).[32]

Man must realize that the use of our natural resources must follow a strategy which does not disturb the ecological balance of the earth.

> There is a very real danger that, in our efforts to increase food production in the short run on a crisis basis, we may adopt strategies that are self-defeating in the long run. The aim of these strategies should not be growth at the cost of environmental deterioration or destruction of natural resources, but rather development with due concern for conservation of environment and resources.[33]

This strategy for the maximization of agricultural production is increasingly promising. Efforts toward such a plan must be adopted on a national and global scale to assure maximum success for the benefit of our generation and future generations.

# III. RESOURCES OF SAUDI ARABIA

## Oil Resources

Even the advent of increased oil production and the corresponding economic growth from a national annual revenue of $4.2 billion in 1972 to $30 billion in 1976 have not ended the many problems of Saudi Arabia.[34] The lack of adequate agricultural advancement is a fact of justifiable concern to the country; and in order to meet the increasing demand for food in Saudi Arabia, it is necessary to utilize all lands capable of being cultivated. In Saudi Arabia the demand for food far exceeds its current capability of agricultural production, thus making the need for advancements in this field a subject of major concern. Twenty years ago the economy of Saudi Arabia was mainly dependent upon small amounts of agriculture in the scattered oases and upon fees taken from pilgrims who come to Mecca, the holiest Islamic city. Large numbers of the population of Saudi Arabia at that time could be described as nomadic, and many of them still roam throughout the country searching for water and forage for their animals.

This economic system has gradually begun to modernize since the discovery of commercial quantities of oil

during 1938. Table 1 shows the amount of revenue that has been earned from oil production from 1950 until 1978. The increase in oil production has provided the country with huge revenues amounting to around $37.8 billion in 1977. Many studies indicate that oil revenue provides about 85 percent of the total revenue earned in Saudi Arabia yearly.[35] The other sectors, such as agriculture, commerce, transportation and industry, provide the remaining 15 percent of the country's revenue.

The contribution of agriculture in the national economy of Saudi Arabia is still not known accurately, but has been estimated lately to be around 8 to 10 percent. The Saudi Arabian government is taking all possible efforts to develop agriculture and is using oil revenue as an important tool for this purpose. The budget for agriculture during the second five year plan (1975-1980) reached $1.3 billion.[36] But, the fact is that most of the investment during the first five year plan (1970-1975) and the second five year plan (1975-1980) went toward the development of infrastructure projects, such as highways, ports and heavy industrial development. More recent data indicates that Saudi Arabia is planning to shift the emphasis of development toward social services, agriculture and aid to private industry during the expected third five year plan (1980-1985).

The discovery of oil in Saudi Arabia has been advantageous and yet at the same time resulted in many

Table 1.--Saudi Arabian Oil Revenue Between 1950-1979 (Million of Dollars).

| Year | Revenue | Year | Revenue |
|---|---|---|---|
| 1950 | 113 | 1965 | 663 |
| 1951 | 165 | 1966 | 790 |
| 1952 | 212 | 1967 | 909 |
| 1953 | 226 | 1968 | 927 |
| 1954 | 281 | 1969 | 959 |
| 1955 | 275 | 1970 | 1,214 |
| 1956 | 283 | 1971 | 1,945 |
| 1957 | 303 | 1972 | 2,795 |
| 1958 | 302 | 1973 | 4,340 |
| 1959 | 306 | 1974 | 22,574 |
| 1960 | 346 | 1975 | 25,676 |
| 1961 | 378 | 1976 | 33,500 |
| 1962 | 410 | 1977 | 37,800 |
| 1963 | 607 | 1978 | 35,200 |
| 1964 | 523 | | |

Source: Compiled from Arab Oil Magazine, Vol. 14, No. 10, Kuwait, July, 1979, p. 19 (Arabic).

disadvantages. Some of these advantages and disadvantages are described below.

Advantages of Oil

1. Oil has provided Saudi Arabia with a large amount of capital, which is necessary to modernize and develop the country. The budget for the second five year plan (1975-1980) reached $142 billion, but many projects have been delayed due to the lack of manpower and technical limitations.[37]

2. Oil also provides energy to operate the machines used in the development of the country. Oil is also used to operate the desalination plants, to produce energy for agricultural equipment, to produce fertilizers, and for many other purposes. However, the total consumption of oil in the Arab countries is very small, estimated at around two million barrels per day, even though oil contributes about 90 percent of the total energy consumed in these countries.[38] In Saudi Arabia the total consumption of oil per day is only 166,000 barrels, or 1.8 percent of the total oil produced, according to 1977 per day oil production. Of the remaining oil produced, 98 percent is exported abroad. The total production of oil in 1979, for example, accounted for 8.8 billion barrels per day, while it accounted for only 3.8 million barrels per day during 1970. This indicates the small amount of oil consumed internally

in Saudi Arabia, which is due to the fact that oil is used mostly to produce gasoline to operate private vehicles.

3. The oil industry could provide opportunities for employment. However, today Saudi Arabia is dominated by the oil industry, but it is the sector in the country which employs the least number of laborers. As Table 2 shows, the total number of persons employed by the oil industry is only 2.5 percent of the total Saudi Arabian labor force, while agriculture employs 46.2 percent. The high percentage of people engaged in agriculture in Saudi Arabia is a characteristic present in most middle eastern countries. The Saudi Arabian oil industry requires highly skilled laborers, which come from abroad, due to the lack of skilled laborers within the country. The sector which employs large numbers of the labor force, second to agriculture, is the service sector, which employs 21.8 percent of the total labor force in the country. This is due to the fact that large numbers of the population are engaged in commerce or employed by governmental agencies.[39]

Disadvantages of Oil

If there are advantages due to the discovery of oil in Saudi Arabia, there are undoubtedly disadvantages as well, which appear to be more obvious recently, especially when oil production exceeds internal demand.

1. In Saudi Arabia the average rate of growth of agricultural output has been 1.7 percent, compared with

Table 2.--Employed Persons 15 Years of Age and Over Classified by Type of Economic Activity and Region--1966 (thousands).

| Type of Activity | Region | | | | | Total | Percentage of Total |
|---|---|---|---|---|---|---|---|
| | Central | East | West | North | South | | |
| Agriculture, Fishing, Livestock & Bedouin | 83.3 | 33.8 | 78.2 | 55.5 | 213.9 | 464.8 | 46.2 |
| Mining & Quarrying | 0.3 | 23.9 | 0.2 | 0.3 | 0.5 | 25.2 | 2.5 |
| Manufacturing | 7.2 | 7.3 | 18.7 | 1.0 | 6.8 | 41.1 | 4.1 |
| Construction | 32.1 | 11.2 | 46.5 | 3.5 | 10.8 | 104.0 | 10.3 |
| Electricity, Gas & Water | 0.9 | 1.4 | 3.4 | 0.2 | 2.6 | 8.3 | 0.8 |
| Commerce | 18.3 | 10.7 | 41.4 | 5.5 | 19.9 | 95.8 | 9.5 |
| Trans., Com. & Storage | 10.5 | 7.8 | 18.4 | 1.6 | 5.6 | 44.0 | 4.4 |
| Services | 60.7 | 24.9 | 87.9 | 18.4 | 27.0 | 218.9 | 21.8 |
| Activities Not Adequately Defined | 2.2 | 0.8 | 1.0 | -- | 0.5 | 4.5 | 0.4 |
| Total | 215.5 | 121.8 | 295.7 | 86.0 | 287.6 | 1006.6 | 100.0 |

Source: Compiled from Central Planning Organization, Development Plan, Central Planning Organization, Riyadh, Saudi Arabia, 1970, p. 66.

8.2 percent for the oil industry and 30.2 percent for other manufacturing, while the average gross domestic product was 7.9 percent during 1966-1969. From this we can determine that oil has failed to increase the production of agriculture as well as animal husbandry. The reason behind this decline of agricultural production is partially the increasing sedentarization of nomads and the fact that other jobs, whether with oil companies or with the government, pay better. Data indicates that Saudi Arabia had net exports of livestock before the discovery of oil; but since the oil industry progressed, the decline in animal husbandry has turned Saudi Arabia into a net importer.[40]

2. Another result of oil is the migration of rural people to the towns, leaving the agriculture sector with a shortage of laborers. Gradually this has decreased agricultural production, resulting in the need to import from abroad.

3. By way of Table 3 we can compare the needs of Saudi Arabia in terms of internal oil consumption plus the amount of oil which must be produced and sold in order to earn revenue for internal development of the country, according to the first five year plan (1970-1975), with the amount of oil actually produced. Since 1975 approximately 50 percent of oil production was in excess of the country's needs. Prior to that time the amount of oil needed ranged from 60.2 percent in 1973 and 22.1 percent in 1974 of the

Table 3.--Crude Oil Production/Internal Oil Consumption and Developmental Expenditure in Saudi Arabia Between 1970-1977.

| Year | Development Expenditure (Million $) | Oil Exports Needed to Cover Dev. Exp. | Internal Oil Consumption | Amount of Oil Needed to Cover Int. Con. & Dev. Exp. | Actual Oil Production | Percentage of Oil Actually Needed to Cover Int. Con. & Dev. Exp. |
|---|---|---|---|---|---|---|
| | | (1,000 bbl. per day) | | | | |
| 1970 | 512.0 | 1,597.7 | 42.5 | 1,640.2 | 3,799.1 | 43.2 |
| 1971 | 752.0 | 1,823.3 | 47.1 | 1,870.4 | 4,768.9 | 39.2 |
| 1972 | 12,310.7 | 2,207.5 | 54.8 | 2,262.3 | 6,016.3 | 37.6 |
| 1973 | 2,073.4 | 4,505.1 | 68.2 | 4,573.3 | 7,596.2 | 60.2 |
| 1974 | 4,741.4 | 1,785.1 | 87.7 | 1,872.8 | 8,479.7 | 22.1 |
| 1975 | 12,310.7 | 3,395.5 | 117.2 | 3,512.7 | 7,075.4 | 49.6 |
| 1976 | 15,482.2 | 3,964.9 | 158.0 | 4,122.9 | 8,577.2 | 48.1 |
| 1977 | 21,238.0 | 4,586.3 | 166.2 | 4,752.5 | 9,200.0 | 51.7 |

Source: Compiled from Arab Oil Magazine, Vol. 14, No. 10, Kuwait, July, 1979, p. 22 (Arabic).

oil produced. This means that a great excess of oil is produced, resulting in an excess of revenue.

It can be determined that the economy of Saudi Arabia is a one source economy. Oil is the source upon which the country primarily depends, and oil revenue allows the country to import all its needs. However, the government is making efforts to diversify the economy of the country in order that the economy will not fail when oil revenue eventually declines. So far this policy has been unsuccessful, and new plans must be adopted to reduce the high dependency upon oil revenue.

## Water Resources

All the studies made by the United Nations and its specialized associates have reached the same conclusion, being that there is the possibility of facing a water crisis in the near future in most parts of the world. The results of a conference held by the United Nations in Argentina during 1977 showed that the delegations from many countries realized how dangerous the water crisis is. They reached a conclusion that by 1990 $100 billion must be invested in projects to provide the world's urban and rural areas with adequate water supplies, and another $100 billion is needed for irrigation purposes in many countries.[41] The main source of fresh water for human beings is in the rivers and lakes, but many arid areas have no single river or lake, such as is the case in Saudi Arabia.

The main source of fresh water in Saudi Arabia is groundwater reservoirs, but these reservoirs are limited in the amount of water they hold. Many of these reservoirs already have lost large amounts of their water because the rapid exploitation of their water has been faster than the rate of replenishment from rainfall.

Because of the rapid and uncontrolled growth of the population and the development of industry and agriculture, many countries are facing shortages in water supplies. Many arid zones, including Saudi Arabia, are determined to use the oceans as a source of fresh water, even with the realization by such countries that desalination is still a very expensive process. The need for more fresh water provides these countries with no other choice. In Riyadh, Saudi Arabia, for example, the consumption of water in 1956 was only 10,000 meters$^2$ daily, but this demand increased to fifteen times that amount in 1977. In recent years, the government has established desalination plants on the east and west coasts of the country in order to meet the increasing demand for water, despite the expense. The era of desalination plants in Saudi Arabia probably began with the critical shortage of water that faced the small town of Al-Wajh in 1967. During that year Al-Wajh, with approximately 2,500 inhabitants and being located 400 miles north of Jiddah on the Red Sea coast, had faced seven years of drought which resulted in the decline of groundwater reservoirs.[42] This crisis resulted in the people of Al-Wajh

being unable to drill for their water needs. Therefore, the government had to drill artesian wells as far as forty-three miles outside of the town. The water was brought to the town from these wells by trucks at a rate of 240,000 gallons per month, or about five gallons per person per day. Not only was this quantity insufficient to meet the daily need of each inhabitant, but the cost was too high, being nearly $20 per thousand gallons. Therefore, the Saudi Arabian government installed a desalination plant in late 1967 with a daily capacity of 65,000 gallons, which provided the town with twenty gallons of water per person per day for less than $2 per thousand gallons. The experience of the town of Al-Wajh is not unique in Saudi Arabia. Similar stories are being repeated in many parts of the country, as Saudi Arabia moves ahead in its development of water resources.

Water Sources at Al-Kharj

Because water is scarce in Saudi Arabia, the natural vegetation is very limited. Agriculture is only located where there is sufficient groundwater for irrigation. In the southwest, agriculture depends upon twenty inches of rainfall per year, whereas in the central and eastern oases it depends upon pits, springs or wells. About 15 percent of the total Saudi Arabian land area is capable of being cultivated, but only 1 percent is currently under cultivation. Saudi Arabia imports a large amount of food each

year because the arable land is not capable of providing enough food to support its population of four to eight million. The concentration of farming is heaviest in the fourteen major oases throughout the country. These oases contribute over 80 percent of the agriculture which is produced in Saudi Arabia itself. The Al-Kharj oasis is one of these oases which the country depends upon to produce some of the food it needs, especially the production of vegetables.

Until 1965 the Saudi Arabian government did not have sufficient data about the groundwater resources in the country. Then in that year the government contracted with some companies to explore the maximum potential of groundwater. One of those surveys shows, for example, that there is an enormous amount of groundwater in the Nefud Desert, equal to 20,000 $km^3$, all of a quality capable of being used for agricultural purposes.[43] However, groundwater resources are only capable of supplying sufficient amounts of water for a short period of time. In many wells throughout Saudi Arabia the level of water is declining constantly. Therefore, many wells have to be sunk to a depth of 500 meters, and many cases reach either saline or brackish water. To overcome these problems, the government has built a total of twenty dams as an artificial way to replenish groundwater.

Groundwater in most Saudi Arabian agricultural areas ". . . is found in the sedimentary formations

underlying most of northern, eastern and southern Saudi Arabia. The aquifers are mainly sandstones, but there are also limestones separated by water barriers or aquicludes which are shales and marls."[44] Deep aquifers, more than 700 meters below the ground surface, and medium and shallow aquifers, as far as 200 meters below the ground surface, are the sources of groundwater in Area V, where the Al-Kharj district is located (see Figure 1).

The Minjur and Wasia-Biyadh aquifers are the two major deep aquifers in Area V. Infiltration provides only a slight amount of water to such deep aquifers. Additionally, the water level in these aquifers has been slowly decreasing largely due to the fact that the rate of recharge is surpassed by the natural easterly outflow. This decrease has been taking place since the last Pluvial epoch 10,000 years ago, and this explains why the water table is so deep. The largest groundwater reservoir in this area is the Minjury aquifer, which contains an estimated 460,000 million cubic meters (MCM) of water in its sandstone.[45] This water is of sufficiently good quality for general use, but expensive to pump and develop. Minjur supplies approximately 7 percent of the total water exploited in Area V, mostly to Riyadh. Mining at Riyadh from 1956 to 1968 caused a forty-five meter decrease in the water level. Al-Kharj has access to the Minjur aquifer, which may be tapped by artesian wells. However, there is no need to utilize these aquifers at Al-Kharj for another fifty years,

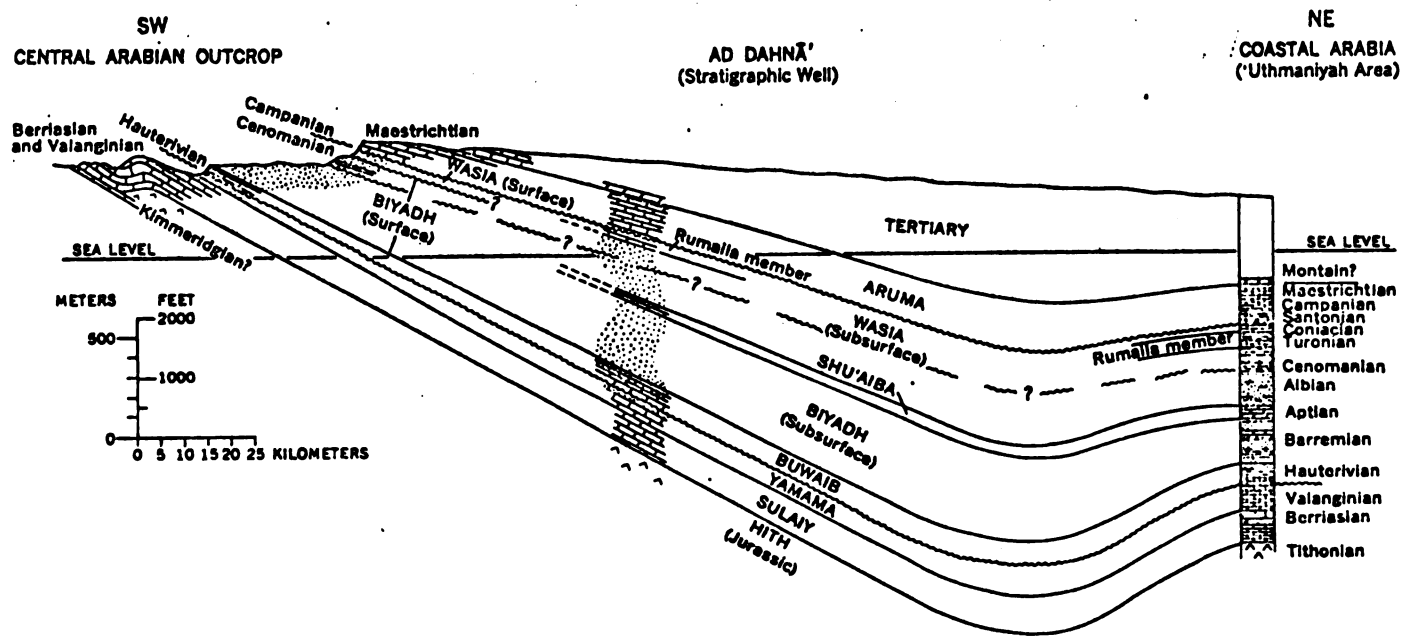



Figure 1.--Schematic Section Showing Cretaceous Surface-Subsurface Relationships.

Source: R. W. Powers et al., Geology of the Arabian Peninsula: Sedimentary Geology of Saudi Arabia, Geological Survey Professional Paper 560D (Washington, D.C.: U.S. Dept. of the Interior, 1966).

when it is expected that the shallow aquifers currently in use will run out.

Limestone aquifers are widely distributed and not suitable for direct tapping, though they do contain great quantities of water. Water in such areas can be used directly only where the rock has turned to karst, due to weathering. Such is the situation in the eastern lowlands of Wadi Al-Sulaiy, Al-Kharj and Aflaj to the south of Al-Kharj. However, when water levels in more permeable aquifers fall, due to pumping, water from adjacent limestone squifers drains off into the more permeable aquifers. This is the case in limestone aquifers upstream of the Al-Kharj plain, which drain into the sandy alluvial aquifers in the middle of the plain.

A study of the Al-Kharj groundwater resources concluded that there is a huge reservoir of water containing an estimated 10,000 MCM of water. The aquifers under Al-Kharj plain are of several varieties, and about 5,000 MCM of water is stored in aquifers less than 100 meters below the surface.

In the past, groundwater extracted at Al-Kharj has been less than the inflow, resulting in little change in the water table level, which is approximately ten meters below the surface. However, there has been an increase in mechanized pumping since 1945, resulting in an increase of the draw-down. In fact, the water level had been dropping even prior to 1945. In an article written by

Douglas D. Crary in 1951 about the Al-Kharj agricultural project, he states that a threat caused by the natural environment ". . . is the possible limit of the water supply. The water table dropped thirty-five feet during a recent four-year period, chiefly because of a rather intensive use of newly introduced drilling rigs and pumps. At Al-Kharj itself, the water level in Ain Dhila and Ain Semha has dropped twenty feet since their first pumping in the 1930s.[46] The annual recharge only to the plain of Al-Kharj is estimated by Sogreah, an international survey company, to be sixty-six MCM. However, in 1968 more than 119 MCM of water was mined, resulting in a loss of fifty-three MCM. There has been a serious fall in the water level because of increased extracting of water, especially at Al-Dilam, Hayathim, Al-Kharj, Sulamyah and Yamamah villages of the Al-Kharj district.

Between 1968 and 1993 there would be an approximate average water level decrease of thirty-five to forty meters, with an estimated extraction of 3,000 MCM between 1980 and 1985.[47] But with the use of only 220 MCM per year, the water reservoir at the Al-Kharj plain is expected to last for fifty years. When the Al-Kharj aquifer does run out, the Minjur and Wasia-Biyadh formation aquifers, as mentioned earlier, will be available to support the agricultural activities at the Al-Kharj district. To achieve this goal, strict governmental regulation is needed to control the withdrawal of water from the wells located at the farms in

the Al-Kharj area. This is being done partially by the Ministry of Agriculture and Water by preventing some farmers from drilling new wells at their farms. It is hoped that this will help stop the exhaustion of the Al-Kharj plain aquifers.

Desalination Projects

The initial result of the Second Five Year Plan (1975-1980) was an increase in the demand for water. During these years the construction of buildings and industrial plants rose, and a greater number of foreign laborers made way to the cities. There was also an increased demand for greater quantities of water for agricultural purposes. All of this led to a higher rate of water consumption. To supply these urgent needs for water, the Saudi Arabian government has undertaken a massive investigation of underground water resources. These studies have been carried out by international consultant firms, which have located many aquifers with large quantities of water. According to surveys that have been made, large volumes of groundwater were discovered in eleven major aquifers.

The majority of this water is stored in two major groundwater regions: the basement complex of the west and the sedimentary formations of the east. In the west, groundwater is tapped by shallow wells and settlements are usually concentrated around these wells. In this area the well water turns saline the nearer they are to the Red Sea

coast. In the east, however, the highest quality water is obtained from sandstone aquifers. The water level in these aquifers has been declining continuously because the natural discharge is greater than the recharge. Also, large quantities of water from these aquifers are lost by the process of seepage. The seepage of water from the Eocene aquifer system in the east, for example, evaporates at Sabkhahs, along the gulf coast.

To overcome the shortage of groundwater in the future, the government of Saudi Arabia established the first desalination plant in Jiddah in 1970. The project was undertaken by an agreement made in 1965 between the government of Saudi Arabia and the United States. In 1970, the first stage of the plant came into operation with a daily capacity of five million gallons of water. Four later stages of expansion were planned to increase the output to twenty million gallons of water a day, and 200,000 kilowatts of power by 1975. The expansion of the desalination plants is due to the increase in the population. For example, in 1974 Jiddah's population reached 561,104; though twenty years ago it was just 15,000. The desalination plant in Jiddah cost the government of Saudi Arabia $18 million.

Another major desalination plant is being constructed at Al-Khobar, on the Arabian Gulf, to supply the towns of the eastern province with potable water. This plant will produce as much as 7.5 million gallons of water per day

in its first stage, which will be followed by other stages to increase the capacity of the desalination plant.

In Riyadh, another plant is being established to distill the saline groundwater. There are a few other desalination plants distributed throughout the country, where there is need for them (see Table 4). These plants usually have a small production capacity, such as the plant that is planned for Al-Kharj, which will use brackish groundwater.

These plants are important in countries such as Saudi Arabia which have no surface water nor sufficient amounts of rainfall to supply their people. However, there is also fear that the groundwater resources will be extracted to a disturbing degree.

Energy in Saudi Arabia is relatively cheap because natural gas is available in huge quantities. The availability of relatively cheap energy has encouraged the government of Saudi Arabia to go ahead with its plan to build large-scale desalination plants close to the energy sources on the east and west coasts of Saudi Arabia (see Figure 2). During the period between 1975 and 1985, for example, Saudi Arabia is planning to invest a total of $7 billion on desalination projects.

Most of the water produced in these desalination plants, especially in Jiddah and Al-Khobar, will support the urban and industrial needs of the east and west coasts. As the largest desalination plants in the country, they

Table 4.--Total Capacity of Desalination Plants in Saudi Arabia.

PHASED PRODUCTION PROGRAMME OF DESALINATION PLANTS

WESTERN COAST

PROJECTS IMPLEMENTED AND UNDER IMPLEMENTATION

| projects | | water in million litres/day | power in megawatts | starting date |
|---|---|---|---|---|
| Jeddah | phase I | 22·727 | 50 | 1970 |
| | phase II | 45·455 | 100 | 1978 |
| Al Wajh | phase I | ·273 | | |
| | phase II | ·545 | | |
| Duba | phase I | ·273 | | 1969 |
| | phase II | ·545 | | 1976 |
| Umlj | phase I | ·545 | | 1969 |
| Haql | phase I | ·545 | | |
| total | | 70·903 | 150 | |

PROJECTS OF CURRENT FIVE YEAR PLAN

| | | | | |
|---|---|---|---|---|
| Jeddah | phase III | 90·909 | 200 | 1978 |
| | phase IV | 227·273 | 500 | 1979 |
| Medina/ | phase I | 90·909 | 200 | 1980 |
| Monawarah | phase II | | | |
| Yanbu | phase I | 22·727 | 50 | 1978 |
| Rabeq | phase I | 1·091 | | 1977 |
| Al Wajh | phase III | | 150 | 1980 |
| Duba | phase III | 22·727 | 50 | 1978 |
| | | | | 1979 |
| Umlj | phase II | 4·545 | 10 | 1978 |
| Haql | phase II | 6·818 | 15 | 1977 |
| Al Lith | phase I | ·682 | | 1977 |
| Al Qunfuda | phase I | undecided | | |
| Farasan | phase I | ·682 | 1·5 | 1977 |
| total planned | | 472·908 | 1176·5 | |
| grand total | | 543·546 | 1326·5 | |

EASTERN COAST

PROJECTS IMPLEMENTED AND UNDER IMPLEMENTATION

| | | | | |
|---|---|---|---|---|
| Al Khobar | phase I | 34·091 | | 1974 |
| Al Khafji | phase I | ·545 | | 1974 |
| total | | 34·636 | | |

PROJECTS OF CURRENT FIVE YEAR PLAN

| | | | | |
|---|---|---|---|---|
| Al Khobar | phase II | 443·235 | 400 | 1978 |
| Al Khafji | phase II | 22·727 | 50 | 1978 |
| Al Jubail | phase I | 136·364 | 300 | 1978 |
| | phase II & III | 772·727 | 1700 | 1979 |
| | | | | 1980 |
| | | | | 1981 |
| | | | | 1982 |
| Al Safania | | undecided | | |
| Al Uquar | | undecided | | |
| Kharj | | undecided | | |
| total planned | | 1375·053 | 2450 | |
| grand total | | 1409·689 | 2450 | |

Source: Mohammad Al-Faisal, "The Oil-Into-Water Miracle," The Geographical Magazine 49(2) (1977).

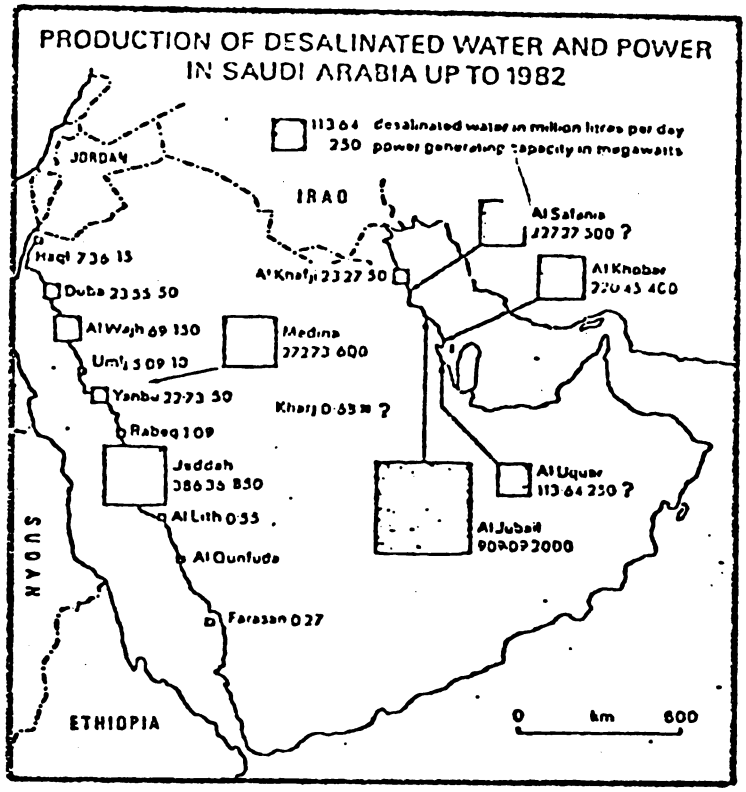



Figure 2.--Production of Desalinated Water and Power in Saudi Arabia Up to 1982.

Source: Mohammad Al-Faisal, "The Oil-Into-Water Miracle," The Geographical Magazine 49(2) (1976).

will expand continuously to meet the requirements of the Five Year Plan (1975-1980).

New water resources are being discovered, while other resources are being exploited rapidly. Agriculture consumes the most water in Saudi Arabia--about 50 percent of the total natural resources of water. The total area of irrigated land at present is about 149,282 hectares. The government is taking efforts to increase the irrigated area by 50,000 hectares, depending upon new water resources being discovered. The estimate is that the total water used for irrigation reached 1.85 billion cubic meters in 1970. The official estimate of the increase in the demand for water for irrigation during 1980 is around 2.5 billion cubic meters. In order to reduce the large amount of water being used in irrigation, some experimental stations have been established for animal husbandry, cultivation of forage crops, crop production, and the study of the water requirement of each.

There is hope also that water produced from the seas will be available for daily use in urbanized areas, while the groundwater resources will be devoted completely for purposes of irrigation.

## Evaluation of the Desalination Plant Projects in Saudi Arabia

Most scientists and experts who deal with the desalination of sea water as a solution to the world demand for a constant water supply agree that this process of

obtaining fresh water is too costly. Christiaan E. Gischler argues that "although desalted water is still relatively expensive, much has been done to make it cheaper by enlarging the plants, based on the principle of economics of scale, and by the integration of water production with power production."[48]

In Saudi Arabia most of the desalination plants are of dual purpose, for the production of distilled water and electric power. The availability of gas and oil makes Saudi Arabia suitable for the construction of desalination plants. These plants are located on the Red Sea coast in the west and on the Arabian Gulf in the east. In the west, fuel oil from the Jiddah refinery is used to run the plants, while on the east coast natural gas is used to generate the plants. Geographers have also considered the problem of the high cost of desalination plant construction. Peter Beaumont states that there are at least two obstacles facing desalination plants:

1. The life of a desalination plant is usually short. It can run between 15-25 years, and large amounts of capital are needed to replace damaged equipment.

2. There is a continuous need to establish new desalination plants due to the increasing rate of the demand for water.[49] Due to these problems, it is not yet economically feasible for most countries to build and maintain desalination plants. However, there is no indication that the government of Saudi Arabia will abandon desalination plants

as a way to obtain fresh water. This is because the increase in the population, the decrease of groundwater supplies and the lack of any more suitable solution make desalination plants the best choice, no matter what the economic drawbacks are.

The Saudi Arabian government is also planning the use of distilled water in agriculture during the next Five Year Plan (1990-1995). This notion of using desalinated water in agriculture is strongly opposed by Georg Borgstrom, who states that "the pumping up and out over the continents requires enormous energy amounts. Furthermore, little thought has been given to the salt mountains which would involve heavy disposal costs, to say nothing of the complications involved in keeping all this salt from finding its way to fields and groundwater resources."[50]

In 1975 the total estimated world production of desalinated water was $10^9$ gallons per day, or 44 $M^3$/sec. Of this amount, 2.5 percent was produced in the Arabian Peninsula. Saudi Arabia's total capacity to distill water will be almost 14 $M^3$/sec. in 1985.[51]

The growing demand for water will continue in Saudi Arabia because of its ambitious development plans to modernize the country, its increase in population number, and the continuous inflow of foreigners to the country. The building of new desalination plants will not definitely solve the problem if it is not accompanied by sufficient plans to conserve natural water in towns as well as in rural

areas. Many aquifers are dangerously drying up, mainly from overuse, and soon there will be insufficient groundwater both for domestic use and agricultural purposes. It is, therefore, important that the government of Saudi Arabia emphasize its regulations of water conservation, especially in the areas that have potential to sustain its agricultural production, depending mainly upon their groundwater resources, such as the case in Al-Kharj.

## Agricultural Resources

The economy of Saudi Arabia is, without a doubt, dominated by the oil industry. The capital that is earned from oil is available in huge quantities; but there are limited funds for investment in agriculture, due to the harsh physical environment of the country.

Agricultural activity takes place where sufficient amounts of water are available, whether groundwater or through rainfall. For this reason agriculture is predominantly in the scattered oases and dry stream beds throughout Saudi Arabia, where groundwater is obtained from springs and wells. The only area which has enough rainfall for irrigation is the southwestern portion of the country, particularly Asir and Jaizan. This area receives between 200 and 500 mm of rainfall annually, which is sufficient for farming. The central and eastern portions of the country only receive less than 100 mm of rainfall annually. The result is that agricultural activity in these portions of the

country is found only on the oases where agriculture depends mainly upon groundwater. The most important oases in these areas are Al-Qasim, Al-Kharj, Al-Qatif and Al-Hasa (see Figure 3). The total area of Saudi Arabia is 2,253,000 $km^2$. Of this, the total arable land which is actually under cultivation is 3,852 $km^2$, or .2 percent of the total land. Only 330 $km^2$ of this land has enough rainfall to maintain agriculture and the rest, 3,522 $km^2$, is irrigated by groundwater. It is estimated that the amount of land suitable for cultivation is ten times the amount of land currently under cultivation.[52] However, this would be the case provided there were sufficient supplies of water for irrigation.

During 1978, 61 percent of the Saudi Arabian population was engaged in farming, which declined from 1960 when the figure was 71.5 percent. The decline in the proportion of the active population engaged in agriculture is due to the rural-to-urban migration of the people. Many rural people have moved to the cities looking for work which is more stable and profitable than agriculture. This has created another problem for agriculture, being the lack of a labor force. This has resulted in the bringing in of workers from abroad. Due to governmental efforts, agricultural land increased about 60,000 acres in 1974 from 1969.[53] This increase resulted from increased assistance offered by the Saudi Arabian government to farmers through the agricultural bank.

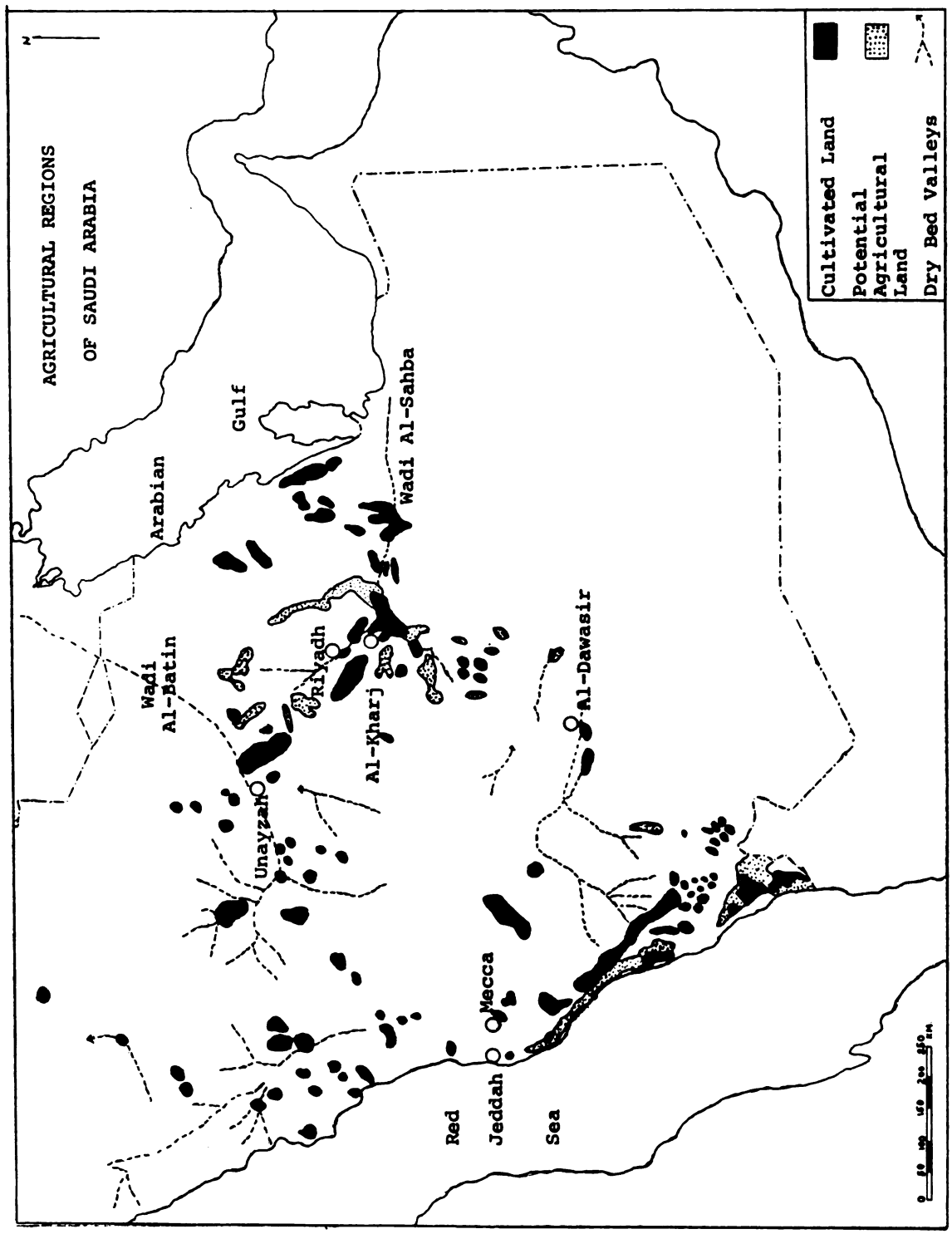



Figure 3.--Agricultural Regions of Saudi Arabia.

The Agricultural Credit Bank

To increase yields in agriculture and to encourage rural people to remain in their villages instead of migrating to the cities, the government established an agricultural bank in 1964. The purpose of this bank is to provide the Saudi Arabian farmers with fertilizers, seeds, machinery and consultations at reduced rates. It is hoped that this procedure will help the farmers to obtain what they need in order to increase their production. The increased demand by the farmers for the bank's loans resulted in an increase of the bank's yearly budget to meet these demands. The annual budget of the bank was around SR 1,038 million during the year of 1976-1977, while the capital was SR 1,438 million in 1977-1978, with an increase of SR 400 million. Eleven major banks are located in the main cities of Saudi Arabia, but most of the villages and oases obtain their services through sixty-three secondary branches distributed throughout the kingdom.

There are two types of loans the bank offers to the farmers. The first is the short-term loan, which represents about 18 percent of the total number of bank loans. The second is the medium-term loan, which is the main type of loan offered by the bank to cover its activities, representing 82 percent of the total number of bank loans. The importance of the medium-term loan is due to the nature of these loans, which are used to provide the requirements for agricultural projects. These loans have contributed to the

mechanization of agriculture and the extension of the cultivated area.

Jeddah's agricultural bank has the highest number of loans in the country. The total number of loans there is around 4,629, while the Al-Kharj agricultural bank ranked fifth with a total of 1,757 loans during the 1977-1978 year. The value of the loans, as indicated in Figure 4, offered by the Jeddah agricultural bank was the highest, totaling more than $33 million; while the Al-Kharj agricultural bank ranked second in terms of the value of loans, reaching about $29 million (see Figure 4).

Most of the short-term loans at Al-Kharj were granted to cover the wages of workers, which amounted to $653,376 during 1977-1978. This constituted about 88 percent of the total bank subsidies. Loans for the purchase of chamical fertilizers ranked second, contributing 19 percent of the bank subsidies.

Medium-term loans at the Al-Kharj branch ranked first because most large agricultural projects are concentrated within its service area. There are thirteen projects planned for Al-Kharj, and the bank is committed to finance these projects with loans totaling $12.6 million.[55]

Noticeably, the demand for animal feed, engines and agricultural machinery is nationwide by the Saudi Arabian farmers. This fact is shown in Figure 5, which indicates the subsidies granted by the bank during 1977-1978. Most of these loans were for animal feed, which amounted to about

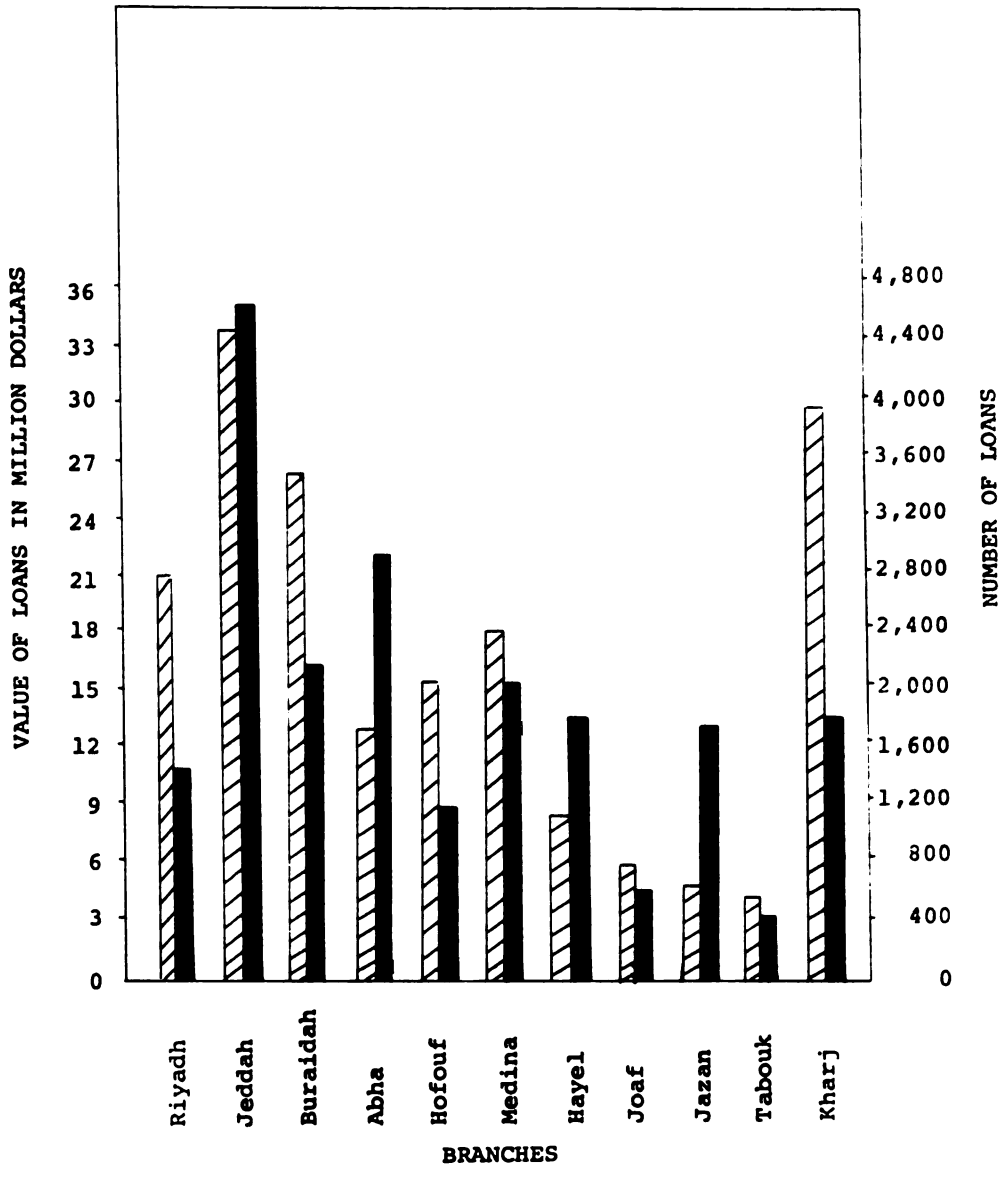



Figure 4.--Annual Credit Movement Distributed by Bank Branches During 1977/1978.

Source: Ministry of Agriculture and Water, Saudi Arabian Agricultural Bank, Annual Report, Riyadh, Saudi Arabia, 1978, p. 48. (Arabic)

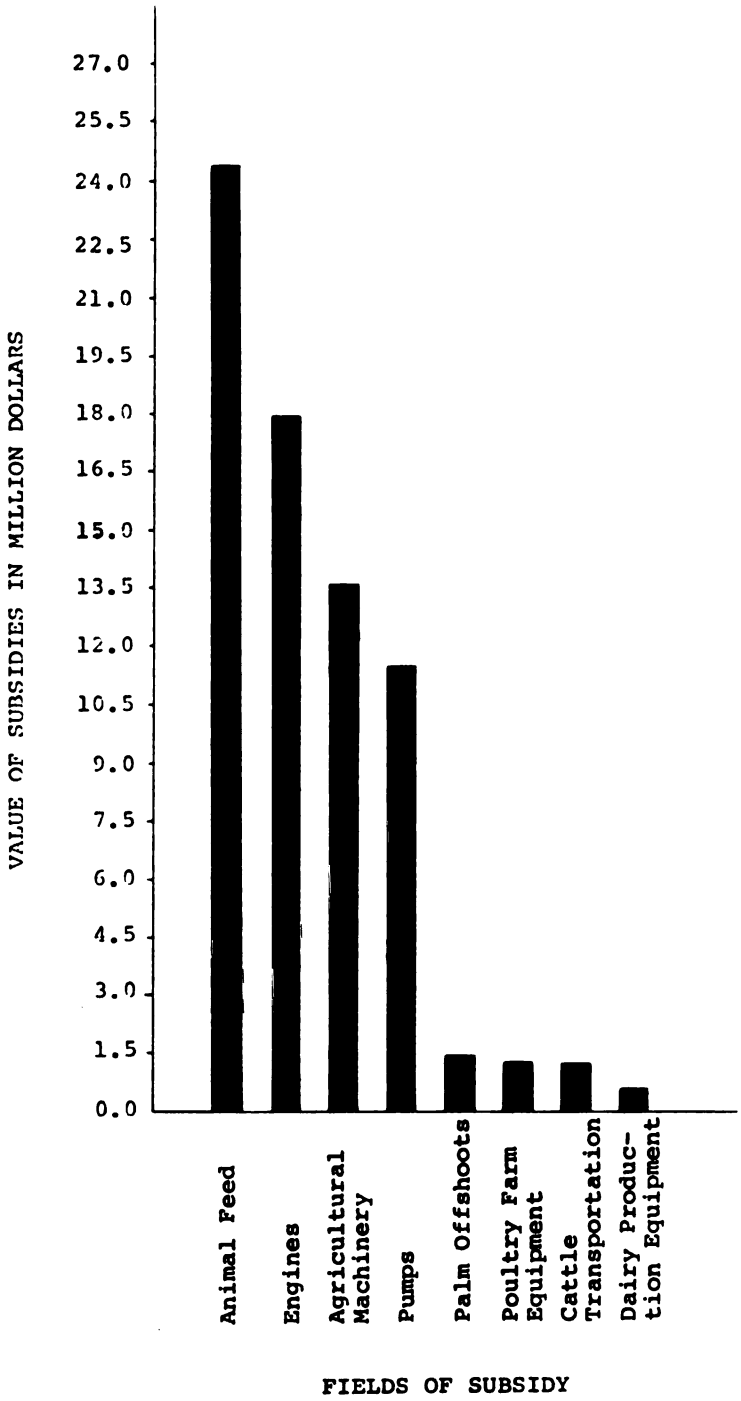



Figure 5.--Subsidies Extended During 1977/1978 Through the Agricultural Bank.

Source: Ministry of Agriculture and Water, Saudi Arabian Agricultural Bank, Annual Report, Riyadh, Saudi Arabia, 1978, p. 54. (Arabic)

$24 million. Subsidies for engines ranked second at about $18 million, and those for agricultural machinery were third (see Figure 5).

Farmers are not the only sector that the bank loans cover, as there are also other activities related to the production of food. Well planned agricultural activities such as poultry farms, dairy projects, animal fattening projects, agricultural marketing projects through cold storage, and other investment projects are mainly to encourage the establishment of agricultural projects to produce some types of food that are highly demanded by the people of Saudi Arabia.

## The Al-Hasa Irrigation and Drainage Project

This project is located around the Al-Hofuf oases in the eastern region, and is planned to serve fifty villages with adequate water supplies to support agricultural activity. Many villagers here had abandoned their farms due to the accumulation of salt in the soil, because of the ineffective drainage system, and the movement of sand dunes covering a large portion of these villages. In 1967 the government arranged a plan to safeguard the remaining 8,000 hectares of land for cultivation, and to stop the movement of sand dunes. Different methods were used to stop the movement of the sand dunes, and it was found that the most economical method was the planting of trees, which now cover an area of 645 hectares. In 1971 the project

was completed, including the building of 1,520 km of open concrete canals for the purpose of irrigation and drainage of the 8,000 hectares.[56] It is hoped that with such a project the cultivated land could be increased by 12,000 hectares. The water for this project is obtained from thirty-six wells located in the area. This area received the least amount of annual rainfall in Saudi Arabia, which is less than 2.6 inches. With high temperatures which reach 120°F during the summer, the estimated rate of water evaporation is very high, reaching more than 97 inches per year. This project will use about 235 $M.M.^3$ of water yearly.

The Qatif Oasis

In the Al-Qatif oasis on the eastern coast of Saudi Arabia a total of 10,000 acres of land are under cultivation, supporting approximately 50,000 people. The average farm size is two acres. About 90 percent of the total acreage is planted with date palms and 9 percent with alfalfa, because of their high resistance to saline water. The water of the Qatif oasis has a salt content of 700 to 3,500 parts per million. The excessive use of water for irrigation coupled with ineffective drainage has caused the land to become water-logged and salt has accumulated on the surface. Thus the land has become less productive and many farmers have abandoned their farms. In the Al-Qatif oasis the farmers who grow alfalfa consume large amounts of water. Due to the extensive heat of the eastern coast, the amount

of water required to irrigate alfalfa is even higher. It is estimated that one acre of land and 2,500 tons of water are required to produce three tons of alfalfa. This means that the 900 acres planted with alfalfa at the Al-Qatif oasis require a total of 2,250,000 tons of water to produce about 2,700 tons of alfalfa. This amount of water being used is very large, being equivalent to 22 inches of rainfall.[57]

The government has built an irrigation-drainage project to reclaim 7,000 hectares of land, including the establishment of an agricultural experiment and training center, which was completed in 1966. It is hoped that this project will improve the cultivated land of the oasis, and eventually this will encourage the farmers to remain on their farms.

## The Al-Kharj Agricultural Project

Historical Background.--The first attempt to develop agriculture was during 1937, when the Saudi Arabian government made an agreement with the American Oil Company (Aramco) to help establish an experimental agricultural project at Al-Kharj. In 1941 the first power-driven farm machinery was used at Al-Kharj. These machines consisted of six tractors purchased by Saudi Arabia through Aramco.[58] In 1942 the United States sent an agricultural mission to visit the site of the Al-Kharj agricultural project. Aramco supplied

this mission with engineers and geologists to help conduct the necessary research of water and soil, and to conduct land surveys. This assistance was the first stage of American participation in the development of Al-Kharj. One major effort was the construction of irrigation canals and the installation of new pumps on huge water pits. Ain Al-Samha and Ain Dhila pits were the major water sources of the farm. These two pits are 400 feet deep and about 300 feet in diameter. They are connected underground, so when pumps are installed to lift the water to the farmland, the water level of both lowers fourteen to fifteen feet.

The Al-Kharj agricultural project is connected by a series of canals, the main one being built in 1943. At the far end of the main canal from Ain Dhila, from which most of the water is taken, is Bijidiah farm. Bijidiah's great distance from the well results in a great deal of water evaporation and seepage en route, and it is the farthest area which can be used at this time for irrigation.

The seven major farms in the project were as follows:

Sha'aba farm -- 150 acres of dates, wheat and vegetables.

Palestine farm -- 65 acres most of dates.

Heish farm -- 250 acres of wheat and dates.

Musri farm -- 475 acres of wheat, dates and nine varieties of truck crops.

Baksheesh farm -- This farm is provided by the government for cultivation by any local inhabitants who are capable of farming it.

Bijidiah farm -- 785 acres of alfalfa, wheat and vegetables.

Another farm was located at Khafs Daghra, which was added to the project around 1945 and has been primarily supervised by Americans. It is irrigated by a pit delivering less water, and has thus been planted primarily with sixty acres of wheat and 200 of other crops.[59]

A great variety of crops were grown at these farms due to the experimental nature of this project. However, the project faced quite a few obstacles. One such problem was the increasing salt content of the soil due to the high alkali content of the water used in irrigation. This problem has caused a good deal of the land at the project to be abandoned, or to be planted with date palms. Another obstacle faced by the project was the capital investment, which exceeded its profits for many years. K. S. Twitchell stated that ". . . crop production reached the goal in 1951 when the cash value of the harvest exceeded the cost of operation. For many years the reverse was true."[60] The most critical year for the project was in 1946, when the American supervisors left Al-Kharj. Consultation was continued by the Americans until 1960, but the lack of qualified management was the major factor which led to the gradual deterioration of the project. This agricultural project

at Al-Kharj could be considered successful only if knowledge was gained about how to maintain an agricultural project. However, not only was the agriculture itself unsuccessful, but little was learned through the project. William Seifert has stated that if any knowledge was gained from this farm, it has not ". . . filtered down to the small Saudi farmers. More effort must be concentrated in the area of training the small farmer to use the new methods that are available to him."[61]

Current Status of the Project.--The total size of this farm is currently 2,500 acres, located at Al-Shaba wadi, east of Al-Kharj town. Of this amount, only 1,000 acres of land are in condition for farming at this time; and this is the case only if adequate supplies of water for irrigation are made available. The 1,500 acres which are not ready for farming are covered with a layer of windblown sand. The land currently suitable for farming is divided into parcels. Each parcel contains 12.5 acres, which are cultivated primarily with forage for the purpose of feeding cattle, or with wheat, barley and maize. The soil at the agricultural project differs from one location to another, but the texture of the soil found at the agricultural research station which occupies a portion of the land of the project has been classified according to physical characteristics into three types: sand, which represents 80

percent of the soil content; silt, being 6 percent; and 14 percent of the soil is clay.

The main water source of this farm is Ain Dhila, which is located 15 km from the farm. This water is transported to the farm by open canal. An analysis of water from Ain Dhila indicates that the water contains a high rate of dissolved solids, especially calcium and sodium. The analysis of water from wells and springs used at the agricultural research station showed total dissolved solids ranging between 1,886 and 5,778 parts per million in five test wells and in Ain Dhila.[62]

This farm was owned by the Ministry of Finance and National Economy since the establishment of this project in 1937. But in 1977 the possession of this project was transferred and it was placed under the authority of the Ministry of Agriculture and Water. Since then many suggestions have been made to reorganize the farm, but only a few were applied. One of those suggestions was to replace the open can which transfers water for irrigation from Ain Dhila with new underground plastic pipes, to prevent the loss of water by evaporation. Relative to farm animals, it has been noted that there are 250 head of cattle, but the large number of oxen and dry cows results in only forty-five which produce milk. It has thus been suggested that the number of oxen be decreased to the required amount of one per fifty cows, and that the dry cows be replaced. Additionally, since Aramco's departure, all the farm equipment has

gradually deteriorated because of the lack of proper maintenance. In order to enhance the productivity of this farm, the administrators have transferred some agricultural equipment here from the Haradh project. Currently, however, all the equipment at this farm must be replaced, and more effective management is also needed. The poor drainage system, the accumulation of salt, the great degree of water loss by evaporation, and poor management are familiar problems which seem to dominate Saudi Arabian agriculture in most of these agricultural projects.

Animal Husbandry

Large numbers of livestock in Saudi Arabia, particularly sheep, camels and goats, are still fed by grazing. Grazing is a common occupation of bedouin throughout the country, even though some livestock are fed with fodder grown at agricultural projects, such as Al-Kharj. The tradition of grazing has been practiced by Saudi tribesmen for centuries, but in recent years it has faced critical problems. Many of these problems are due to particular characteristics of the Middle-East and other arid and semi-arid regions throughout the world. Three particular problems are as follows:

1. The limited amount of grazing land available, due to overgrazing by large numbers of herds in the past;
2. Damage to grazing land by droughts; and

3. The removal of the plants upon which animals graze by bedouin, who use the plants, including their roots, as a fuel source.

In the western part of the country, however, a system has been developed for grazing. It is referred to as the "Ahmia" system and is practiced by tribesmen in the area. This system calls for limited grazing in the Ahmia area, and according to Marion Clawson, a degree of range conservation was undoubtedly practiced. The system was successful; however, in 1953 it was decided that this land should be distributed to its users on a first-come, first-serve basis. However, overgrazing quickly resulted, and soon reduced the condition of this formerly protected land to that of the land of other areas which had never had restricted use.[63]

In an effort to control the bedouin, the Saudi Arabian government successfully unified the tribes of the country. Later a program was conducted to settle the bedouin, in hopes that they would then be able to participate in the development of the country. This settlement program, however, resulted in an increase in animals, especially near water sources. The increased number of animals on the local grazing land resulted in accelerated damage to the land. Current estimates of the livestock populations are as follows:

| | |
|---|---|
| sheep | 2,800,000 |
| goats | 1,400,000 |

| | |
|---|---|
| camels | 600,000 |
| cattle | 270,000 |

Goats are extremely destructive of natural vegetation. The high number of goats, therefore, alarmed F.A.O. experts; and they suggested that the Ministry of Agriculture and Water take steps to control the problem. A major suggestion was that the government encourage the bedouin to replace their goats with sheep, and that the government provide them with high quality sheep at reduced prices for this purpose. Camels are also excessively destructive to natural vegetation and less productive, so it was suggested that they too be replaced with sheep, with governmental assistance.[64]

Approximately 40 percent of the land in Saudi Arabia is used for grazing by bedouin. Of this amount only about 5 percent of the land is considered excellent for grazing, the most ranging from good to poor in quality. From 1955 to 1963, however, a severe drought in Saudi Arabia resulted in a 90 percent loss of livestock, especially in the dry areas in the north and east, which receive less than three inches of rainfall annually. For example, the total number of livestock at Al-Qatif and Al-Hasa prior to the drought was 430,000. The drought resulted in a decrease of 88 percent of the livestock, leaving only 49,337 surviving animals.[65] In the western region a higher number of animals survived, largely due to the fact that this area receives more than eight inches of rainfall annually.

Desertification is also expanding in arid and semi-arid regions, due to overgrazing, as is the case in parts of Iraq and Syria. It is a mistaken belief of most bedouin that there is no limit to the natural resources which support them and their animals. In order to protect the environment of Saudi Arabia strict laws must be adopted and enforced which will prevent the destruction of the country's natural resources through misuse.

In Saudi Arabia dairy projects are limited to four areas, which are Al-Kharj, Riyadh, Jeddah and Medinah. The government has supported these projects by offering loans totaling $13.2 million during 1978.

At Al-Kharj the production of milk takes place predominantly in four areas, three of which are privately owned businesses and the fourth being part of the Al-Kharj agricultural project owned by the government. The breeds of cattle at these areas are mostly Friesian and Jersey, with a total number estimated in an unpublished report at around 1,652. These four farms produce about 4,927,632 kg of milk per year, which is consumed in Riyadh. The local farmers at Al-Kharj consume milk produced at their own farms.

By way of Table 5 we can determine the correlation between the size of a farm and the numbers of their live-stock. The number of cattle increases directly with the size of the farm. The range is very small, being between 1.7 and 6.4 cows per farm. The situation relative to

Table 5.--Livestock by Size of Holding in Saudi Arabia, 1971-1974.

| Size of Holding (ha) | Number Per Holding | | | |
|---|---|---|---|---|
| | Cattle | Sheep | Goats | Poultry |
| <0.1 | 1.7 | 13.0 | 16.8 | 10.2 |
| 0.1 - <0.2 | 2.0 | 14.7 | 15.3 | 11.3 |
| 0.2 - <0.5 | 2.2 | 17.2 | 15.6 | 13.4 |
| 0.5 - <1 | 2.6 | 19.3 | 16.5 | 12.7 |
| 1 - <2 | 2.5 | 19.7 | 17.0 | 13.2 |
| 2 - <3 | 3.0 | 17.9 | 15.9 | 13.2 |
| 3 - <4 | 3.1 | 22.8 | 18.2 | 21.0 |
| 4 - <5 | 3.2 | 19.8 | 15.4 | 15.5 |
| 5 - <10 | 4.1 | 24.2 | 17.5 | 17.6 |
| 10 - <20 | 4.7 | 27.7 | 18.1 | 18.9 |
| 20 - <50 | 4.9 | 31.3 | 17.5 | 21.4 |
| 50 - <100 | 5.3 | 48.7 | 17.0 | 22.1 |
| ≥100 | 6.4 | 131.5 | 16.6 | 23.9 |
| All Holdings | 3.0 | 22.4 | 16.7 | 15.3 |

Source: Nasir Ahmed Khan, Patterns of Agricultural Development in Arab Countries (Kuwait: The Arab Planning Institute, 1979), p. 187.

poultry is similar in that the number increases with the size of the farm, is between 10.2 and 23.9 per farm. The number of sheep also increases with the size of the farm, between 12.0 and 131.5 sheep per farm, with two slight variations in the medium-size farms. There is not such a clear cut relationship relative to the size of a farm and the number of its goats. However, the number of goats per farm is fairly constant, with the middle size farms often having as many as two more goats than both the large and small farms.

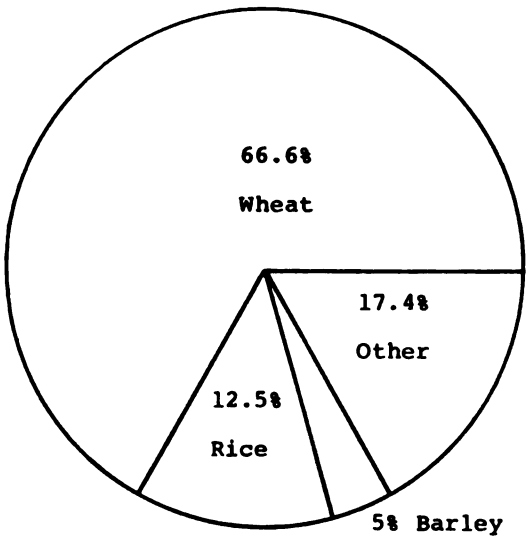
Saudi Arabian Imports

Saudi Arabia has a very high number of imports, as most of the needs of the country come from abroad. The value of total imports to Saudi Arabia in 1975 was SR 14.8 billion, and in 1976 imports increased over 100 percent, reaching SR 30.6 billion. Imports continued to increase in 1977, though at a slower rate of about 68 percent. The majority of the items imported consist of mechanical and electrical appliances and parts, but large quantities of food are also brought in from abroad. Most processed food and wheat-flour are imported from the United States, which is the major country from which Saudi Arabia receives its imports, providing about 19 percent of the total Saudi imports.[66]

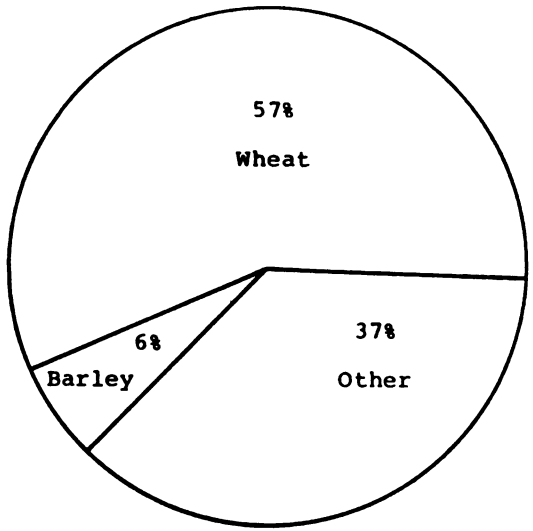
According to estimates made by F.A.O. during 1977, cereals imported by Saudi Arabia constitute about 79

percent of the total cereals used in the country. Of these imports, 66.6 percent is wheat, with the remaining 33.4 percent consisting of rice, barley, oats and all other cereals. Cereals produced in Saudi Arabia furnish 21 percent of the country's needs, 57 percent of which is wheat. This clearly indicates that most of the cereal consumed in the country is wheat, being the majority of the food imported as well as the main cereal produced in the country (see Figure 6).

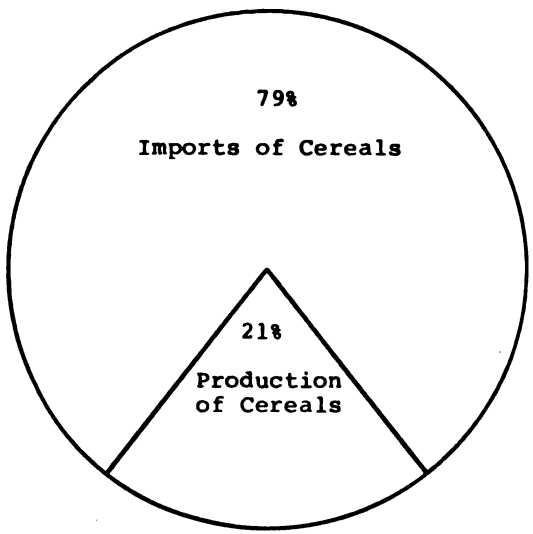
In 1962-1964 Saudi Arabia was self-sufficient only in its production of meat and of fish, as indicated in Table 6. Since then the country has produced less than the required amounts of all six items on this table, and estimates indicate the same will hold true in 1985. This low production ratio is largely due to an increasing demand for these items by an increasing population. Vegetables and fruit are the only commodities listed which show any signs of being able to deal to any degree with the increasing demand. Vegetables are most likely the most profitable of these commodities, and thus increasing numbers of farmers grow vegetables than in the past. This makes the probability that vegetables will be produced to a degree that most nearly approaches the market demand very high. The 1985 estimate of fruit production is less founded, though, and may not reach such a high self-sufficiency ratio.




IMPORTS OF CEREALS
DURING 1977




PRODUCTION OF CEREALS
DURING 1977




IMPORTS INTO PRODUCTION OF CEREALS IN
SAUDI ARABIA DURING 1977

Source: F.A.O., Production Yearbook 32 (1977); and Trade Yearbook 31 (1977) (Rome: The U.N. Publications.

Figure 6.--Imports Into Production of Cereal in Saudi Arabia During 1977.

Table 6.--Internal Production/Import Commodity Ratio (in thousand metric tons).

| | Wheat | Meat (beef, lamb & poultry) | Fish | Milk | Fruit | Vegetables |
|---|---|---|---|---|---|---|
| 1962-64: | | | | | | |
| Production | 142 | 27 | 20 | 114 | 451 | 171 |
| Demand | 293 | 27 | 20 | 122 | 486 | 197 |
| Gap | 151 | -- | -- | 8 | 35 | 26 |
| S.S.R. (%) | 48.5 | 100 | 100 | 93.4 | 92.8 | 86.6 |
| 1972-74: | | | | | | |
| Production | 73 | 23 | 31 | 155 | 526 | 271 |
| Demand | 440 | 61 | 36 | 323 | 661 | 335 |
| Gap | 367 | 38 | 5 | 168 | 135 | 64 |
| S.S.R. (%) | 16.6 | 37.7 | 86.1 | 48.0 | 79.6 | 80.9 |
| 1980 (Basic): | | | | | | |
| Production | 260 | 71 | 43 | 248 | 775 | 516 |
| Demand | 758 | 223 | 64 | 721 | 1,003 | 616 |
| Gap | 498 | 152 | 21 | 473 | 228 | 100 |
| S.S.R. (%) | 36.3 | 31.8 | 67.2 | 34.4 | 77.3 | 83.8 |

Table 6.--Continued.

| | Wheat | Meat (beef, lamb & poultry) | Fish | Milk | Fruit | Vegetables |
|---|---|---|---|---|---|---|
| 1985 (Supply): | | | | | | |
| Production | 250 | 83 | 35 | 275 | 871 | 580 |
| Demand | 727 | 273 | 72 | 836 | 1,040 | 695 |
| Gap | 477 | 190 | 37 | 561 | 169 | 115 |
| S.S.R. (%) | 34.4 | 30.4 | 48.6 | 32.9 | 83.8 | 83.5 |

S.S.R.: Self-sufficiency ratio.

Source: Compiled from various tables. Nasir Ahmed Khan, Patterns of Agricultural Development in Arab Countries (Kuwait: The Arab Planning Institute, 1979), pp. 59-64.

## Climate and Soil of Al-Kharj

### Climactic Characteristics at Al-Kharj

The estimated area of Saudi Arabia is 2,253,000 $km^2$, making it the largest country in the Middle East. It is divided into seven zones according to topography, but there are four main topographical zones that are the most important.

In the western coastal plain and mountain zone along the Red Sea, the height of some mountains reaches 9,000 feet.[67] In this region, and especially in the southwest, there is the highest rate of rainfall. For example, in the Asir region the rainfall reaches twenty inches (500 mm) as an annual average.

The central plateau is the second zone, containing the Al-Nafud and Al-Dahna deserts. The most important phenomena of the central plain is Jabal Tuwayq (Tuwayq Mountain), which is a broad plateau about 300 miles wide and 4,500 feet high. Cities such as Riyadh and oases such as Unayzah and Al-Kharj are located in this zone, which has an average annual rainfall of three inches (less than 100 mm). The oases of this region produce fruits, alfalfa and other vegetables, and are dependent upon artesian wells.

Third is the eastern Arabian Gulf plain, which is a low relief, with salt and mud flats, and sufficient groundwater to support the agriculture in the Al-Hasa and Al-Qatif oases.

The fourth and last major zone is the southern desert of Rab Al-Khali (The Empty Quarter), which stretches from the inner margins of the Yemen highlands to the mountain chains of Oman.[68] Almost no humans, animals or plants exist in this vast area of 250,000 square miles, with an exception of the edge of the desert, where the Al-Murrah tribe still roams.

The summer in Saudi Arabia in general is very long and hot, lasting more than six months out of the year. During this season high temperatures reach 120°F, and this causes a high rate of water evaporation. Winter temperatures may drop as low as 30°F, especially in the upland area of Asir, in the southwestern portion of the country and in some inner portions of the country as well.

The recording of weather data in Saudi Arabia is a recent phenomena, and accordingly there has not been a long period in which to establish accurate statistics about the weather conditions. The earliest recording of weather data in Saudi Arabia was during the fifties. In some areas, such as Al-Kharj, records began even later than that. The first weather data recorded for Al-Kharj is that collected by Sogreah in 1966, and also by the agricultural experimental station at Al-Kharj, which was established during the sixties. However, Glen Francis Brown, in 1949, described the climate of the Al-Kharj region as follows:

> Al-Kharj district lies within one of the largest low-latitude deserts. Rainfall is meager, perhaps on the order of 100 millimeters (4 inches) annually. Rains

> are mostly of the desert torrential type and are usually concentrated during the winter and spring months from December to May. . . . Daily maximum recorded temperatures approach 120°F during the summer months and daily minima approach freezing at night in the winter months. Temperature range averaged about 35°C. The lowest relative humidity was about five percent.[69]

It appears that the weather records for Al-Kharj have indicated approximately the same temperatures for at least thirty years, especially when we compare this weather description to the weather data that has been obtained for the area between 1966 and 1977.

In Table 7 the Al-Kharj area appears to be an extremely arid region. Summer temperatures reach 40°C to 45°C between May and October. The same table shows the small amount of rainfall that the region received from July, 1977, to June, 1978, being less than one inch, or approximately 10.5 mm. However, Al-Kharj region groundwater resources do not depend on its own area's rainfall to replenish these aquifers, but rather on the rainfall of the entire area to the east of Jabal Tuwayq (Tuwayq Mountains).

There is a rare risk of frost during the winter season in the Al-Kharj region from December to February. The temperature can drop as low as -6°C, as occurred in February of 1967. Frost usually results in a considerable amount of damage to many kinds of crops, especially any plants of the cucumber family which are sown at the beginning of January.[70]

Table 7.--Average Weather Reading at Al-Kharj Station Between July, 1977 and June, 1978.

| Month | Average Mean Temperature (°C) | | Average Relative Humidity (%) | | Evaporation | Monthly Rainfall |
|---|---|---|---|---|---|---|
| | Mean of Max. | Mean of Min. | Max. | Min. | mm | mm |
| 1977 | | | | | | |
| July | 43.83 | 22.65 | 16.55 | 8.31 | 16.92 | - |
| August | 44.59 | 22.78 | 20.18 | 11.00 | 14.80 | - |
| September | 41.69 | 19.22 | 23.03 | 11.13 | 13.10 | - |
| October | 34.78 | 16.08 | 43.59 | 21.72 | 8.62 | 10.40 |
| November | 26.04 | 10.33 | 59.83 | 26.06 | 5.91 | - |
| December | 23.68 | 7.46 | 62.76 | 28.08 | 4.49 | - |
| 1978 | | | | | | |
| January | 20.42 | 3.74 | 61.61 | 25.97 | 4.54 | - |
| February | 23.96 | 5.76 | 61.59 | 24.00 | 6.43 | 10.50 |
| March | 29.73 | 11.16 | 46.27 | 18.00 | 9.40 | 0.30 |
| April | 35.95 | 19.87 | 42.88 | 17.22 | 11.08 | 6.80 |
| May | 40.92 | 20.17 | 41.43 | 12.43 | 13.38 | 9.50 |
| June | 42.42 | 21.42 | 18.48 | 10.10 | 16.42 | - |

Source: Ministry of Agriculture and Water, Agricultural Research and Development, Annual Report, Riyadh, Saudi Arabia, 1978, p. 5. (Arabic)

The monthly humidity data for Al-Kharj (see Table 8) indicates the extremely arid climate. This results in a high degree of evaporation.

Al-Kharj's potential evapotranspiration was estimated by Sogreah Company by the use of the Turc and Blaney-Criddle formulae. The results of the Turc formula have shown that the annual potential evapotranspiration reaches a maximum of 2,405 mm. This result was compared with Colorado tank measurements, and it has been seen that the Turc measured data are more likely acceptable, considering the extreme nature of the Al-Kharj climate. Also, Sogreah has adopted the Turc estimates because this method has been tested over a wider range of climate conditions than the Blaney-Criddle method, which estimates the annual potential evapotranspiration of Al-Kharj to be around 1,964 mm. The latter estimate was not adopted because data for summer months differ excessively from the measured data by the Turc formula.[71]

Wind direction and speed have an important effect upon farming in the Al-Kharj region, due to the fact that the crops need some form of protection against the mechanical and drying effects of the wind and wind erosion. "Experience in the U.S.S.R., the U.S., and Mexico has, however, demonstrated that the most effective wind erosion control measures are windbreaks and crop cultivation in strips rotating with grassland."[72] But many farmers in Al-Kharj do not understand or ignore the importance of

Table 8.--Monthly Humidity Data for Al-Kharj.

| | 1966 | | | | | | | | 1967 | | | | Mean May-April |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | March | April | |
| Mean Maximum | 30.3 | 33.3 | 28.7 | 26.7 | 29.9 | 32.9 | 63.7 | 72.4 | 30.0 | 85.7 | 65.0 | 52.8 | 50.1 |
| Mean Minimum | 12.0 | 15.8 | 12.5 | 10.0 | 10.1 | 16.7 | 25.3 | 24.0 | 33.0 | 23.7 | 26.0 | 19.7 | 19.1 |
| Mean | 21.1 | 24.1 | 20.0 | 18.4 | 20.0 | 34.6 | 44.5 | 48.6 | 56.5 | 44.7 | 45.5 | 36.1 | 34.6 |

Source: Compiled from Sogreah, Water and Agriculture Development Studies, Area V, Feasibility Report, Ministry of Agriculture and Water, Riyadh, Saudi Arabia, 1968.

planting trees around their farms as windbreaks to control soil blowing, reduce the drying effects of the wind on soil and plants, and strong wind velocities, especially in sandy soil such as at Al-Kharj. Other farms in the area plant types of trees that require small amounts of water, called tamarisks. These trees are able to survive in an extremely arid region, depending mostly upon seasonal rainfall. Also, this method has been proven to be economically feasible and is recommended.

Terrain and Soil

The land of Al-Kharj contains various complex substances of sand and pebble alluvial fans, with fine wadi (valley) alluvium and accumulated windborne sand locally forming active dunes. The Sogreah soil survey indicated that the surface of the alluvial fans is slightly wavy and slopes in towards the present flow route to the east. The survey also shows that wind erosion has affected the finer soil constituents, leaving gravel and rolled pebbles behind. Vegetation on this land is sparse. The wadi deposits are, to a varying extent, heterogeneous in texture, ranging from loamy to loam. Textures generally tend to be finer in the eastern part of the Al-Kharj plain. Much of this land is generally very flat and under cultivation. The plain has a thin upper layer of windborne sand not suitable for cultivation because it lacks organic matter. In preparation for cultivation, this upper layer of sand must be mixed

mechanically with the organic soil beneath it. The presence of gypsum crust in the southeastern plain of Al-Kharj indicates poor drainage in this area in the past.

There is no available data concerning the type of soil in the Al-Kharj area except the survey conducted by Sogreah, which covered 880 hectares of land and tested 139 soil samples from the government agricultural farm of Al-Kharj. The analysis of this soil indicates that they are loamy in the deep layers and sandy loam to sand in the upper layers. Some natural drainage occurs because of the permeability of the alluvial layer, which consists of silt, sand and gravel. The clay to silt ratio in the soil is low, but this could be corrected with the introduction of organic matter to the soil. The average moisture content in the loam to sandy loam soil is 125 mm, but the average is less in the sandy loam to sand, at around 45 mm.[73]

## Population

The total population of Saudi Arabia is still uncertain, even with the information obtained through the 1974 official census. In 1976 the government of Saudi Arabia indicated the population to be 7,012,642 according to the 1974 census. Richard T. Nyrop, in the Area Handbook for Saudi Arabia, indicated that many foreign observers consider the Saudi figure too high. The reason for the doubts as to the accuracy of this figure is the fact that

the wide geographical mobility of the nomads complicates the taking of an accurate census.[74]

There have been a number of additional estimates made by companies (i.e., Aramco), international authorities (i.e., United Nations), and private observers. The United Nations estimate in 1974 was even higher than the Saudi figure at 8.71 million, and 9.52 million in 1977.[75] But the United Nations estimate seems far too high, especially considering estimates by other sources which range as low as 4.1 million for the years 1971-1972.[76]

The number of the Saudi Arabian population is not agreed upon by many observers, and there are also differing population estimates for Al-Kharj. The total population of this area, according to the 1974 census, is 73,820. This figure includes Al-Kharj town, its surrounding villages, and the nomads in the area. The same census showed that the population of Al-Kharj town is only 28,465, of which 6,170 persons are engaged in agriculture and the rest occupied by other types of civil service jobs.[77] Population data obtained through a census conducted by the Ministry of Agriculture and Water during 1974 shows different figures for the farmers of Al-Kharj. The agricultural census revealed that there are 16,406 people who make their livings through agriculture at Al-Kharj, of which 10,150 persons work as farmers at Al-Kharj, and the remaining 6,256 are farmers at the emirate of Al-Dilam.[78] In the population census of Area V, the total number of persons

who are living in the villages of Al-Kharj, including Al-Dilam, is 17,364. This differs from the figure obtained by the Ministry of Agriculture and Water.

However, many people who depend upon agriculture for their living do not live on their farms. Most of them seek a better living in the cities, while renting their farms to others. This phenomena is widespread not only at Al-Kharj, but also throughout all rural areas in Saudi Arabia.

The total number of farmers at the Al-Kharj emirate, according to the census of the Ministry of Agriculture and Water, is 8,267. The following table shows the classification of farmers at Al-Kharj according to the official census of 1974. As this table shows, there are only 6,170 persons who engaged in agricultural activities in the area.

This table indicates that large numbers of farmers are manual laborers, as 3,589 or 58 percent of the total number of farmers are classified as laborers. Only 766 persons, or 12 percent of the farmers, work in the field of animal husbandry and poultry. Additionally, only 3 percent of the total number of people engaged in agriculture in the Al-Kharj area are women. Of these women, 85 percent work in animal husbandry and poultry. This indicates that a very small number of women participate in the labor force of this area.

Table 9.--Classification of Farmers at Al-Kharj, Saudi Arabia.

| Classification of Farmers | Male | Female | Total |
|---|---|---|---|
| Farm managers | 4 | - | 4 |
| General farmers | 587 | - | 587 |
| Plant and fruit farmers | 1,039 | 3 | 1,042 |
| Animal husbandry and poultry | 758 | 8 | 766 |
| Nonspecialized laborers | 920 | 11 | 931 |
| Plant and fruit laborers | 1,490 | 5 | 1,495 |
| Animal husbandry and poultry laborers | 1,039 | 150 | 1,189 |
| Other agricultural laborers | 140 | - | 140 |
| Tree cutters | 7 | - | 7 |
| Hunters | 9 | - | 9 |
| Total | 5,993 | 177 | 6,170 |

Source: Compiled from figures taken from Ministry of Finance and National Economy, Central Department of Statistics, Population Census of Area Five, Riyadh, Saudi Arabia, 1974, p. 245.

Recently, the most serious problem facing the development process in Saudi Arabia is the shortage of skilled manpower. There is a definite lack of well-trained people to handle jobs. A recent survey indicated that many governmental agencies have created training departments within their administrative structures. The Ministry of Agriculture and Water, due to the lack of skilled people, has created its own training department, which has the following goals:

1. Training in farm machinery and irrigation: This program is planned with the cooperation of the United Nations.
2. Agricultural training plan: The purpose of this program is to provide training for employees in the different agricultural areas.
3. Farmer training plan: This program is probably the most important for Saudi Arabia because it allows many farmers and their children to become familiar with the agricultural problems that they face and helps them to solve these problems.[79]

These programs are necessary to replace foreign technicians and to reduce the dependency upon foreign workers. However, it is not possible, at least currently, to depend upon the Saudi labor force because half of the citizens of Saudi Arabia are not productive, due to the fact that this group consists primarily of consumers rather than producers. Other factors, such as the fact that the role of women in

society in Saudi Arabia is still very small, increase the demand for foreign workers, especially since the implementation of the five year plans (1970-1980).

It is estimated that about 45 percent of the labor force in Saudi Arabia is non-Saudi.[80] Saudi Arabia has the natural resources and the capital for the development of the country, but it severely lacks the manpower which is necessary to utilize the money and resources.

# CHAPTER IV

# QUESTIONNAIRE ANALYSIS

## Introduction

Al-Kharj is an oasis located 55 miles southeast of Riyadh. This oasis is situated on the plateau of Nejd, 1,360 feet above sea level. It is connected to the capital city by a paved highway and a railroad. One of the largest and most important characteristics of central Nejd is Tuwaiq Mountain, which is located 150 to 200 miles west of Al-Kharj.

The Al-Kharj oasis is comprises of 24 villages along wadi Al-Kharj. Wadi Hanifa stretches from northwest of Al-Kharj and joins wadi Al-Sahba, which stretches east of Al-Kharj town to the southeast portion of the eastern province of Saudi Arabia (see Figure 7). Due to the infrequent and undependable rainfall, irrigation is a dominant system for the Al-Kharj area. Wells are sunk to over 300 meters below the surface in order to reach the deep water after exploitation of the shallow aquifers. Another source of water are pits, which are formed by the solution of anhydrite and the collapse of overlying limestone, exposing the groundwater. There are four pits in the Al-Kharj area. Three of these pits, Ain-Dhila, Ain-Semha, and Ain-Umm

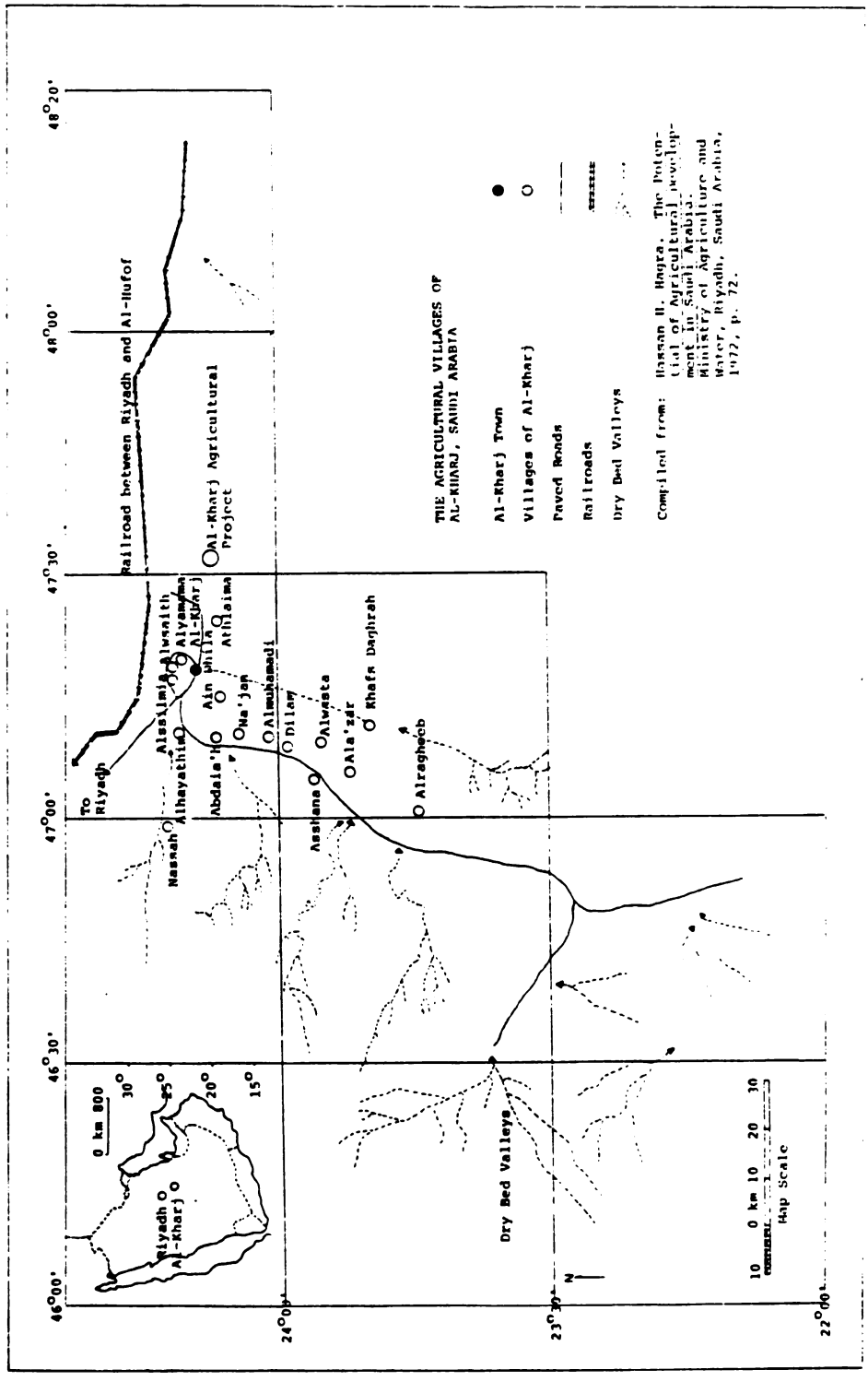



Figure 7.--The Agricultural Villages of Al-Kharj.

Khisa, are located west of Al-Kharj town; while the fourth, Khafs-Daghra, is located southeast of Al-Dilam district. Excessive use of the water in these pits has resulted in a lowering of the water level, leaving only the Ain-Dhila pit as the major water source for agriculture.

The soil texture of wadi Al-Kharj varies between tight colloidal clay to sandy loam. This soil becomes unsuitable for cultivation as soon as the alkali content increases. In this case, an effective drainage system is necessary, because the concentration of calcium sulphate, which tends to make the soil useless for farming, is increasing.

The total land in Al-Kharj district, excluding Al-Dilam, is estimated to be 81,301.25 acres, of which only 58,107.75 acres are suitable for cultivation. Currently, only 41,547.75 acres, or 72 percent of the land suitable for cultivation, is under cultivation. The land which is in use at the present time is used for the following:

1. Part of this land is farmed with permanent crops, mainly palm trees. This land occupies a total of 4,766.75 acres, or 8 percent of all land currently farmed.
2. Land cultivated with temporary crops, such as vegetables (tomatoes, potatoes, and okra), fruit (citrus and grape), wheat and fodder (clover and alfalfa), occupy 17,185.75 acres (30 percent).

3. The third portion of land is temporarily fallow as part of the rotation system that is being practiced by the Al-Kharj farmers in order to maintain the soil fertility. This constitutes 19,595.25 acres, or 34 percent of the total land cultivated at this time. Hence, the total productive land varies from one season to another.

The remaining 28 percent of the land suitable for cultivation is currently unused, but has the potential for future development. This land is owned by the government.

Currently, developmental plans for Al-Kharj are being carried out by the government and by private investors to stimulate an increase in production of agricultural crops. These efforts and many other aspects will be discussed through the analysis of the survey conducted in the Al-Kharj area during the summer and fall of 1979.

## Methods of Farming in Al-Kharj

The study of farm size in any country is very important because it allows observers to make accurate conclusions about the systems that are being used to divide the agricultural land. Economic and political policies, as well as the natural environment, have a great effect upon the types of farming practiced in any country. Social behavior and tradition also effect the activity of each individual from one place to another.

In Saudi Arabia, farms are generally small. J. H. Stevens, in his article Oasis Agriculture in the Central and

Eastern Arabian Peninsula (1972), has indicated that 70 percent of the total holdings in the eastern regions of Saudi Arabia are usually less than 2.5 acres. A similar situation is found in the southwestern portion of the country, where the majority of Saudi farmers are concentrated. A contrast to these places are the farms in the central part of Saudi Arabia. The farms in the Al-Quseem Oases, for example, are larger. Here only 29 percent of the holdings are less than 2.5 acres, while about 20 percent of the holdings are larger.[81]

The following table shows the size of the farms at Al-Kharj, which is located in the central region of the country. About 32 percent of the holdings have an average size between 2.5 and 9 acres, while 40 percent of the farms surveyed are between 10 and 49 acres. As shown in Table 10 a small number of farms (around 14 percent) exceed 50 acres, while there is a gap in the farms of 500 to 1,000 acres. The study also indicates that there are only two farms which exceed 1,000 acres. In fact, these two farms are among other uncommonly large farms in the area which are between 1,000 and 4,000 acres. These farms specialize in producing large quantities of agricultural products. Their production ranges from animals to crop foods such as vegetables, wheat and fodder. They use more machinery and hire large numbers of laborers.

The large size farms in the central region of Saudi Arabia, as at Al-Kharj, have been explained by Richard F.

Table 10.--The Sizes of Farms at Al-Kharj.

| Size of Farm (Acres) | Number of Farms | Percentage (Of Total Farms Sampled) |
|---|---|---|
| 0 - 4 | 24 | 16.0 |
| 5 - 9 | 25 | 16.7 |
| 10 - 19 | 26 | 17.3 |
| 20 - 49 | 34 | 22.7 |
| 50 - 99 | 21 | 14.0 |
| 100 - 499 | 18 | 12.0 |
| 500 - 999 | -- | -- |
| 1,000 - over | 2 | 1.3 |
| Totals | 150 | 100.0 |

Nyrop in his book Area Handbook of Saudi Arabia (1977), as due to family extensions of ownership, and because some of these farms have been granted by the government to loyal army leaders for their help in unifying the country in the past.[82]

The increase in the land under cultivation at Al-Kharj is a fair indication of the rate of progress in the area. Two documentations have been obtained from the Ministry of Agriculture and Water which date back to 1974 and 1965. From a comparison between these two documentations and the 14 year period in between their preparation, it has been determined that a great expansion of agricultural land has occurred at Al-Kharj. During 1965, the total agricultural

area in both Al-Kharj and Al-Dilam districts was 61,619.75 acres, with a total of about 1,194 farms.[83] Of this total land, only 17,281.25 acres were cultivated, or only 28 percent of the total land suitable for farming at that time.

But in 1974, the agricultural survey revealed that the total agricultural land in Al-Kharj and Al-Dilam districts has reached 83,716.25 acres. Of the total land, 64,595.25 acres, or 77 percent of the total land suitable for farming, is under cultivation. Even though the estimated agricultural land in 1974 increased by 49 percent over 1965, the number of holdings that have been established has increased by only 7 percent, reaching a total of 1,283 farms in both the Al-Kharj and Al-Dilam districts. The cultivated land has increased substantially in the area due to subsidies that are granted by the government of Saudi Arabia, encouraging the expansion of agricultural land and thereby hopefully increasing the production of agriculture.

One of the questionnaire sample results has indicated that the cultivated land at Al-Kharj is either operated by the owners or rented by others. The study indicates that 78.7 percent of the sample farms were operated by their owners, while the remaining 21.3 percent of the farmers have tenants to operate their farms. These tenants work the farms and receive a salary each month, while some have the right to grow whatever they want and give the owner a yearly rent. The amount of rent varies according to

their agreement, and it must be paid whether or not the crop has succeeded in every calendar year. Other tenants work on these farms as sharecroppers.

Many native farmers of Al-Kharj still operate what are referred to as date gardens. This kind of farming consists of cultivating a few crops in the shade of date palms. According to a survey conducted in the area, 79 percent of the farmers have indicated that they grow date palms, among other crops. However, 21 percent of the farmers believe that growing date palms is not profitable; and accordingly, they have eliminated the cultivation of date palm trees.

Some of these farms have the tendancy to emphasize the cultivation of other crops which have a greater demand in the local market. Desert condidtions permit only restricted agricultural production. However, date palms, which have a high rate of resistance to the rigid environment of the Arabian desert, grow well. These trees can withstand a wide range of soil textures, especially soil which has high percentages of sand. Also, they can exist for longer periods of time in severe droughts and survive the high alkaline content of irrigation water.

A study by the Ministry of Agriculture and Water shows that 70 percent of the date palm trees at Al-Kharj bear fruit, while 30 percent do not. Another indication of the decreasing importance of palm trees appears at Ain-Dhila village of Al-Kharj, where a large area is owned by the

government. This land is only planted with abandoned, non-bearing date palms. There is a gradual transformation from date palm cultivation to wheat, alfalfa, clover, vegetables and some fruit trees such as citrus and grapes, all of which have proven to be suitable for the area. However, the cultivation of fruit is still of minor importance among other crops, as only 10 percent of the farms indicated that they grow grapes and/or citrus.

Al-Kharj area has been greatly effected by the growing of urban areas, especially Riyadh, the capitol. To provide the food requirements of these areas, the farmers of Al-Kharj have concentrated their efforts on growing crops that are in demand in these markets. Vegetables and wheat have been shown to be the items which have the highest demand among the people of urban areas. The government of Saudi Arabia has made efforts to assist farmers in growing these commodities. From 1971 to 1974 a program was launched at Al-Kharj to disseminate a new breed of what called Mexipak. Experiments on this variety of wheat have proven it to be of good quality and to produce high yields--more than the local variety of wheat. But in 1975, another variety of wheat, called Jori 69, was proven through many experiments to be more appropriate for the Al-Kharj environmental conditions.

Farmers of Al-Kharj hesitate to cultivate a single crop due to their fear of financial loss. For example, in

1978 many farmers faced a severe winter frost, called "Arbeania," which destroyed the tomato crop of that season. Another reason for the diversity of crops raised is connected with the market. Sometimes the local market experiences a superabundance of certain imported goods, which become cheaper than the same items produced locally. Although the agricultural system of Saudi Arabia is one which mainly produces daily household food needs and sells what is left over, recently the local market demand seems to play an increasingly important role in determining the attitude of farmers toward the growing of certain goods.

Since there is growing demand for animal feed production, most of the farmers in the area have expanded cultivated areas for clover.

From the questionnaire sample, 148 out of 150 farmers, or 99 percent, grow mostly vegetables, wheat and clover. These commodities are grown primarily due to the market demand, profitability and the suitability of these crops to the characteristics of the area's soil.

The use of agricultural technology in Saudi Arabia is relatively recent. The use of tractors, for example, in the farming system began during the forties. The first tractor introduced to the Saudi farmer was at the agricultural project of Al-Kharj in 1941. Since then, new innovations in agriculture have slowly spread to many farms throughout the country.

Pump machines, which are used to draw water from wells to irrigate the farms, were the first step by which the Saudi farmer began to deal with technology. Unfortunately, the use of gasoline operated pumps has caused the increasing draw-up of water for the purposes of irrigation, which has recently led to lower underground water tables. This has forced many farmers to drill deeper wells to reach deep aquifers. At Al-Kharj these wells are drilled in the sandstone and limestone layers to a depth ranging between 100 and 300 meters.

The advancement of agricultural technology in Saudi Arabia is a complex subject with varying viewpoints, some of which are expressed below:

1. The average size of farms in Saudi Arabia is very small, and this does not allow the extensive use of power machines. Additionally, farmers of small farms are not in the financial position to obtain these machines, except with the assistance of the government through subsidies.
2. Saudi Arabia lacks the skilled manpower that is needed to operate these machines. But increased use of power machines in Saudi Arabia has the potential to solve the problem of manpower shortages.
3. Although there is a possibility of increasing the arable land, there is not a sufficient amount of water for irrigation.

At Al-Kharj, responses to the questionnaire concerning the question of whether they use machines in their farming were predominantly affirmative, as 85 percent of the farmers questioned use different kinds of machinery in their daily farm work. Fourteen of the 150 farmers stated that they are not in a position to buy machines such as tractors, harvesters and others. Those farmers constitute a small percentage of the farmers, around 9.3 percent. Farms which do not own machines usually use equipment rented from local contractors. The owners of these farms want to use the new technology offered to them in the agriculture sector. Only a small percentage, around 5.4 percent, of the respondents indicated they prefer using traditional methods of farming. This fact reveals the positive attitude of farmers toward agricultural advancement.

The government, through the agricultural bank, has offered subsidies to enable farmers to buy the machines they need. Small farms at Al-Kharj have benefited less from these subsidies because of the economic fact that small farms are not able to cover the expense of these machines. To bridge this obstacle, a few small farms join together to rent a tractor for the ploughing season, or to remove the accumulated sand dunes around their farms. Only the larger farms own their machines.

Nearly 100 percent of the total farms sampled have gasoline operated pumps (16 horsepower) attached to their wells. This is the primary machine used here. The second

major machine in use is the tractor. This study revealed that 89 percent of the farmers use tractors. Only 2.6 percent of the farmers own harvesters and equipment for loading. These are the large farms. However, 5 percent of the farmers responded that they depend on manual labor and use no such machines. Almost all of the farmers own motor vehicles, at about 99.3 percent. However, these vehicles are generally trucks which are primarily used for the purpose of transporting their crops to the local markets of Al-Kharj. The two main markets to which the farms bring their products are Al-Kharj Market and Riyadh city. The availability of direct paved roads to Riyadh has increased the percentage of the farm production that is brought to the capitol.

Due to the scarcity of rainfall in the Al-Kharj district, the irrigation system is a dominant factor in the survival of the villages of the area. Old drilled wells have been equiped with modern pumps in order to obtain larger quantities of water and to enable the farms to reach the deep aquifers. Recently, due to the government regulation of groundwater use, farmers cannot drill new wells on their farms before they obtain a written governmental agreement. This rule has been adopted because of the fear that drilling new wells may substantially decrease the groundwater level. Uncontrolled use of water for irrigation may drop the level of groundwater to a depth that might make the pumping of water uneconomical in the near future. Hydrological

inspections must be made at the sites of the farms to determine whether the farm is qualified for the drilling of a new well. They also instruct the farmers about the procedure that may be followed to drill a well.

The questionnaire sample has shown that at least 98.7 percent of the farmers depend upon wells to irrigate their farms. The amount of water they receive is satisfactory, and great quantities of it may be wasted through excessive irrigation. The intensive use of water has resulted in water logging and salt accumulation at some farms. In particular, farmers in the Al-Yamama village lack the availability of a drainage system, which has resulted in salinization of their farms.

At Al-Kharj, only a few wells have had the contents of their water analyzed in the government laboratory. Five wells at Ain-Dhila have been tested, and results indicate a high rate of various dissolved solids in the water of these wells, especially calcium, which ranges between 243 to 662 parts per million, and sodium, which ranges between 115 and 736 parts per million. The total dissolved solids in these five wells ranges between 1,500 and 5,000 parts per million.[84]

One factor which affects the Saudi Arabian economy in the agricultural sector, particularly at Al-Kharj, is the increasing dependence upon foreign laborers. Through the questionnaire analysis, it appears that as high as 38 percent of the farms in the area hire laborers. The majority of these laborers are Egyptian, and a small number of them

are Pakistani. It is indicated through the questionnaire that the use of foreign workers is more common on the farms which are larger than 50 acres, while the smaller farms depend primarily upon the efforts of the household members. The use of laborers on the larger farmers is mainly due to the fact that these farms produce crops to be sold at the market. Contrarily, the small farms produce crops for their household consumption and sell only what is left over. Still, the majority of farmers, or 62 percent of the sample, have indicated that they depend only upon their own efforts in the farming process. The influx of foreign laborers has resulted in a change in the social structure, as the members of farm households are engaging in activities other than agriculture.

Most of the workers on farms in Saudi Arabia are considered permanent laborers, which means that they live and engage in agricultural activity on the farm. Thus, they receive a monthly payment. However, 38 percent of the laborers are considered seasonal workers who come to work only on the active days of farming.

## Hazards and Problems

During the past three decades, Saudi Arabia has made considerable efforts to enhance the agriculture sector in the country. These efforts emphasize drilling wells, building dams to infiltrate rainwater into the soil, and allocating subsidies to the farmers. But these steps are not

sufficient to balance the many problems encountered in many of the Saudi oases. The Al-Kharj area is one of the oases which has been effected by numerous hazards. The scarce literature available concerning Al-Kharj indicates only a little about the hazards which the farmers in this area encounter. The survey responses obtained from farmers in various villages in the area indicate the types of problems and hazards the farmers of Al-Kharj have in raising their crops and livestock. These responses will also help derive ways in which the government may help to solve the farmers' problems.

It must be indicated here that these responses may not reflect the true status of the area, because the farmers themselves do not necessarily understand the reasons for their problems, but simply notice the results. Many such problems can only be determined by experts. Nevertheless, the farmers are in a position to help by acknowledging the existence of some problems to the experts, who can in turn determine the cause. Although the questionnaire displays that 36 percent of the farmers interviewed have no complaints regarding their farming, the remaining 64 percent have encountered some kinds of troubles during their years of crop cultivation.

The major problem in the area is soil salinity. Fifty of the 150 farmers surveyed, or 33.3 percent, have high rates of salt deposits. Others have poor drainage, poor quality water and the lack of available groundwater for

irrigation. These farms constitute 20.7 percent of the total farms surveyed. Ten percent of the farmers have other problems which effect the growing of crops, such as wind erosion, sand dune movement, the need to apply greater quantities of fertilizers in order to increase the percentage of organic matter lacking in Al-Kharj soil, and soil mixing.

Soil mixing is the mixing of the deep loam soil layer with the upper sandy loan to sand layers, which experience has shown results in greater production at Al-Kharj. But this process requires farmers to spend great amounts of time and money to mix these two layers together.

Another example is the solution to the generally low clay/silt ratio in Al-Kharj soil. This can be corrected by the addition of organic matter to the soil. The Agricultural Bank has the burden of supplying Al-Kharj farmers with adequate types and amounts of chemical fertilizers in order to produce better quality and greater quantities of crops.

A major goal of the Saudi Arabian government is to increase the quantity of livestock in the country. This policy is being adopted for the purpose of reducing the amount of meat and milk imported from abroad. Al-Kharj is considered the ideal area for such endeavors. It is located near the largest urban area in the country, which is the primary consumer of meat and milk. The Ministry of Agriculture and Water is planning to change the governmental agricultural project at Al-Kharj to sheep and cattle breeding, and fodder cultivation. This project, as previously

mentioned, has encountered several failures relative to food crop cultivation from 1941 to 1977. It has been suggested that trained laborers and equipment from the Haradh project be used at Al-Kharj's farm. Currently, the cultivation of fodder at this project is being increased primarily for use as animal feed.

Farms at Al-Kharj average two cattle each, and recently most farmers purchase Friesian or Jersey cattle in belief that these kinds of cattle yield more milk than the domestic varieties. In terms of sheep, a large number are found in the area; but since most of the herds are owned by the nomads, no statistical data is available concerning their number. Many farmers at Al-Kharj own only a few sheep and goats. The questionnaire sample has shown that 103 of the 150 farmers (68 percent) own sheep and goats. The number of goats, however, is decreasing due to the fact that sheep are more profitable. Most of the sheep breed in the area are of domestic origin, but small numbers of sheep have been seen which are of types usually breed by the nomads of Syria and Iraq.

The survey conducted in the area also indicates that at least 22 percent of the farms possess cattle, while the number of camels is diminishing. The camel is often useful in the lifestyle of nomads, but not as important for settled farmers. Only 4 percent of the farms have indicated that they do own camels.

No reliable data is available relative to the number of poultry, but an estimate by the Ministry of Agriculture and Water indicates that there are about 13 poultry farms with a total of approximately 1,006,980 chickens which produce approximately 57,000 kg. of meat per year.

When the farmers of Al-Kharj were asked about the reason for breeding these types of livestock, 58 percent replied that they do so for their domestic use only. But 34.7 percent breed them because of market demand. The increasing population in the urban areas such as Riyadh was an important factor which has led many farmers to concentrate on animal husbandry. However, the percentages indicated above reflect the fact that the primary reason for breeding animals is still for personal family consumption.

To obtain more productive and healthy livestock, a special treatment must be given to the animals. In Saudi Arabia, increasing the meat supplied by the local farms is important in order to reduce the amount of meat imported to the country. Medical care is needed to prevent epidemics of animal diseases; and due to the rigorous heat of summer, suitable shelter must be provided, especially for non-domestic livestock breeds. Proper animal feeding enhances the quality of the animals; and agriculture is the source which supplies the livestock with adequate fodder. In Al-Kharj, no major or serious difficulties are found concerning animal husbandry. A majority of the farmers, or 61.3 percent, have indicated that they encounter no problems. The most needed

form of governmental aid would be to provide more effective medical care, which 22 percent of the respondents have indicated they lack. However, around 12.7 percent of the farmers have other problems, such as the lack of suitable shelter and labor shortages. Foreign laborers refuse to work with livestock. The reason behind their refusal has not yet been determined. If we compare all the difficulties in the livestock field, medical care seems to need the most attention. If improved medical care is made available to the farmers, animal husbandry has the potential for development.

## Governmental Assistance

When the Saudi Arabian Agricultural Bank was created, its first purpose was to filter new technology to Saudi farmers through the activities of the Bank. Farmers in many areas of the country are reluctant to use modern agricultural machines. There is evidence which indicates that large numbers of Saudi farmers still employ farming methods which have been used for centuries. However, other recent evidence has shown that Saudi farmers are increasingly interested in the use of tractors for farming. These facts are noticeable because of the increased appearance of agricultural machines on farms in the area. The increasing budget of the Agricultural Bank demonstrates a healthy attitude and the eagerness of Saudi farmers to develop their farms for maximum productivity. It is through the Agricultural Bank that the farmers have been introduced to modern agricultural equipment.

However, the adoption of new technology must be spread to increasing numbers of farmers in order to further agricultural advancement in Saudi Arabia.

Many farmers at Al-Kharj receive loans or assistance from the Agricultural Bank. According to the questionnaire, the majority of farmers (93.3 percent) indicate that they have received some forms of subsidies; whereas only 6.7 percent indicated that they had not received loans through the Bank. The highly desired loans from the Bank are the farm machinery subsidies, because the Bank bears 45 percent of the cost of all machinery purchased by farmers or tenants. Next in importance are those loans which are used to drill new wells, or to deepen existing wells when the groundwater level has dropped, requiring more drilling to reach the deep aquifers. Loans are also granted for the purpose of well casing operations. The benefits of the use of fertilizers, whether local or imported, have been discovered by the farmers. Applying chemical fertilizers to the soil is being increasingly practiced. The government subsidizes chemical fertilizers by reducing prices nearly 50 percent.

As shown in Table 11, most loans constitute the three elements of machinery, well drilling and fertilizers. More than 67 percent of the farmers request these types of subsidies.

No relationship has been shown between the size of farms and types of loans received by the farmers, except with regard to loans for agricultural machinery. Small farms are

Table 11.--Types of Loans Received by Al-Kharj Farmers.

| Types of Loans | Number of Farms | Percentage of Total Farms Surveyed |
|---|---|---|
| Machinery and Well Drilling | 9 | 6.0 |
| Machinery, Well Drilling and Fertilizers | 78 | 52.0 |
| Machinery and Fertilizers | 12 | 8.0 |
| Machinery | 2 | 1.3 |
| No Loans | 49 | 32.7 |
| Totals | 150 | 100.0 |

unable to obtain loans for such machinery, as their sizes preclude them from efficiently utilizing the machines.

## Private Agricultural Project

The government of Saudi Arabia has set up agricultural projects throughout the country. Some of these projects have been partially successful, but others have encountered many obstacles which have gradually led to their deterioration. Such difficulties, as encountered by these projects, have previously been described in detail regarding the Al-Kharj (pp. 55-62) agricultural project and other projects, such as the Al-Hasa irrigation and drainage project.

Facts have been accumulated through years of experience in operating these projects which seem to indicate that

some of these projects could best be operated if owned by private investors. In such a case, governmental assistance could be given to the private farmers from the Ministry of Agriculture and Water. However, private investors hesitated to become engaged in such projects because this kind of investment is highly unpredictable in terms of profits earned. At Al-Kharj, a few private investors have decided to engage in agricultural production in spite of all the hazards and problems that are expected.

Among the 150 farms which have been surveyed by this study, it has been found that one of them is not only considered the most modern farm in Al-Kharj, but also in the entire country. This is mainly due to the high standard of equipment being used, and the skilled management and laborers who operate the farm. This farm is located 40 km. south of Riyadh, and it is one of the largest farms in Al-Kharj, being 4,000 acres which are cultivated with a variety of crops. Small sections of the farm, estimated at around 2.25 acres, are occupied by the first and only greenhouses ever built in Saudi Arabia. These 14 greenhouses are operated and maintained by German technicians, and they produce vegetables and fruit throughout the year. Adjacent to the greenhouses is the open land, which is the heart of activity on the project. This land contains approximately 1,500 bearing palm trees, while the rest is cultivated with vegetables, maize, fruit, clover, and barley. Korean and Arab laborers

work together in this area, and they are equipped with agricultural machinery and skilled management.

At this farm, there are currently 2,500 sheep and goats, a few camels, and 420 cattle which will be a source of milk in the near future.

A new method of irrigation is being practiced at this farm, which is considered the latest innovation applied in agriculture production. This is the use of underground plastic pipes to carry water for irrigation. This method of irrigation is being adopted in order to preserve the valuable groundwater by prventing a good deal of evaporation. A major disadvantage of using this method of irrigation is the fact that considerable costs remain constant. The same is true relative to the production of food crops in greenhouses.

Two natural difficulties could have negative effects upon this farm. First, the high velocity of wind is effecting the crop growth. Secondly, the percentage of the alkaline content of the soil is estimated to be 30 percent and increasing with the use of groundwater for irrigation.

No decision has been made as to whether this farm has the potential to be successful and to be used as a model to other investors. Years of experience in operating such a farm should determine its fate. According to the owner's statement, this agricultural project has been successful since its first establishment in 1974, as it currently earns a 70 percent profit yearly.

## Social Status

It is a fact that educated people are more capable of serving their country than those who have no education at all. For this reason, the Saudi government is spending millions of dollars each year to promote the educational system and to reduce the high rate of illiteracy in the country. The new generations in the urban areas have better chances of obtaining an education than those in the rural areas.

To determine the level of education the farmers of Al-Kharj have obtained, a question on this subject was applied in the questionnaire formula. One of the striking results shown in Table 12 below is that most of the farmers have no formal education, and they can neither read nor write.

Table 12.--The Level of Education of Al-Kharj Farmers.

| Level of Education | Number of Farmers | Percentage of Total Farmers |
|---|---|---|
| Primary school not completed | 28 | 18.7 |
| Primary school completed | 8 | 5.3 |
| High school completed | 4 | 2.7 |
| College completed | 3 | 2.0 |
| Able only to read and write | 41 | 27.3 |
| Unable to read or write | 66 | 44.0 |
| Totals | 150 | 100.0 |

The ability of some farmers to read and write, as indicated by the farmers, results from their desire to read the holy book of Islam, the "Koran." This shows the role of religion as a positive factor in the matter of education.

As indicated above, the largest percentage of farmers are unable to read or write, being 44 percent, and the second largest group are those who only know how to read and write, being 27.3 percent. Those farmers who completed only some primary school represent the third largest group, at 18.7 percent. This clearly indicates that there is a lack of formal education. Ten percent of the farmers questioned completed primary school, high school or college, which shows that such levels of education are uncommon. The college educated farmers, at 2.0 percent, are generally businessmen who reside in Riyadh and operate agricultural projects in the area at the same time.

Farmers at Al-Kharj are responsible for supporting an average household ranging between five and six members. Farmers who have more than six children comprise 40.7 percent of the sample, and 27.3 percent have at least five members. The children of the farmers could be a great deal of help at the Al-Kharj farms, except for the fact that most of them are under the age of sixteen years. Fifty-six percent of the farmers have indicated that their children do not assist them with the farm work because they prefer to attend school. None of the farmers indicated that their wives assist them

in the farm work. This also multiplies the need for foreign laborers, as mentioned earlier.

Agricultural development at Al-Kharj can be improved with the assistance of highly educated people who are able to perceive the requirements of the natural environment. The farmers' understanding of the delicate environment of this arid area is important in order to maintain its usefulness; and increased literacy of the farmers will aid this effort.

# V. SUMMARY AND CONCLUSION

The major type of farming in Saudi Arabia is referred to as oases agriculture. Such farms are found wherever there is plenty of readily available groundwater and suitable soil. Due to this fact, agriculture production is limited and farming is scattered according to the strewn nature of the oases. The oases are usually small in size; and accordingly, the average farms are small. In Saudi Arabia the average landholding is between two and five acres. But this is not the case in the central region of Saudi Arabia, as this thesis indicates.

Because of the small size of the Saudi Arabian farms and their low production, Saudi Arabia is a net importer of most of its foodstuffs. From 1962 to 1964, though, Saudi Arabia was self-sufficient in the production of meat and fish. But since then, even the production of these commodities has declined, and Saudi Arabia is no longer able to support the needs of the increasing population of Saudi Arabia for foreigners.

Even the advent of increased oil production and the corresponding economic growth and revenue, which reached $30 billion in 1976, have not ended the many

problems of Saudi Arabia, including the field of agriculture. Of the total land area of Saudi Arabia, only .2 percent is under cultivation. Estimates indicate that the amount of land suitable for cultivation is ten times greater than the amount of land currently under cultivation.

Agriculture in Saudi Arabia is encountering many challenges and problems which must be solved before more steps are taken to expand cultivation to the remaining land suitable for agricultural production. The first and most crucial obstacle to the expansion of agriculture is the limited sources of fossil groundwater. It would be possible to cultivate all the land suitable for cultivation only if there were sufficient quantities of fresh water available for irrigation. For example, the cultivated land in Al-Kharj could be increased if new sources of groundwater are located.

Since rainfall is scarce and does not exceed three inches yearly, the natural replenishment of the groundwater is not capable of equalling the rapid rate of extraction. Many wells, particularly in Al-Kharj, produce poor quality water for irrigation. This groundwater may render the soil useless in a few years, due to salt deposits.

Desalted water has been proven uneconomical and impractical for use in irrigation. Many scientists and researchers have doubts about the effectiveness of desalted water as a source of fresh water for crop production, even though desalted water may be proven necessary for personal

use in urban areas. The main objections to desalted water are that the use of this water in irrigation will eventually double the risk of contamination of groundwater sources due to the accumulation of salt extracted at these desalination plants, and that the establishment and maintenance of desalination plants is costly.

Another problem on Saudi Arabian farms is that excessive amounts of water are applied in irrigation, as has been noticed at Al-Kharj. "They do so in the naive and erroneous assumption that if irrigation is useful, the more so the better."[85]

Farming knowledge is still weak among most of the Al-Kharj farmers. This is primarily due to their illiteracy and secondly to the lack of training programs. To enhance the agricultural situation in the country, the Saudi Arabian government has been active in establishing agricultural projects wherever such projects are feasible and it appears they would have a high probability of success. Unfortunately, these projects have encountered difficult problems which have not yet been satisfactorily solved.

In 1941, the first agricultural project was established at Al-Kharj. Later, during the sixties, three other projects were built, namely the Al-Hasa irrigation and drainage project, the Al-Hufof drainage project and the Haradh project. During 1960, the Al-Kharj agricultural project was abandoned due to the deterioration of its equipment and the economic loss that resulted from its operation.

The lack of experienced laborers and the salt deposits have also caused the project to fail. The Al-Hasa and Al-Hofuf projects in the eastern regions face the problem of excessive water loss by evaporation.

Agricultural production at Al-Kharj has managed to continue, and the agricultural land has expanded despite these and other problems. There are two key factors in the continuation of farming in this area. One factor is related to the governmental subsidies that are granted to the farmers, and the second is the use of foreign workers. The Agricultural Bank at Al-Kharj has provided the Saudi farmers with fertilizers, seeds, machinery and consultants at reduced rates. Loans to cover the wages of workers have helped to a great degree and increased the use of foreign workers rather than the dependence upon the farmers' family members for assistance on the farms.

Through the study conducted in Al-Kharj, it appears that the most important element which has led to the continuous cultivation in the area is the increased availability of workers. There are many problems in the area which often encourage many farmers to seek better, permanent jobs in the cities, especially since the discovery of oil. It has been noticed that most of the farmers' children are influenced by their aspirations to continue their education and engage in civil service employment. This trend of young people moving away from farm work may cause an accelerated need for foreign laborers. Increasing numbers of laborers

will increase governmental subsidies to cover their wages, which will increase the cost of agricultural production on the Saudi farms.

The depletion of groundwater, the accumulation of salt, the huge loss of water for irrigation by evaporation, poor drainage systems, the rural to urban migration of farmers and the poor management of agricultural projects are familiar hazards and troubles that are faced by agriculture at Al-Kharj, as well as in the other oases of Saudi Arabia. The significance of this study is to encourage governmental agencies to focus their attention on steps to eliminate the effects of the hazards encountered at Al-Kharj. This would result in the improvement of the environment and the welfare of the Saudi citizens. Any plans to expand agriculture at Al-Kharj must be preceded by intensive scientific research to control these hazards which hinder the development of agriculture in the area.

# FOOTNOTES

## FOOTNOTES

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# APPENDIX

# QUESTIONNAIRE

# APPENDIX

## QUESTIONNAIRE

Date: _____
Location: _____
Interview Number: _____

I am a candidate for a Master's degree in Geography at Michigan State University in the United States. For my thesis on the agriculture at Al-Kharj, I would appreciate your help in answering some questions which would be helpful in my study.

1. What is the size of your farm?

| | | | |
|---|---|---|---|
| a) | 0- 4 acres _____ | e) | 50- 99 acres _____ |
| b) | 5- 9 acres _____ | f) | 100-499 acres _____ |
| c) | 10-19 acres _____ | g) | 500-999 acres _____ |
| d) | 20-49 acres _____ | h) | 1,000-more acres _____ |

2. How long have you been living at Al-Kharj?

_____ years

3. Do you own this farm?

_____ -Yes _____ -No

A) If your answer to Question 3 is no, what is the relationship between you and the owner?

a) Tenant _____
b) Sharecropper _____
c) Other (specify) _____
d) Not applicable _____

4. Where would you prefer to live, at Al-Kharj? or in a city such as Riyadh, the capital?

I) I prefer to live at Al-Kharj because:

a) I want to be close to my family. _____
b) I don't like cities. _____
c) I want to be close to my land. _____
d) Other (specify) _____
e) Two or more of the above reasons. _____
f) Not applicable. _____

II) I would prefer to live in a city because:

a) It is more profitable to live in a city. _____
b) My relatives live in a city. _____
c) There are available schools for my children in a city. _____
d) Other (specify) _____
e) Two or more of the above reasons. _____

5. What is your source of water for irrigation?

a) Pits _____
b) Wells _____
c) Springs _____
d) Other (specify) _____
e) Two or more of the above _____

6. Do you get a sufficient supply of water for irrigation?

a) Yes. _____
b) Yes, but I lack the capital to purchase modern equipment for irrigation. _____
c) Yes, but I lack a drainage system. _____
d) No. _____
e) No, because of the poor quality of the water. _____
f) Other (specify) _____

7. How do you practice farming?

a) By using skilled farmers. _____
b) By practicing and learning from our mistakes. _____
c) By directions from the government. _____
d) Other (specify) _____
e) Two or more of the above. _____

8. Would you like to use machines for farming?

a) Yes, and I do use machines. _____
b) Yes, but I don't know how to use them. _____
c) Yes, but I can't afford to buy them. _____
d) Yes, but I lack trained laborers. _____
e) No, because I prefer traditional methods. _____
f) No, because my farm is too small to use machines. _____
g) Other (specify) _____

9. What kind(s) of machinery do you use for farming, and for what purpose(s)?

a) Machines for harvesting _____
b) Tractor(s) _____
c) Equipment for loading _____
d) Other (specify) _____
e) Two or more of the above _____
f) None of the above _____

10. Do you have any kinds of motor vehicles?

_____ -Yes _____ -No

11. If your answer to Question 10 is yes, do you use your vehicle(s) to transport your livestock or crops?

a) Yes, for livestock _____
b) Yes, for crops _____
c) Yes, for both _____
d) No, for personal purposes _____
e) Other (specify) _____
f) Not applicable _____

12. What kind(s) of crops do you grow?

a) Dates _____
b) Vegetables _____
c) Wheat _____
d) Alfalfa _____
e) Fruits _____
f) All of the above _____
g) Other (specify) _____
h) Vegetables and alfalfa (answers b & d)

13. Why do you choose to grow the crops listed in your answer to Question 12?

a) Market demand _____
b) Profitability _____
c) Suitability for this kind of soil _____
d) Owner's demand _____
e) Other (specify) _____
f) Market demand, profitability and suitability of this kind of soil (answers a, b & c) _____

14. What kind of troubles or hazards do you encounter with your crops?

a) Soil salinity _____
b) Poor drainage system _____
c) Poor quality water _____
d) Unbalances fertilizer procedure _____
e) Over irrigation _____
f) Under irrigation _____
g) Other (specify) _____
h) Two or more of the above _____
i) No troubles or hazards

15. What kind(s) of animals do you have?

a) Sheep and/or goats _____
b) Camels _____
c) Cattle _____
d) Sheep/goats and camels _____
e) Sheep/goats and cattle _____
f) Camels and cattle _____
g) All of the above _____
h) None of the above _____

16. Why do you breed these kinds of livestock?

a) For personal domestic use _____
b) For market demand _____
c) Suitability of land and/or crops _____
d) Owner's demand _____
e) Profitability _____
f) Other (specify) _____
g) Two or more of the above _____
h) Not applicable

17. What kind(s) of difficulties do you encounter with your livestock?

a) Insufficient medical care _____
b) Lack of suitable food _____
c) Lack of suitable shelter _____
d) Lack of water _____
e) Other (specify) _____
f) Two or more of the above _____
g) No difficulties _____
h) Not applicable _____

18. What kind(s) of assistance do you get from the Saudi Arabian Agricultural Credit Bank?

a) Loans to purchase agriculturel machinery _____
b) Loans to drill wells for my farm _____
c) Half the price of fertilizers _____
d) Half the price of animal feed _____
e) Two or more of the above _____
f) All of the above _____
g) None at all _____
h) Other (specify) _____

19. Have you received any benefit from the government land reclamation of 1968?

a) Yes, by its increasing my farm size _____
b) Yes, by its increasing my income by better utilization of my land _____
c) No, I have not benefited _____
d) No, because it benefited the large corporations _____
e) Other (specify) _____

20. Do you have hired laborers to help you farm?

_____ -Yes _____ -No

21. If your answer to Question 20 is no, why not?

a) It is not easy to find trained laborers _____
b) I cannot afford to pay them _____
c) The farm is too small _____
d) My family helps me on the farm _____
e) Other (specify) _____
f) Not applicable _____

22. What level of education have you completed?

a) I have had some primary schooling _____
b) I have completed primary school _____
c) I have had some high schooling _____
d) I have completed high school _____
e) I have had some or completed a college education _____
f) I have had no formal education, but I am able to read and write _____
g) I can neither read nor write _____

23. Which of the following age groups are you in?

a) 0 - 19 years _____
b) 20 - 29 years _____
c) 30 - 39 years _____
d) 40 - 49 years _____
e) 50 - over years _____

24. How many members are there in your family?

a) 1 _____
b) 2 _____
c) 3 _____
d) 4 _____
e) 5 _____
f) 6 or more _____

25. Which of the following family members assist you with your farm work?

a) All of them _____
b) My wife only _____
c) My children only _____
d) None, I work alone _____
e) None, as I hire laborers _____
f) Other (specify) _____

26. In which one of the following age groups are the majority of your household members?

a) Under 16 _____ d) 24 - 40 _____
b) 16 - 18 _____ e) 41 - 65 _____
c) 19 - 23 _____ f) Over 65 _____

27. In order to assist me in the evaluation of your needs to practice farming, it would be helpful if you would indicate your average yearly household income:

_____

28. Would you like to add any additional information?

_____

_____

_____

THANK YOU VERY MUCH FOR YOUR ASSISTANCE AND COOPERATION.

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