AGRICULTURAL LAND USE PATTERNS IN RELATION TO THE PHYSICAL, LOCATIONAL, AND SOCIOECONOMIC FACTORS IN THE ASSARAH REGION OF SAUDI ARABIA

By

Salih Ali Al-Shomrany

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ABSTRACT

AGRICULTURAL LAND USE PATTERNS IN RELATION TO THE PHYSICAL, LOCATIONAL, AND SOCIOECONOMIC FACTORS IN THE ASSARAH REGION OF SAUDI ARABIA

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This study examined the land use patterns of the Assarah Highland region, which is located in southwestern Saudi Arabia and has been regarded as one of the most actively used agricultural regions in the Arabian Peninsula. In recent years, land use for agriculture in the region has progressively been diminishing owing to a series of complex environmental factors; some of these are physical, whereas others are locational, socioeconomic, and institutional.

The main focuses of this study were (1) to describe the changes and developments in the agricultural land use patterns in the Assarah region and (2) to examine specific agricultural land use patterns in relation to physical, locational, and socioeconomic determinants.

The Bashut-Al-Alaya district in the central part of the Assarah region was selected as the representative area. Primary data were collected and analyzed to determine the effect of selected environmental factors on agricultural land use patterns and the relationships between the factors and the types of agricultural land use.

The techniques used in analyzing the data were frequency distribution, chi-square, Pearson correlation matrix, and factor analysis.

The conclusions reached in this study are: (1) there is a strong relationship between the spatial distribution of the patterns of agricultural land use and the physical, locational, and socio-economic determinants; and (2) the agriculture in the representative area in particular and in the Assarah region in general is diminishing and will continue to diminish because of low agricultural productivity, shortages of water supply, rural-urban migration, lack of good transportation facilities, poor extension services, fragmentation of agricultural land, soil erosion, and lack of an agricultural marketing system and of planning for better use of agricultural land. This writer identified specific areas for further research and recommended measures to reverse the trends of diminishing agriculture not only for the study area but also for the entire agricultural region.

To my parents, my wife,

and my children.

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TABLE OF CONTENTS

Page

Page

LIST OF TABLES

Page

Page

LIST OF FIGURES

Page

LIST OF PLATES

Page

CHAPTER I

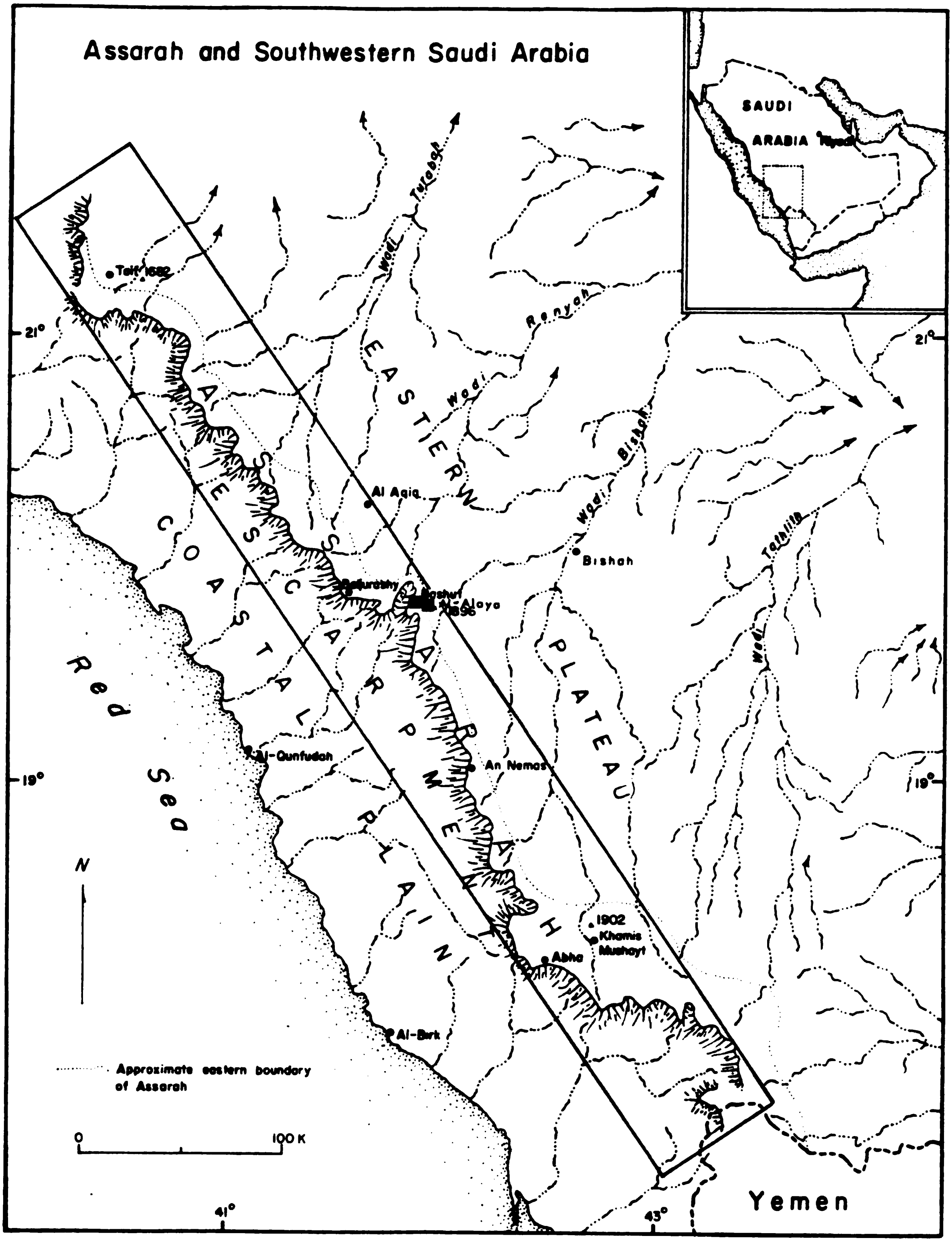
INTRODUCTION

> When Saudi Arabia is mentioned, the stereotype image that jumps to one's mind is that of a vast desert where uninterrupted sand dunes form the physical landscape. . . . Assarah is the exception to many blanket generalizations that have been made about Saudi Arabia. (Mughram, 1973, p. 2)

The Assarah highland region in the central part of southwestern Saudi Arabia is characterized by abundant natural resources. These resources include a good-quality soil trapped by human-made terraces, the highest rain-receiving area in Saudi Arabia, and the availability of minerals, livestock, and wildlife. In comparison to other regions in Saudi Arabia, the Assarah highland is unique in its recreational resources and the beauty of its natural scenery (Figure 1, Plate 1).

Assarah is an agricultural region and the human beings here, at least up until recently, had depended on agriculture as the main source of their livelihood. A subsistence type of mixed farming dominates the area. It seems that the climatic factors, especially the precipitation, are some of the most important natural forces that encourage agriculture in such a rugged and harsh environment.

Normally, agriculture in Saudi Arabia is practiced in the flat, fertile valleys and oases where the water supply for irrigation is more easily available, but in the Assarah highland agricultural land is at a



Source: AL-Shomrany, 1980, p. 4

Figure 1

(a) A beautiful 'other' view of Saudi Arabia: Greenery, Plateaus and Mountains in the vast sea of sand

(b) Another view of the same beautiful landscape that follows miles and miles of the same panoramic view

Plate 1

premium. The farmers in the region have transformed the available land for agriculture by terracing, which has long been used by the farmers to increase the quota of farmland, to stem soil erosion during the rainy season, and to conserve water (Al-Shomrany, 1980, p. 150) (Plate 2).

Statement of the Problems

For centuries the Assarah highland has been regarded as one of the most actively used agricultural regions in the Arabian Peninsula. In recent years, particularly after the discovery of oil in the eastern region of the country, the use of land for agricultural purposes has been continuously diminishing. Farms have generally been abandoned; farm animals have been sold; and the younger generation has migrated to work in the cities, where high-paying jobs have been found more tempting than farming at home.

Up to 1970, the farmers in Assarah had been cultivating most of their terraces to produce food for their own consumption as well as shipment to the neighboring regions. Now, the majority of the farmers import food from outside the region, and the abandonment of the terraces is increasing. It is believed that this depletion of the agricultural land is related to many environmental determinants. Some of them are purely physical, while others are locational, socioeconomic, and institutional. The effects of these environmental factors on the type, distribution, and the decline of land use for agricultural purposes are very challenging and complex from the standpoint of geography.

(a) A general view of the patterns of agricultural land use in the southern part of Assarah

(b) A general view of the patterns of agricultural land use in the northern part of Assarah

Plate 2

The purpose of this study is to analyze the agricultural land use in the Assarah highland, Saudi Arabia, with regard to the positive as well as negative effects of the physical, locational, socioeconomic, and institutional environmental factors.

The Rationale for This Study

The justification for the need and importance of this study lies in the fact that (1) there has never been a comprehensive study concerning the type and distribution of agricultural land use in the Assarah region with respect to the physical, locational, and socioeconomic factors; (2) the present decline of and encroachment on agricultural land pose a very challenging problem from an agricultural and geographical point of view. The trend in the land use in Assarah bodes ill for the agricultural future, both in the long and short runs. The short-term effect on the agriculture is discernible in that the area is continuously on the decline; and in the long run the region may be rendered totally unfit for agriculture with the disappearance of the man-made terraces. The walls of the abandoned terraces have already collapsed owing to a poor or totally nonexistent maintenance, and the soil that had accumulated over thousands of years has already been washed away by rains and thunderstorms; and (3) this study, it is hoped, will provide a material and intellectual inducement to other researchers to investigate further the issues arising out of this research. Hopefully, this study will help the decision makers with the basic information contained in this investigation in planning for the future.

The Objectives of the Study

The main objectives of the study are (1) to describe the changes and developments in the agricultural land use patterns discernible in the Assarah region during the last three decades, (2) to examine the specific agricultural land use patterns in relation to the physical, locational, and socioeconomic factors in the study area in particular and in the Assarah region in general; (3) to determine what physical, locational, and socioeconomic factors have influenced and are still influencing the agricultural land use patterns in the region; and (4) to recommend an optimum use of agricultural land in the Assarah region in the future.

Organization of the Study

This study is divided into seven chapters. Chapter I briefly outlines the objectives and the limitations of the study. Chapter II is divided into two sections. The first section discusses the general literature relating to the physical, locational, and socioeconomic factors, and the second focuses on the literature dealing specifically with the study area. Chapter III describes the sources of the data, the method of and the approach to the data collection, and the techniques of analysis. Chapter IV focuses on the agricultural development in Saudi Arabia in general and in the Assarah region in particular. Chapter V examines the major changes in and developments of the agricultural land use during the last three decades. In Chapter VI, the main focus is on the patterns of agricultural land use with regard to the physical, locational, and socioeconomic factors. Finally, the last chapter includes the conclusions reached by this study and the recommendations and suggestions made by this study for further research in the Assarah region.

Limitations of the Study

A broad-based research is faced with many problems and difficulties: First, the Assarah region is isolated from the rest of the country and is little known to researchers because of its rugged topography. Second, the basic reference materials about the region are very scanty. The only materials available for this study were a Ph.D. dissertation by Mughram in 1973, an M.A. thesis by Al-Shomrany in 1980, another M.A. thesis by Al-Ghamdi, and four general reports about the southwest region of Saudi Arabia published by the Ministry of Agriculture in 1969. Third, the most frustrating difficulty faced by this investigator was the total nonexistence of any detailed maps of the land use or the topography of the region. In short, it was soon found that any reliable data on the region were either severely limited or difficult to obtain from the offices of the Ministry of Agriculture. Fourth, the field survey, on which this investigation relies heavily, was extremely difficult to conduct and inordinately time consuming because of the highly rugged terrain, poor transportation facilities, and the location of the villages away even from the new paved highway that runs north-south through the region. Fifth, the personal interviews that were resorted to were beset with difficulties because a research inquiry like the present one was something strange to the entire population and they were extremely suspicious. Many prospective interviewees confused the questions with some kind of secret inquiry that had some bearing on their incómes and holdings. Many of the farmers interviewed were very reluctant to cooperate. Besides, this interviewer had to engage in prolonged discussion before any meaningful answers could be elicited to the main issues being investigated in this research. Some farmers refused totally to be interviewed or to engage in any discussion whatsoever. Those who made themselves available for interview had to be reached either in the central mosque or around their farms, and, often enough, the interviews had to be staggered into more than one session to suit the interviewees' schedules. Sixth, as has already been pointed out, the greatest difficulty encountered by this investigator was the nonavailability of any contour or land-use maps of the region. He had to rely on his own maps, sketches, and photographs of the region. It took him an inordinately long time to collect the reliable data, which have proven significantly rewarding for this dissertation.

In short, the information on which this study is based was built almost from scratch, as there existed no reliable body of comprehensive data regarding the study area. The data collection, it must be pointed out, took a heavy toll of this researcher's time, money, and prestige, as the people in the area largely look down upon all research: What can an outsider find out that we do not know already?

However, the moments of exhilaration experienced out of new insights and knowledge have sufficiently compensated for the hardships suffered, perhaps, as a necessary hazard faced by all who venture abroad on the rough seas. The field survey, which was undertaken in pursuit of this researcher's thesis for the master's degree at Michigan State University, has widened his knowledge of the land, its people, their customs and problems, and has enriched him in experience, which, despite his frequent visits with his family in the region and his childhood spent in the area, would have remained static and less illuminating, but for the trek of discovery through his native countryside.

CHAPTER II

REVIEW OF THE LITERATURE RELATING TO THE PHYSICAL LOCATIONAL, AND SOCIOECONOMIC FACTORS AFFECTING AGRICULTURAL LAND USE

In the analysis of agricultural land use patterns, several factors operating in various combinations in space and time determine the types, the spatial distribution, and the use of the land resources. Works by Adams (1960), Baker (1921), Barlowe (1978), Chisholm (1969), Dhillon (1977), Dunn (1952), Found (1971), and Symons (1979) have identified at least four groups of determinants, that is, the site characteristics, cultural preferences and perceptions, systems of production, and locations relative to the market, controlling land use.

While this study is primarily concerned with the physical, socioeconomic, and locational factors in the analyses of agricultural land use patterns, it is the purpose of this chapter to examine the manner in which these environmental factors operate to bring about spatial variations in agricultural production. It is hoped that conceptual and empirical background of the agricultural land use analysis, examined in the following pages, will provide a broad framework within which to formulate the present study.

Physical Factors Influencing Agricultural Land Use

Physical factors play a dominant role in determining the geographical distribution of agricultural land use patterns. Among the most recognized important physical factors affecting the agricultural land use are the topography, the climate, and the soil (Barlowe, 1978; Griffin, 1972; Symons, 1979).

The Climate

To a large extent, the moisture, precipitation, snowfall, hail, fog, humidity, the rate of evaporation, temperature conditions including sunshine, farming seasons during spring and fall, frosts, and wind determine land use (Symons, 1979, p. 21). In this regard, Baker (1921) pointed out:

> A third of the area of the United States and Asia, almost one half of Africa, and fully two-thirds of Australia are unsuited to crop production because of deficient moisture; a half or more of Canada and of Siberia, because of deficient temperature. The climatic factors also affect the use of the land indirectly because of their influence upon the comfort and health of the people. The tropics, where half of the arable land of the world is located, are probably not suited to permanent occupation by the white race. The yellow race, however, appears to possess a wider climatic range of adaptation and is able to live, labor and reproduce in the tropics. (p. 18)

Precipitation and the Supply of Water

Too much moisture, either from that trapped in the soil or from underground reservoirs and/or rivers and streams, is as harmful to agriculture as too little, but adequate moisture, trapped in the soil, helps plants to absorb the nutrients from the soil. Yet,

> The amount of water entering the soil . . . depends on a host of factors: the intensity and duration of rainfall, soil texture and structure, the amount and type of plant cover, the amount of leaf litter and humus on and in the surface soil, the amount of water already in the soil, and the steepness of slope. (Amato, 1976, p. 53)

In this regard, precipitation, for any given period of time, is considered highly significant to agricultural production as it provides the badly needed trapped soil moisture. Otherwise this much-needed moisture has to come from artificial irrigational means (Symons, 1979, p. 24).

Rain as a Source of Soil Erosion

Rainfall, however, can be equally harmful to agriculture if it becomes a source of soil erosion. This erosion is largely caused by runoffs which remove the upper layers of the soil much faster than they are replaced by fresh deposits. Heavy thunderstorms are another cause of heavy soil erosion. However, the amount of this soil erosion is dependent on the intensity of the rainfall, the nature of the soil including its texture and structure, and the slope of land. Low-slope areas abate the force of the runoffs, whereas the high-slope areas experience the full fury of the runoffs, resulting in a heavy denudation of the soil. Thus, moderately sloped areas have a moderate soil denudation.

> Protection against erosion calls for maintenance of vegetative cover, contour ploughing and construction of contour ridges, banks, stream control, etc. . . . . The risk of erosion should inhabit many farming practices and ought indeed, in some region, to be a major factor in deciding on the type of farming to be practised. . . . (Symons, 1979, p. 26)

Floods as a Source of Destruction

Floods are in part caused by poor drainage due to the soil texture and structure. Heavy rainfalls, for these structural and textural reasons, in regions of low rainfall and high evaporation, cause catastrophic floods and heavy erosions of the topsoil and the destruction of crops and vegetation.

Snow

Snow has both a positive as well as a negative effect on agriculture. When the snow melts in the low areas, it adds to the water reservoir of the soil. On the other hand, snow insulates the soil against low temperatures seeping down to the lower levels of the soil, protecting it from soil frost. Farmers in these areas take advantage of the protection provided by the snow and sow the fields in the autumn. Most of the negative effects of the snow, in fact, are due to its accumulation in the winter when farms become uncultivable and, if cultivated, result in a total loss or damage to the crops (Symons, 1979, pp. 26-27).

Effects of Temperature

The temperature of the soil and the surrounding atmosphere are as important for germination as rain and snow. Plants require varying degrees of temperature for their growth, maturation, and fruition. For agriculture, the ideal temperatures are 18 to 25 degrees centigrade. Low temperatures stunt the growth of plants; high temperatures in the initial periods of plant growth kill the young seedlings. It is estimated that the minimum temperature for wheat and barley is five degrees centigrade and for maize (corn) nine degrees centigrade (Symons, 1979, p. 27).

In order to understand the part temperature plays in agricultural production, we must have a fair idea of the life cycle of various crops, the period involved from sowing to harvesting times, and the kinds of atmospheric conditions most conducive to their growth. Most crops need what has come to be called the frost-free days, at least in the initial stages. Given this condition, wheat needs a minimum of 5 degrees centigrade and 1400 degree days of accumulated temperature. Rice, on the other hand, needs 3000 degree days, with an average temperature of 20 degrees centigrade (Symons, 1974, p. 28).

> However, temperatures far above the freezing point slow or stop the growth of many crops. Although the number of frost-free days usually has been used to indicate the length of the growing season, the temperature at which plants are killed varies greatly for different species, and even for different cultivators of the same species. Some are killed at temperatures well above 32 F (0 C). A rapid drop in temperature kills more frequently than does a slow drop to the same degree. (Metcalfe & Elkins, 1980, p. 100)

Frost

Frost is one of the main killers of crops, and the damage caused by it is particularly heavy wherever it occurs, often interrupting agricultural planning. In Siberia, for example, permafrost limits the growth of the tayga to larch and other trees. Agricultural cultivation in Siberia is limited only to the summer, with the result that agriculture is less rewarding than elsewhere in the world. Regions of very high altitude share the same fate owing to frost.

> Abnormally late frosts are particularly damaging since they catch a high proportion of plants at the seedling or early leafing stages when they are most vulnerable. Recovery, however, may take place if the frost is not too severe or repeated. Otherwise the farmer's only remedy is to re-seed with later maturing varieties, which is not always possible. (Symons, 1979, p. 29)

However, farmers have devised ways to protect their crops from frost. For instance, farmers keep paraffin heaters burning under the trees and plants, or they constantly keep spraying them with water throughout the frosty period. But either method is expensive and laborious (Symons, 1979, p. 29).

> Almost all of the earth's surface affords sufficient access to sunlight to permit some type of crop, range, or forest use. Optimum use of this possible access to sunlight, however, is prevented by temperature extremes--primarily by the problem of short growing seasons and unseasonable frosts. Baker has estimated that around one-fourth of the earth's land surface is too cold for wheat culture. Much of this area has value for forestry purposes, as is attested by the northern forests of Alaska, Canada, the Scandinavian countries, and the Soviet Union. Some of it also has commercial value for summer range, for the pasturing of sheep and cattle, and for provision of forage for wildlife and reindeer. Yet large areas such as the city expanses of the Arctic and the Antarctic must be written off as waste so far as current agricultural uses is concerned. (Barlowe, 1978, pp. 26-27)

Light and Sunshine

Light and sunshine are essential for agricultural growth and productivity. The sun provides the energy for photosynthesis in plants which, in turn, provide the carbon compounds that feed plant life. Solar energy also powers the water cycle. That is, it purifies and desalinates ocean water and provides fresh water upon which land life depends (Miller, 1982, pp. 63-82).

> The photosynthesic efficiency with which a plant converts light energy to chemical energy stored in the plant tissue sets the upper limit of crop output per acre. In other words, if photosynthesis is occurring at its maximum rate, additional inputs of water or fertilizer will not increase productivity. In regard to this environmental constraint, Bonner suggests that the upper limit of crop yield, as determined by the factors that regulate photosynthesic efficiency, is already being approached in those regions with the highest level of agricultural output, viz. Japan, Western Europe, and the United States. (Amato, 1976, pp. 49-50)

Length of Day

The length of day is a factor in plant growth and allows plants and crops to grow rapidly in regions of high latitude. During short summers, especially when the sky is clear, plants can complete the flowering and seeding essential to reproduction of the species, for rapid photosynthesis allows useful plants to use the long day to breed and preserve the species. In the tropical regions, the length of day is always below the critical level for some plants such as potatoes. In the subtropical regions, there are many plants that require about 100 hours of darkness for flowering. For some species the length of day (light) and the shortness of night (darkness) are unimportant (Symons, 1974, p. 30).

> Regardless of how favorable light, carbon dioxide, moisture, and nutrient conditions may be, plant growth ceases when the temperature drops below a certain minimum value or exceeds a certain maximum value. Between these limits there is an optimum temperature at which growth proceeds with greatest rapidity. Change points out that these temperatures are comparatively low for cool growing season crops such as oats, rye, wheat, and barley minimum 32 to 41 degrees F., optimum 77 to 88 degrees F.,

> and maximum 88 to 99 degrees F. For warm growing season crops such as melons and sorghums, the critical temperatures are considerably higher: minimum 59 to 65 degrees F., optimum 88 to 99 degrees F., and maximum 111 to 122 degrees F. (Amato, 1976, p. 51)

Winds

Winds increase the rate of evapotranspiration and consequently increase the need for water. They, often enough, are a source of destruction to agriculture and cause serious damage to the crops because of their excessive force due to velocity. Their positive contribution to agriculture consists in the driving force for windmills for pumping water for irrigation and generating electricity, as affirmed by the following passage:

> In regions subjected to strong winds, like the British Isles, cereal crops are frequently blown over or lodged and strength of stalk is an important factor in choice for variety sown. Very strong winds sometimes thresh the crop while it stands leaving only a straw residue to be harvested. "Killing" winds in many countries are associated with particular directions of origin. The Misteral of the South of France, a cold, northerly wind funnelled by the Rhone Valley, sometimes brings heavy losses to growers of olives, citrus and other fruits on the Mediterranean low land. . . . (Symons, 1979, p. 30)

Based on the analysis of the effect of the climatic factor on agriculture, this investigator finds the conclusions reached by Barlowe (1978) in <u>Land Resource Economics</u> fully justified--that

> . . . only 34 percent of the world's land area enjoys both an adequate and a reliable supply of rainfall, and that only 200 million acres--considerably less than 1 percent of the world's surface land area--benefit from irrigation. Baker's estimates show that only 11 million square miles, 20 percent of the earth's land surface, have suitable temperature and moisture conditions to permit wheat culture. Of the 41 million square miles with suitable temperature conditions for wheat, Baker found that 17 million were too dry while 13 million were too wet for wheat culture. (p. 27)

The Soil

The soil, besides providing the medium for agricultural activity, serves to preserve the moisture for crops and stores badly needed nutrients essential for the growth and development of plant life. In fact, cereal production is largely restricted to areas of high-clayey-content soil of high natural fertility (Griffin, 1972, p. 124).

> The soils that cover the earth's surface vary considerably in color, structure, texture, physical constitution, and chemical composition and in their natural characteristics. They range from light-colored soils to black earth, from heavy clay to sand and gravel, from shallow soils to deep formations, from soils that tend to be acid to those that are alkaline, and from soils that provide plants with little more than space and foundations to soils of high inherent productive capacity. Agricultural uses vary somewhat in their soil requirements, but most crops are responsive to fertile and productive soils. The same may be said of grazing and forest uses, even though these uses are often relegated to the less fertile and less desirable lands. (Barlowe, 1978, p. 28)

Baker (1925) found that wheat is not grown successfully on sandy, gravelly or peaty, or heavily clayey soils in cool climates. In warm climates, clayey soils take on a more permeable character and are often used for wheat (p. 28).

Amato (1976), on the other hand, pointed out that fine-textured soils of high potential fertility do not necessarily mean that they are the most favored for all or even for most types of agricultural systems. Clayey soils have several characteristics that are not conducive to agricultural production. For instance, the clayey soils are often difficult to cultivate because of their stickiness and plasticity when wet, their firmness when moist, and their tendency to bake hard in hot, dry weather. Furthermore, their low permeability often renders them unreceptive to rainfall, thereby making them prone to erosion from runoff even on gentle slopes. Other deficiencies of fine-textured soils include poor oxygen content and high carbon dioxide levels due to poor aeration, stunted growth of plant life (p. 55).

However, in comparison to the potentially fertile clayey soils, the coarse-textured soils have a low potential for fertility. But this type of soil, characterized by having a texture of sand and gravel, is looked upon as being highly suitable for many forms of commercial agriculture in technologically advanced societies, such as the production of high-value specialty enterprises like fruit and vegetable farming and horti- and floricultures. For the sand- and gravel-textured soils usually have a loose consistency and high tilth quality, favoring ease of cultivation, air and water movement, and root development. Moreover, this type of soil tends to warm up much faster in the spring than the clayey type. Agriculturists, farming on coarse-textured soils, are able to put their produce on the market while prices are still high (Amato, 1976, p. 55).

Soil depth is another element that affects crop productivity and farming practice. If the bedrock is near the surface, normal root development is retarded and the supply of nutrients and water tends to be too low to meet the needs of the crops throughout the growing season.

> Pearson and Harper have indicated that around 46 percent of the earth's surface is covered with "good soils," which are suitable

> for crop use. This estimate may be taken as a general measure of the world's soil characteristics. It must be remembered, however, that soil conditions vary a great deal, that the supply of the more productive soils is relatively limited, that man is continually drawing upon less and less fertile areas, and that the decision as to what is "good soil" involves value judgements that may change with time and circumstances. Furthermore, the requirement of "good soils" for cropland use is not an unwavering one because numerous soil deficiencies can be overcome with fertilization, soil-building practices, irrigation, draining, and other measures. (Barlowe, 1978, p. 28)

Topography

Topography, among the natural factors, greatly affects the geographical distribution of agricultural land use and productivity. Among the most important elements of topography are altitude and slope. The effect of the altitude is largely indirect through the climate, while the slope affects land use and productivity more directly, as agricultural activity is directly limited by the steepness of the terrain.

> The primary consequence of high altitude is lowered air pressure. . . . The secondary effects of decreased mean temperatures and increased precipitation and wind forces are the economically important consequences of higher elevation. (Symons, 1979, p. 46)

At high altitudes, temperatures fall as the altitude from sea level increases at a rate called the lapse rate, because of the exposure and the aspect of the slope. Also, at high altitude winds and precipitation are high and cause severe thunderstorms that erode the soil and damage crops (Symons, 1979, pp. 46-52).

The effect of the slope on agricultural land use is both positive and negative. On flat land, gentle slopes tend to create soils of sufficient depth, fertility, and proper drainage to permit the development of large-scale crop farming. The negative influence upon rural land use is most meaningfully expressed in mountainous regions of the world. Here, relatively high local reliefs associated with rocky soils inhibit any type of crop production in the area. Areas of steep slopes usually have shallow soil profiles and are very rocky and, consequently, unsuitable for plowing. Sometimes these steep slopes with thin soil layers can support only sparse grass with a limited grazing potential. The mountainous regions usually experience heavy soil erosion, which further limits farming. In many places of the world where the terrain is characterized by steep slopes, terracing was the only way to control erosion and conserve water for agriculture (Griffin, 1972, pp. 127-29).

Based on the data from MacGregor (1957) about Great Britain, Amato (1976) illustrated a correlation between the inclination of the slope and the land use. He concluded that slopes of 5 degrees or less are most easily cultivable by farmers; that slopes of 10 degrees, while easily cultivable by farmers on foot with some physical effort, present some difficulties in the use of heavy farm machinery; and that the 20-degree slopes represent the limit beyond which it is well nigh impossible to use heavy agricultural machinery (p. 57).

Finally, Boyce (1974) described the man-land relationship in the following terms:

> Finally, man often modifies physical features to suit his needs. Agricultural crops are surely much affected by climate and soil

> variables, yet man has many ways of overcoming such natural obstacles. He can fertilize poor soil, drain wet soil, irrigate arid areas, and through the application of chemicals, overcome such problems as soil acidity and alkalinity. Given steep slopes, which in their natural conditions normally prevent agriculture because of soil erosion, he may terrace land to make it usable. In rolling topography, the land may be leveled to make it suitable for irrigation. For example, in the Palouse grain-growing area of Washington, special machinery with balancing devices has been developed, so that very steep slopes can be traversed without the machinery tipping over. . . . (p. 40)

Sociocultural Factors

Agricultural land use is as much a product of the physical factors as the socioeconomic and institutional environment. The socioeconomic and institutional factors include the population distribution and density, farmers' perception and attitude, and their organizations and societies, internal and external migration of farmers, urban sprawls, the tenure of agricultural land and fragmentation, farmers' customs, habits and traditions, their education and religion, the state of the technology, and mechanization of agriculture. Among the economic determinants are the labor force, transportation costs, the market, income, production, and the price of agricultural produce. The institutional conditions governing agriculture include state subsidies, agricultural extension and research, land reforms, planning, and taxation (Mohammad, 1980(b), p. 225).

In the following pages, based on an overview of the theoretical dimensions of rural land use with relation to selected socioeconomic and institutional conditions, an attempt is made to explain the role of these conditions as a cause for variations in agricultural land use patterns.

Population Distribution

Population distribution is most significantly related to variations in the spatial distribution of patterns and the intensity of agricultural land use. As in the case with the physical environmental factors, the socioeconomic and institutional factors are seldom independently linked to the geographical patterns of agricultural land use. Rather, they must be analyzed in combination with the physical environmental determinants if a meaningful interpretation of the geographical arrangement of land use is to be made (Griffin, 1972, p. 129).

> If physical elements alone do not explain population distribution, what other factors are involved? Human distributions are molded by the organization, technology and development of economic systems. They are strongly influenced by culture traits, which also affect demographic components of fertility, mortality, and migration. Social disasters, like war, may alter population distribution at any scale. Social and political decisions, such as tax policies or zoning and planning ordinances, are eventually reflected on the population map. Time or inertia has a profound impact on distribution. We must always consider historical circumstances when we are trying to interpret the variable distribution of people over the earth. (Souza & Foust, 1979, p. 43)

Several studies have indicated a positive relationship between the population distribution and the spatial organization of agricultural land use patterns. Baker (1926) classified agricultural regions of North America on the basis of physical, socioeconomic, and institutional factors. He found that the population distribution within each region of the United States is a factor affecting the pattern of agricultural land use (p. 478).

Another study by Griffin (1972) in Uruguay showed a positive relationship between the agricultural land use and the population distribution. In particular, Griffin pointed out that the Uruguay population distribution is the primary cultural phenomenon affecting the pattern of agricultural land use. The country's population is concentrated in the south, particularly around Montevideo, while the rest of the land use has remained unoccupied by the Uruguayan population (p. 130).

The major feature of the population distribution in relation to agricultural land use is the concentration of intensive farming around major urban centers. However, extensive agriculture dominates the areas sufficiently far removed from these major cities, where the cost of transportation of agricultural products inhibits the production of the high-value, bulky, and perishable farm produce. Most of these areas are devoted to an extensive type of land use for grazing. The location of the intensive crop-production areas around urban centers is predicated on the influence of an attractive market (Griffin, 1972, pp. 130-31).

Ethnicity

Sometimes the ethnicity of the population influences the patterns of agricultural land use. In many countries, immigrants usually bring their specialized agricultural skills and techniques with them, establishing a familiar agricultural system of land use patterns (Amato, 1976, p. 63).

The Role of Literacy

Huntington (1926) examined the role of literacy of farmers in agricultural land use of good and poor lands in the northern and southern regions of the United States. He reached the conclusions that the northern-region White, Black natives, and immigrant Whites farming good agricultural land had a low literacy level and those working poor lands, a higher literacy level. However, overall illiteracy is more common on poor-land farms than on the good, as the people on it have limited opportunities to educate themselves because of their poverty. In the South, both the native-born and immigrant Whites, farming good productive land, were found to have a low literacy level, while those on poor farm lands showed higher levels of literacy. The Blacks who live on poor lands have lower literacy levels than Southern Blacks who live on good-soil farms. In other words, those Blacks living on the poor farms in the South are a trifle better educated than those on good farms (pp. 351-53).

Population Density

In many parts of the world there is a distinct relationship between population density and land use intensity. This relationship becomes all the more significant when a large population is concentrated in a small area. The Nile Valley in Egypt forms a good example.

> With Egypt, for example, the average density figure of 37.1 persons per square kilometer suggests a population distribution similar to that found in the United States, which has an average density of 27.6 in its contiguous 48 States. The situation appears differently, however, when it is noted that 98 percent of Egypt's population is concentrated on about 3 percent of its land area and that the Nile Valley has what is probably the highest density of agricultural population in the world. (Barlowe, 1978, p. 59)

The relationship between population density and the intensity of land use will largely determine the level of demand for agricultural commodities and the potential labor supply. The pressure of population has not helped the growth of agricultural production but has, in fact, led to the change in cropping pattern. This phenomenon has been studied particularly in the West Bengal region of India (Williams, 1973, pp. 40-43).

The changing patterns of agricultural land use due to the increasing population pressure could be studied in greater depth at a micro level in a predominantly agricultural tract. Robinson and others (1961) found a high positive correlation between the farm population density and the percentage of the total land used for crops in the rural farm population of the Great Plains (p. 215).

Population Density and Farm Size

There exists a significant relationship between population and the size of a farm. An inverse relationship between farm size and the intensity of land use tends to reflect the fact that larger farms are located in sparsely settled areas where labor is scarce and the demand for agricultural products is low. Chisholm (1969) affirmed that the size of a farm does have some influence on the type and intensity of land use and the density of the rural population.

> Most populations are . . . immobile, finding changes in geographical location and/or employment difficult. Under these circumstances, a change in the number of inhabitants will have an immediate effect upon the size of farms in the area concerned. With an increasing populace, there will be strong pressure for the division of holdings and a general intensification of output. In such a case, it is not the size of farm which is the cause of the type and intensity of agriculture; both are consequences of a more basic factor, the increase of population. (p. 149)

Effects of Farmers' Perceptions and Preferences

Different cultures have different food habits and preferences, and this fact affects the type of food that is produced. For example, Muslims are prohibited to eat pork and Hindus beef by their respective religions. Many Africans and others do not eat protein-rich chicken. On the other hand, Europeans, Americans, and some other cultural groups have very little lamb on their menus. And quite a size of the population of the world is vegetarian. The cultural eating preferences, in turn, affect the patterns of agricultural land use. For instance, the American farmer devotes a sizable proportion of his farm to forage crops, whereas countries like China and India, where animal meat does not form a sizable part of the people's eating habits, devote most of their farming to food grains (De Souza et al., 1979, pp. 159-60).

Rural Migration in Cities

In most societies, migration to urban centers from rural areas is a common phenomenon, particularly when these societies are in the process of industrialization. If this migration is continuous and large, most low-productivity farm lands are abandoned first, and later even the good high-productivity land is left to lie fallow. This migration, in the second place, creates a heavy pressure on the services in the cities. Many socioeconomic and physical causes, in turn, tend to accelerate this exodus to cities. Among the most important are regular drought conditions on farm lands, unhealthy environmental conditions, and very often, lures of bettering one's condition economically (Al-Thubaity, 1981).

The Role of Land Tenure

In many societies, land tenure is both a legal as well as a cultural factor and has a direct effect on agricultural production. Barlowe (1978) pointed out that it is "a concept that involves the many relationships established among men that determine their varying rights to control, occupy, and use landed property."

> Much as agriculture in the modern world differs from the olden days, the ties between farmer and land remain. Thus, the rules controlling ownership of land and the rights of its use are as important as ever. In some countries outdated laws and customs still prevail, in others they have gradually been adapted to new circumstances. Elsewhere revolutionary land reforms have at one stroke abolished the old order. The four main types of land tenure existing today are (1) communal tenure, (2) latifundium or estate, (3) freehold ownership, and (4) tenancy. (Brook et al., 1978, p. 242)

Rural Settlements

Rural settlements influence the geography and organization of agricultural land use. There are three types of rural settlements observed: (1) clustered rural settlements, (2) dispersed rural settlements, and (3) semicluster rural settlements. The first type is referred to as the farm village where the farmers group themselves together in cluster settlements, varying in size from a few farmers to as many as 25,000 essentially agrarian people. The pattern of distribution of land use usually consists of a farmstead in the village and the farms, pastures, and meadows stretched out in the country even beyond the limits of the village.

The second settlement type is known as the isolated farmstead. In this type, the farming community lives in dispersed, isolated farmsteads, at least a mile or so from their nearest neighbors. This type is best suited for efficiency in production and transportation (Jordan et al., 1979, p. 69).

The third type of settlement is characterized by being neither clustered nor dispersed. Instead, the settlements share characteristics of both. The most common types of semiclustered settlements are: hamlets, which consist of a small number of farmsteads grouped loosely together. The hamlet farmsteads lie in the settlement nuclei separate from the crop land. The size of the hamlet is small, consisting of 3 to 20 houses. The row village is a type of semiclustered settlement. In this settlement pattern, a line of farmsteads is spaced at intervals along a road, a river, or a canal. The spatial distribution of the houses of the row-village farmsteads is spaced farther apart from those in a street village. This type is found mostly in North America, Europe, Brazil, and Argentina. The distribution of these farmsteads maximizes control of the farms. That is, farms lie adjacent to the farmers' homes, permitting economies of travel and life in a closely knit community (Jordan et al., 1979, p. 69).

Farm Mechanization

Farm mechanization is a means to an end and not an end in itself. Agricultural mechanization is essentially a labor-saving device and is introduced basically to increase agricultural production, create employment opportunities, and reduce rural poverty and promote equitable distribution of income. It is essential to mechanize agriculture in ways that meet all three objectives at once and to avoid all that adversely affects these goals.

> Since any form of mechanization assists or replaces hand labor in agriculture, it inevitably displaces some portion of the rural labor force. The resulting dislocation may be alleviated in part by local diversification of the economy. Mechanization proceeded in the face of labor shortages in Japan, Korea, and Malaysia, but caution should be exercised elsewhere to make sure that displaced laborers have alternative employment. (Hemmi et al., 1981, p. 9)

Urban Sprawl

Urban sprawl, the expansion of the urban centers into the rural areas, is due to increases in the city populations that require a permanent home in the city and a second home in the countryside. This phenomenon has caused changes in the organization of agricultural land use and a decline in agricultural productivity. Large areas of prime agricultural lands have been encroached upon and converted to urban use (Wilkening et al., 1978).

The Systems of Agricultural Production

Based on the commitment of farm labor, the systems of agricultural production can be classified as peasant-based, capitalist, and socialist systems. Under the peasant-based system, production is carried out in small units by the family members as a joint venture. In both the socialist and capitalist systems, the family still farms the nucleus of the production, but the entrepreneurs can hire and fire farm labor as their needs and the sizes of their operations dictate (de Souza et al., 1979, p. 160).

Economic Factors

The effect of social and cultural factors on agricultural land use was discussed in the previous section. It has been found that social and cultural values can strongly influence crop patterns, especially in the countries where agriculture is a way of life. Farming communities and societies have developed their own habits and traditions, with the result that the crops that are best suited to the soil and that can be economically cultivated are grown. Farmers, through time, have devised means of meeting the variations in their environments. They know the quality of their farms and the crops that are best suited for them under any given conditions of temperature and precipitation. They are aware of the economic gains from choosing particular combinations for their holdings. Further, each farmer knows that growing the same crop, year after year, on the same land results in diminishing returns and will diminish his soil quality. Crop rotation, therefore, is invariably practiced (Mohammad, 1980, p. 334).

Labor

Labor is an important factor affecting all agricultural systems. Labor requirements vary from one crop to another because crops are different. All the countries of the world, even the highly mechanized, capital-intensive countries like the United States, Japan, Australia, Western Europe, the Soviet Union, and other industrialized nations, rely on the availability of a dependable supply of cheap labor, frequently on a seasonal basis. Labor needs are particularly intensive during planting and harvesting seasons.

> In typical British conditions for example, about 5 man-days work are required annually per hectare of wheat, about 25 man-days per hectare of sugar beets and about 170 man-days per hectare of hops. (Symons, 1979, p. 82)

From these figures, it is apparent that labor shortages force a range of specific needs and restrictions on the type of farming that is practiced. In other words, a scarce labor supply has serious consequences for growers and is reflected in higher prices for consumers.

As the population increases, labor supplies increase and more intensive farming becomes inevitable, although desirable land holdings tend to become smaller. Where there is a dense population living on agricultural land, intensive agriculture capable of providing the maximum subsistence is necessary. The paddy or wet rice farming, which can absorb over 4000 man-hours per hectare per year, is a good example of this type of agriculture. Above the optimum, labor input brings diminishing returns, even with rice or other labor-intensive crops.

Transportation

It is essential to move agricultural products from the producers to the consumers. The development of many new agricultural areas in Asia, Africa, and Latin America has been hindered by the lack of good transportation systems. The development of new arable land always requires the construction of good agricultural roads. Roads need to be given a high priority in all development schemes. Review of the road systems in developing countries illustrates their poor communication and high transportation costs. In order to transport farm products to the main markets, the farmers have to use slow, traditional methods of transportation. In developed countries like Western Europe, the United States, Japan, Australia, and New Zealand, the advantages of low unit cost and operating flexibility are apparent in the development of good transportation systems, which include railways, waterways, highways, and agricultural roads. The effect of transportation is obvious in commercial farming with high agricultural productivity and high returns, for example, in the United States. Poor transportation facilities dominate where subsistence agriculture is practiced, for example, in Africa (Griffin, 1972, pp. 134-35; Symons, 1979, p. 70).

Agricultural Marketing

All business activities involved in the flow of food products and services from the producer to the consumer is termed agricultural marketing. In other words, it includes the movement of goods from the farm to the processors, wholesalers, or directly to the individual households. Agricultural marketing influences agricultural land use, in that increased demand for a particular product tends to generate production of that commodity. The lack of agricultural marketing has a negative effect on agricultural land use because commercial farming, for example, tends to become subsistence farming without agricultural marketing opportunities. Together, this need for marketing and the number and the diversity of farmer-producers make farming a financially high-risk occupation. Unless farmers establish and develop some form of group control, as producers they find themselves in a weak position in relation to their markets (Kohls et al., 1980, p. 19; Tarrant, 1974, p. 204).

Income

As with other economic factors, income influences agricultural land use patterns. Farm income, as well as consumer income, is influential in determining what farmers grow on their farms. Farms are devoted to the types of production that fetch the best returns over a number of years. From the practical point, the farmer would not like any increase in production costs for buying more fertilizers or hiring more labor unless the farm income has a corresponding increase. Such a farmer will not allow his farm income to drop unless the cost of production is proportionally reduced. This means that small farms, which do not enjoy economies of scale, must be worked more intensively than large ones to obtain high income. The growth of highly specialized, large-scale agricultural units, such as dairy farming and cattle rearing and fattening operations, are less intensive enterprises and are better suited to large farms, where labor cost is low, than in intensive agriculture. The income derived from these farms, as well as from other commercial agricultural enterprises, is high in comparison with the income from subsistence agriculture.

A general rise in incomes of the population creates an increased demand for agricultural products and brings about a change in the food habits and preferences, affecting the type of food consumed. This results in farmers diversifying plant- and animal-food production. Since all farmers cannot produce all types of food, they tend to specialize in specific agricultural production (Kohls et al., 1980, pp. 84-85).

Agricultural Production

Farmers have little control over the prices at which their products are sold. To obtain a surplus, or personal income, farmers must concentrate on the production they can market and from which they can realize at least their expenses. Such production can be increased by the optimum use of water and land resources and by the selection of crops most suitable to the area. Intensifying farming or increasing the amount of productive land will only increase productivity as long as revenue increases exceed cost increases. Optimum production is achieved when marginal costs and marginal revenues are equal. In other words, profitable production is reached when total revenues exceed total costs.

> For any particular crop or animal product, certain places are particularly favourable for production, i.e., because of climatic, labour and other production factors, and convenient markets, income comfortably exceeds outlay. Away from these favourable areas, cost rises and returns are lower, until eventually the zone is reached where the particular type of production does not pay. . . . (Symons, 1979;, p. 80)

Institutional Factors

Institutional practices that have an effect on agricultural land use include the role of the government policy with regard to subsidies, extension services and research, taxation, and land reform. Institutional factors are important because of their continuing influence on producers' and consumers' economic behavior. While they help make economic behavior more stable, at the same time they help make it changeable, dynamic, and unpredictable. "The various aspects of group, collective, or social action may be described as institution or institutional factors" (Barlowe, 1978, p. 375).

The role of government policy in agricultural land use is discernible in almost every country in the world. Every decision regarding land ownership or the use of its resources is in some way affected by public policies or restrictions. Political factors are more recognizable in some land use patterns than economic and social motives. Real property and estate taxes change land use patterns by making some uses unprofitable. Production of certain crops can be made profitable by the imposition of protectionist measures. Restrictions on imports often serve to protect local producers against foreign competitors.

> Real property taxes represent an annual levy on real estate ownership and can be used to force lands into more intensive uses. Inheritance taxes--or "death duties" as they are known in Great Britain--can force the breaking up of landed estates. The power of eminent domain can be used in the public acquisition of properties from owners who are unwilling to sell. Various aspects of the government's sovereign or police power may be used to protect property rights, prevent fraud, and force individual compliance with public health standards, building codes, or local land-use zoning ordinances. (Barlowe, 1978, p. 380)

Barlowe (1978) illustrated the effect of public policies and restrictions on the development and use of real estate resources by the United States government in such measures as (1) acquiring additions to the public domain and prescribing public land disposal, prompting rapid settlement of public lands; (2) preserving agricultural land and stemming the rapid encroachment of urbanization upon agricultural land use; (3) acquiring land from private owners for forestation, military, and other public purposes; (4) making additional credit facility available to the farmers and conservationists; (5) subsidizing efforts to encourage conservation of water, soil, and land; (6) providing price supports to bring stability to the agricultural sector of the economy and rent controls to prevent tenant-gouging during periods of severe housing shortages; and (7) issuing land-use zoning ordinances, subdivision regulations, forest-cutting restrictions, and directing private land-use practices in the public interest (Amato, 1976; Barlowe, 1978).

Griffin's (1972) study noted that taxation policies have generally affected agricultural land use intensities in Uruguay, while subsidies have played a critical role in determining whether particular crops like wheat or sugar cane can be produced and to what extent.

According to him, such institutional factors exert a greater influence on the intensity of land use than on the spatial distribution of farming systems. Both are important, however, in explaining the causal relationships interacting to produce present patterns of agricultural land use.

Locational Factors Affecting Agricultural Land Use

The purpose of this section is to examine the role of locational factors in the spatial distribution of agricultural land use to bring about spatial variation in agricultural production. The relative location of a place, vis-à-vis its access to important places and the market, often plays a decisive role in determining the uses to which various tracts of land are put for the benefit of local as well as international markets (Barlowe, 1978, p. 35).

The importance of relative location in agricultural land use was first studied by geographers, whose discipline concerns areal differentiation over space. A primary concern of geography is spatial patterns or the relationships of physical and cultural factors in earth space. Since the earliest geographic research, spatial variation has been a unifying theme of geographic studies (Griffin, 1972; Najm, 1982).

The study of areal variations has also captured the attention of many economists, including agricultural economists, since the beginning of the nineteenth century. Economists become involved in analyzing relationships between geographic locations and land use patterns to determine those factors that affected such economic characteristics as intensity of land use, competition between land and the location of enterprises (Barlowe, 1978; Griffin, 1972).

Geographers, regional scientists, and agricultural economists, over the last two and a half decades, have had a growing interest in location theories because of their need for an objective and general explanation for the spatial organization of agricultural land use. This intellectual pursuit has revived interest in several classical theories of location and led to a re-examination and elaboration of Von Thunen's theory of agricultural location (Dayal, 1981, pp. 31-41).

The researcher's intention in this section is to review some of the literature dealing specifically with agricultural land use theory. The importance of relative location is expressed in terms of distance and accessibility to market will be emphasized. The effect of urban sprawl on agricultural land use will also be examined in relation to the recent location theory.

Overview of Agricultural Land Use Theory

Ricardo's model.--Ricardo introduced the concept of economic rent around 1817, and it has since become an important part of classical economic theory. His economic rent relates land quality, measured by natural soil fertility, to farm income. Farm income per acre is greater where soil is more fertile, assuming equal production costs and market prices (Butler, 1980, p. 60). "Ricardo describes economic rent as income arising from the use of land of superior fertility, in comparison with the income that comes from the use of marginal land" (Dayal, 1981, p. 14). Ricardo also indicated that the most fertile first-grade land would be brought under cultivation first, with increasing demand for agricultural products, and because of the population growth, cultivation would extend to less-productive second-grade land. The increased demand would cause shortages of agricultural products in the market, resulting in higher prices and enabling farmers to bring less productive land under cultivation for the welfare of society.

> When less favorable land or second grade land is brought under cultivation, the farmers on more productive land will have an advantage over those cultivating second grade land, in that they will earn additional income per unit of land because of the "original and indestructible power of the soil," that is, the difference in soil productivity. Thus, additional income that the farmers on first grade land get becomes the rent of first grade land. (Dayal, 1981, p. 14)

In other words, Ricardo realized that land is fixed in quantity, immovable, and varies in quality, that is, soil fertility, with the result that progressively low quality land is brought under cultivation as the population and demands rise. The owners of the first-grade land usually receive the same price for their product at the market, but their production costs per unit of output are low, giving them surplus returns. These surplus returns constitute economic rent (Butler, 1980, p. 61).

McCarty and Lindberg presented a diagrammatic version of Ricardo's rent theory (Figure 2). In the center there is an area of "optimum" conditions for the production of certain crops. Toward the

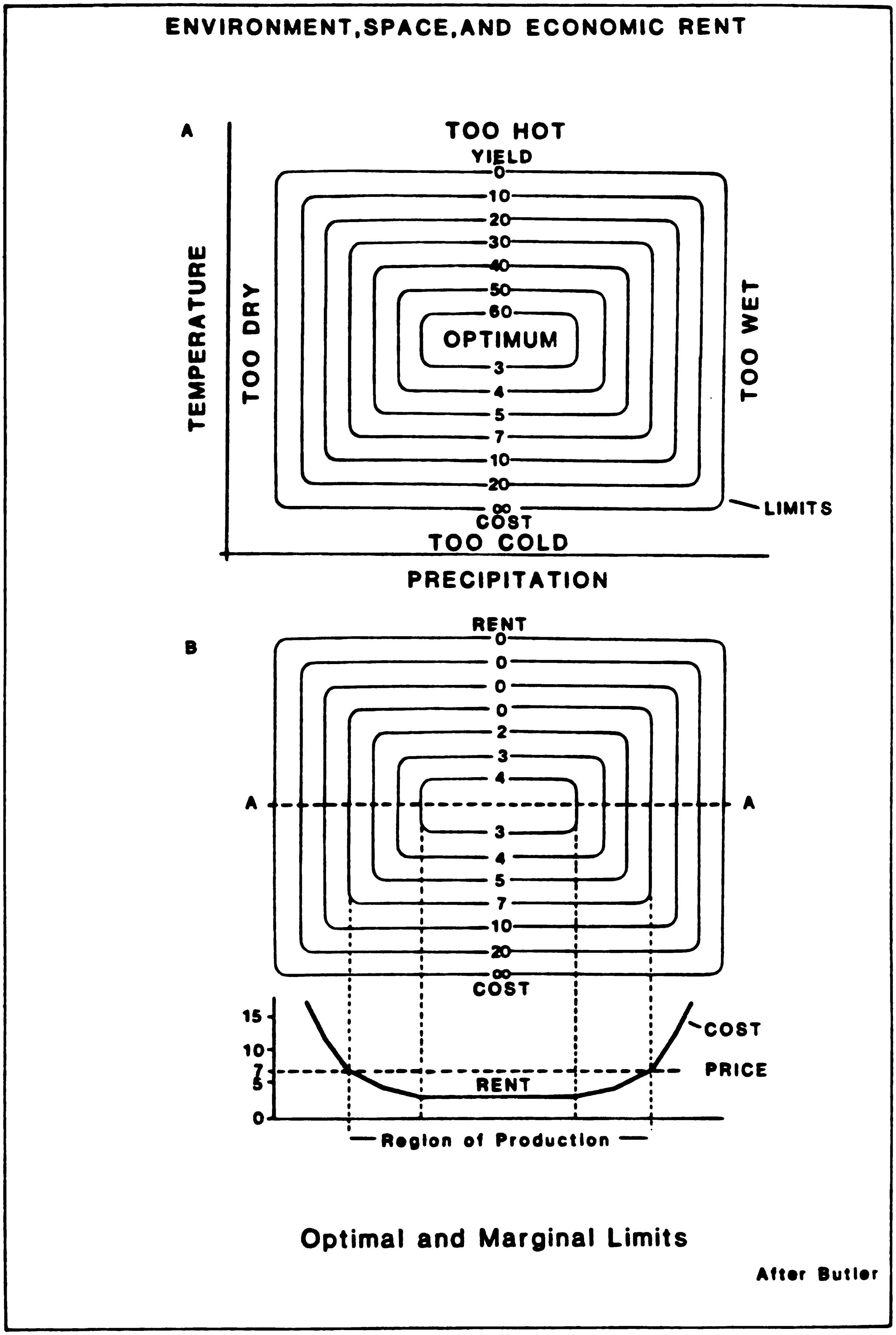

ENVIRONMENT, SPACE, AND ECONOMIC RENT
A
TOO HOT
YIELD
0
10
20
30
40
50
60
OPTIMUM
3
4
5
7
10
20
∞
COST
TOO COLD
TEMPERATURE
TOO DRY
TOO WET
LIMITS
PRECIPITATION
B
RENT
0
0
0
0
2
3
4
A
A
3
4
5
7
10
20
∞
COST
15
10
7
5
0
COST
PRICE
RENT
Region of Production
Optimal and Marginal Limits
After Butler

Figure 2

periphery, conditions become less and less favorable, and a limit is finally reached beyond which production becomes impossible, owing to severe limitations of moisture and temperature (Dayal, 1981, pp. 14-15). The costs of production per acre increase as one moves outward away from the optimal physical conditions for the crop. Rent is high in this central "optimum" zone and decreases toward the periphery (Figure 2-a). The rent of land beyond the zone of production feasibility is zero. In Figure 2-b it has been assumed that a price of $7 per unit will meet the costs of production up to the end of the fourth zone. This establishes the amount and areal extent of rent produced. Beyond the fourth zone, then, land will be cultivated only if there is a rise in market prices increasing the marginal (revenue) productivity of the land. Changes in the climatic variables or prices change the amounts of rent produced and the configurations of the profitable production region (Butler, 1980, p. 62).

Further, in 1817 Ricardo formulated his Law of Comparative Advantage to explain regional differences as the bases for specialization and trade. The theory of Comparative Advantage says that the world output will be maximized if each nation specializes in the production of those commodities and services that it can produce relatively cheaply. The exchange earned from exporting competitive items can then be used to import products in which other countries have a comparative advantage (Butler, 1980, p. 67; Zuvekas, 1979, p. 109).

> Generally speaking, each area tends to produce those products for which it has the greatest ratio of advantage or the least ratio of disadvantage as compared with other areas. This concept is known as the "principle of comparative advantage." In practice, it

> explains why some areas tend to concentrate on the production of a limited number of goods while they look to other areas for many of the products they use. (Barlowe, 1978, p. 268)

Von Thunen's model.--The locational theory of agricultural land use had its origin in northern Germany in 1826 when Johann Heinrick Von Thunen published his classical work, The Isolated State. Von Thunen's model is considered the first economic model of spatial organization that emphasized the importance of relative location in agricultural land use, based on the simple idea that rents decline with distance. From his experience as an estate manager, Von Thunen observed that identical plots of land would be used for different purposes, depending on their accessibility to the market. In The Isolated State he explained the relationships among (1) agricultural prices, (2) distance of farms from the market, and (3) land rent (Berry et al., 1976, p. 126; De Souza et al., 1979, p. 166; Najm, 1982, p. 44).

1. The model assumptions. The model assumptions made by Von Thunen are expressed in the opening lines of The Isolated State. These assumptions enabled him to focus on spatial differences and, in particular, upon the effects of transport costs on agricultural land use.

> Imagine a very large town, at the centre of a fertile plain which is crossed by no navigable river or canal. Throughout the plain the soil is capable of cultivation and of the same fertility. Far from the town, the plain turns into an uncultivated wilderness which cuts off all communication between this state and the outside world.
>
> There are no other towns on the plain. The central town must therefore supply the rural areas with all manufactured products, and in return it will obtain all its provisions from the surrounding countryside. The mines that provide the State with salt and metals are near the central town, which, as it is the only one, we shall in future call simply "the town." (Hall, 1966, p. xxi)

According to Foust and de Souza (1978, pp. 30-31), this landscape is an isotropical surface, an unbounded, flat plain, and homogeneous in all respects. Movement is equally easy in all directions, and the unbounded surface eliminates the need for boundaries. Transportation costs are a simple linear function of distance. Costs are the same per kilometer regardless of the distance travelled. There is only one form of transportation which has been assumed by Von Thunen. The physical environment of the imaginary landscape is completely homogeneous. All land has equal soil fertility. Every hectare produces exactly the same output with a given amount of labor and capital input. In the central part of the isotropical surface there is only one single city or marketplace. The farmers are assumed to sell their product at this market, and the city producers manufacture goods to be exchanged for agricultural products. At the marketplace, the prices are assumed to be stable and fixed. A farmer delivering a load of wheat to the city must take the price offered. Farmers are unable to alter the prices of crops through individual or collective action. Government intervention is excluded. No price supports and controls are allowed. Agricultural production is solely a reaction to the economic conditions. Finally, all inhabitants are assumed to be optimizers. They have perfect knowledge of all possible outcomes of a given action and act solely to maximize profits.

> These assumptions are severe: a plain with complete physical homogeneity; a single market, the "town"; a single source of food supply, the plain; transportation costs related only to volume and distance shipped; and decisions made by economic man, relentlessly

> organizing space in an optimal way. But these assumptions are needed in order to establish the role of distance, whose operation in reality is in constant conflict with other factors affecting land use, including variations in climate, soil fertility, management, and transportation network with its freight-rate structure (Berry et al., 1976, p. 126).

2. The law of diminishing returns and the marginal productivity analysis. The law of diminishing returns is one of the most important factors that affect man in his use of land. This economic principle was an important addition to Von THunen's model of agricultural land use. By the law of diminishing returns, each successive increase of inputs yields a smaller increment of production than the last one (Chisholm, 1969, p. 26). The concept of diminishing returns can best be illustrated by the following quotation from Barlowe (1978).

> Man has long observed that whenever successive inputs of a productive factor are added to a limited fixed factor, a point is soon reached after which the additional or marginal output of product per unit of input decreases and eventually becomes a negative quantity. This principle is known as the law of diminishing returns. (p. 130)

The law of diminishing returns states that as successive units of a variable input (labor) are added to a fixed input (land), the total product (output) usually passes through three stages: (1) an increase in the total physical product at an increasing rate, (2) an increase at a declining rate, and (3) finally a decline (Figure 3) (Barlowe, 1978, p. 131; de Souza et al., 1979, p. 167).

3. Von Thunen's location rent. Von Thunen developed the concept of location rent which makes distance to the market a key variable in explaining spatial patterns of agricultural land use.

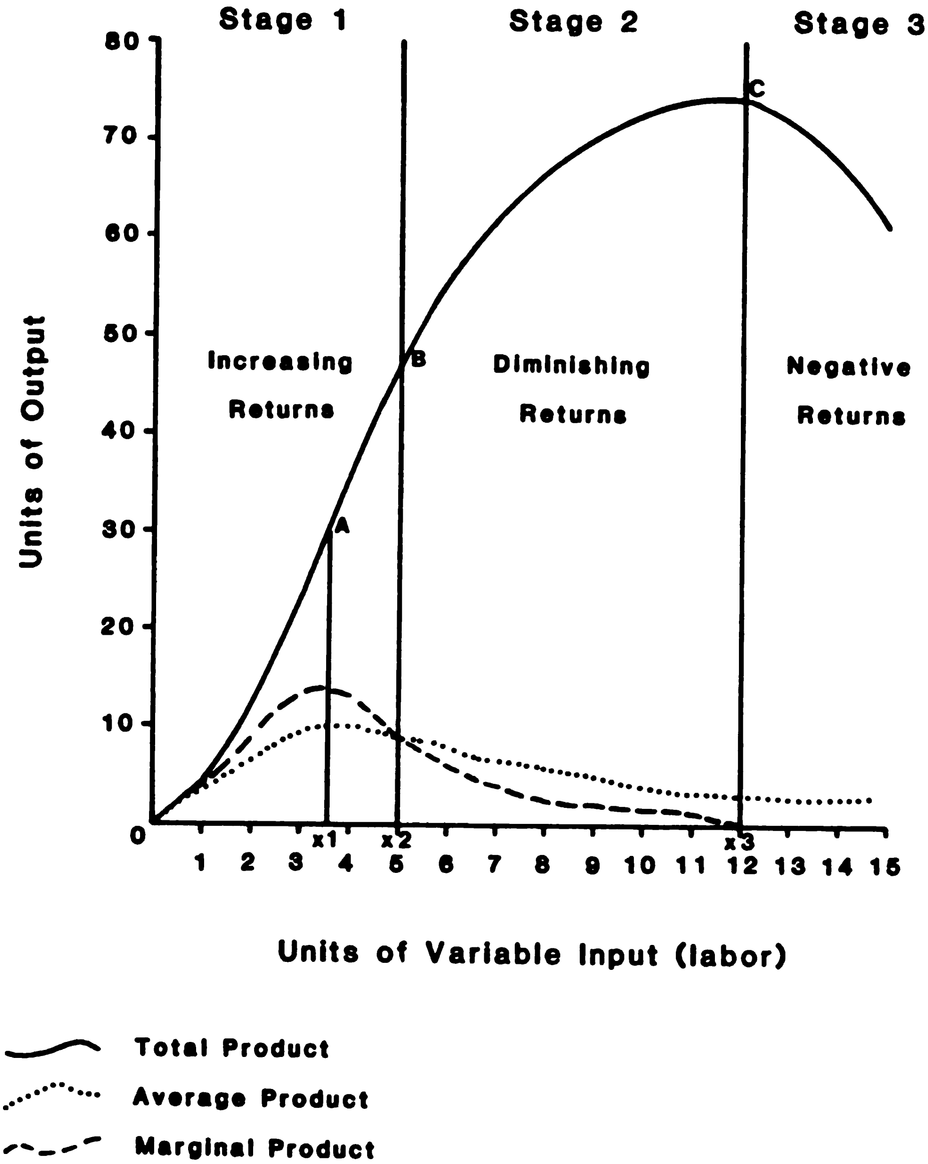


Illustration of Stages of Production Function and Input–output Relationships Involved in Operation of Physical Law of Diminishing Returns

Source: de Souza et. al., 1979, pp. 168, (with modification)

Figure 3

Location rent is not concerned with spatial variation in land quality, but reflects the advantage of nearness of production to the market. According to Von Thunen, farms close to the market have greater location rent per acre than those at greater distances because the unit costs of shipment are lower, and all farmers receive the same price at the market. Von Thunen's location rent is used to allocate land use in ordered patterns around the main market centers (Butler, 1980, p. 63).

> An alternative view of economic rent was provided by Von Thunen. Holding land quality constant, he showed rents decline with distance from the market center. He demonstrated (1) that rent reflects differences in cost of production and transportation at various locations; (2) that a location near the market place is the most productive; and (3) that net profits fall to zero at the margin of cultivation. Geographers often use the term "location rent," as opposed to "economic rent," to express the idea that rents decline with distance from the market place. (de Souza et al., 1979, pp. 170-71)

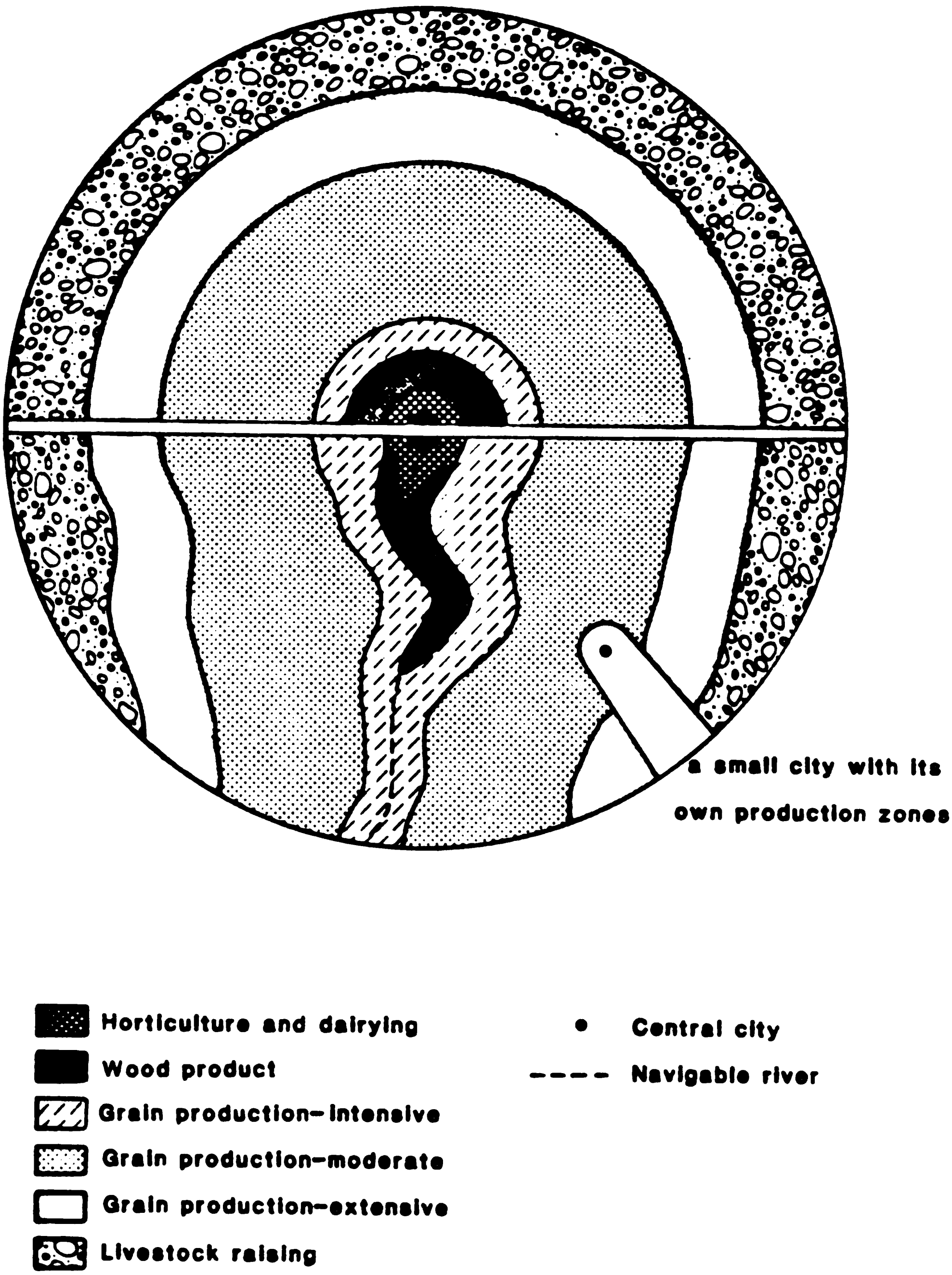
Factors affecting agricultural location patterns with relation to Von Thunen's model.--

1. Market proximity and associated transportation costs. The role of market proximity and transportation costs was the most important factor in the concepts developed by Von Thunen in 1826. As mentioned, Von Thunen assumed an isolated state with one central city, free from all possible effects of other urban markets. According to him, differences in land use in the isolated state can be attributed to variations in transportation costs. Transportation costs, in turn, are dependent upon such other factors as distance to the market, ease of transportation, bulk, weight, and perishability of the products shipped to the market. Von Thunen assumed that agricultural lands near the market (First Zone) would be used for the production of fresh milk and

vegetables. Slow transportation and the absence of refrigeration in his time made it impossible to ship these products over great distances. Due to the high demand for fresh milk and vegetables in the central market (see Figure 4), prices for them were assumed to be high enough to yield a higher rent (Amato, 1976, pp. 27-28).

The Second Zone of Von Thunen's model is devoted to the production of forest products, which are bulky and their transportation cost is high. A continuous demand for firewood and building materials in the city, at that time, would keep the market prices high enough to yield greater returns to the farmer than any other crop except fresh vegetables and milk. The Third Zone is used to cultivate field crops, grain, or hay. More and more land toward the outer edge of the intensive grain-production region is used for moderate and extensive grain production. The last zone of Von Thunen's model is used for grazing, including livestock raising. Sheep and cattle are reared and fed in this area and driven to the market for sale. Beyond this grazing zone (see Figure 4), the outermost zone of the Isolated State is assumed to be generally unprofitable for crops and remains a wilderness (Amato, 1976, p. 28; Barlowe, 1978, pp. 36-39; Najm, 1982, p. 47).

2. Market distance and location rent for a single crop at a single intensity. The relationship between location rent and market distance can be illustrated by reference to one crop produced on land of comparable quality around a city. Von Thunen, in particular, observed that location rent is solely a function of distance because



VARIATIONS IN ZONAL PATTERNS IN THE
LAND-USE MODEL OF VON THUNEN

After Chisholm

Figure 4

distance determines total transportation costs and therefore income. This assumes a constant market price, and transportation cost becomes the single variable determining economic rent (Foust et al., 1978, p. 32).

> Von Thunen in particular observed that when crops produced for a central city market are grown on lands of like fertility, the lands located nearest the city enjoy a definite rent advantage over those located at greater distance. The extent of this rent advantage corresponds with the difference between the transportation costs that arise in the shipment of products from the two areas to market. (Barlowe, 1978, p. 172)

Von Thunen essentially calculated location rents for a single product, as shown in the following formula:

$$R = E\,(p - a) - efk$$

in which:

R = location rent per unit of land

E = output per unit of land

p = price per unit of output (market price)

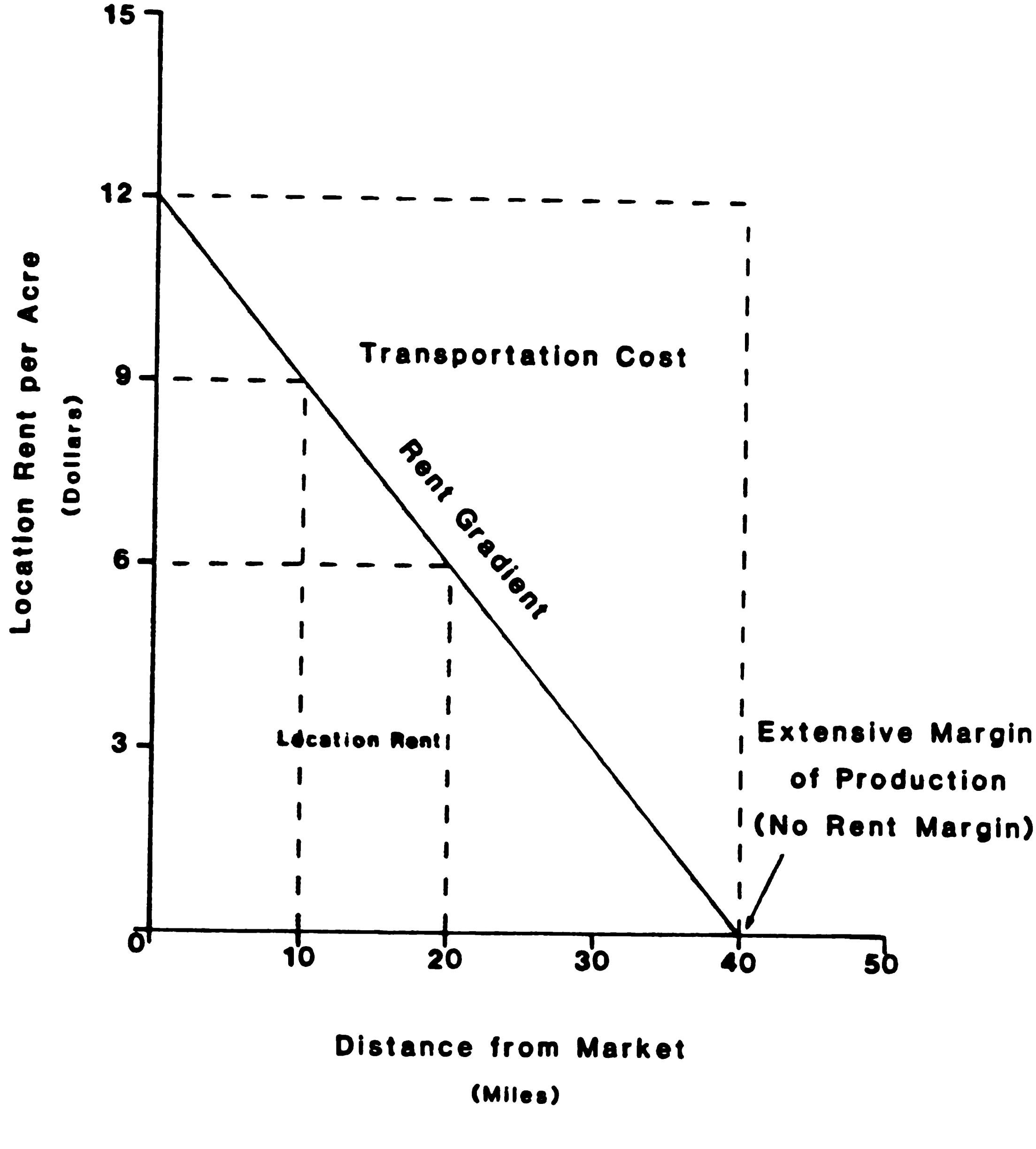
a = production cost per unit of land (including labor)

f = transportation costs per unit of output per mile

k = distance to market

As Figure 5 indicates, the greater the distance from the market, the higher the transportation cost. In other words, the location rent drops to zero or no rent 40 miles from the market. According to Barlowe, any production beyond the extensive margin of production can be accomplished only with a reduction of payments that normally accrue to labor and management.

LINEAR RENT-DISTANCE FUNCTION FOR A SINGLE CROP



Source: Modified from Barlow, 1978, pp. 173

Figure 5

3. Market distance and location rent for a single crop at differing intensities. In Von Thunen's day, when technology was limited, distinct intensities of a single crop, wheat, for example, were clearly discernible, with regard to distance from the market. Von Thunen argued that agricultural land located near the central market enjoyed higher location rent because of its transportation advantage over more distant locations. High-rent land provided the farmers with an incentive to increase output per hectare by increasing inputs of capital and labor.

If it is assumed that a single crop, say wheat, is grown at two different intensity levels, agricultural land close to the market will be devoted to the more intensive farming system (Figure 6). On a steep location rent curve, it is profitable up to 36 kilometers from the central market. More distant land, between 36 and 70 kilometers from the market, enjoys less intensive wheat farming and a rent curve less steep than the previous one. As Figure 6 shows, the margin of transference between the two intensities of wheat farming occurs at the intersection of the bid-rent curves. The separation between intensive and extensive systems illustrates the economic principle of the highest and best use of agricultural land. According to this principle, agricultural land is allocated to that use which earns the highest location rent for its owners, but not necessarily for the tenant farmers de Souza, 1979, pp. 174-75).

4. Market distance and location rent for multiple crops. The most prominent contribution of Von Thunen's study was his determination

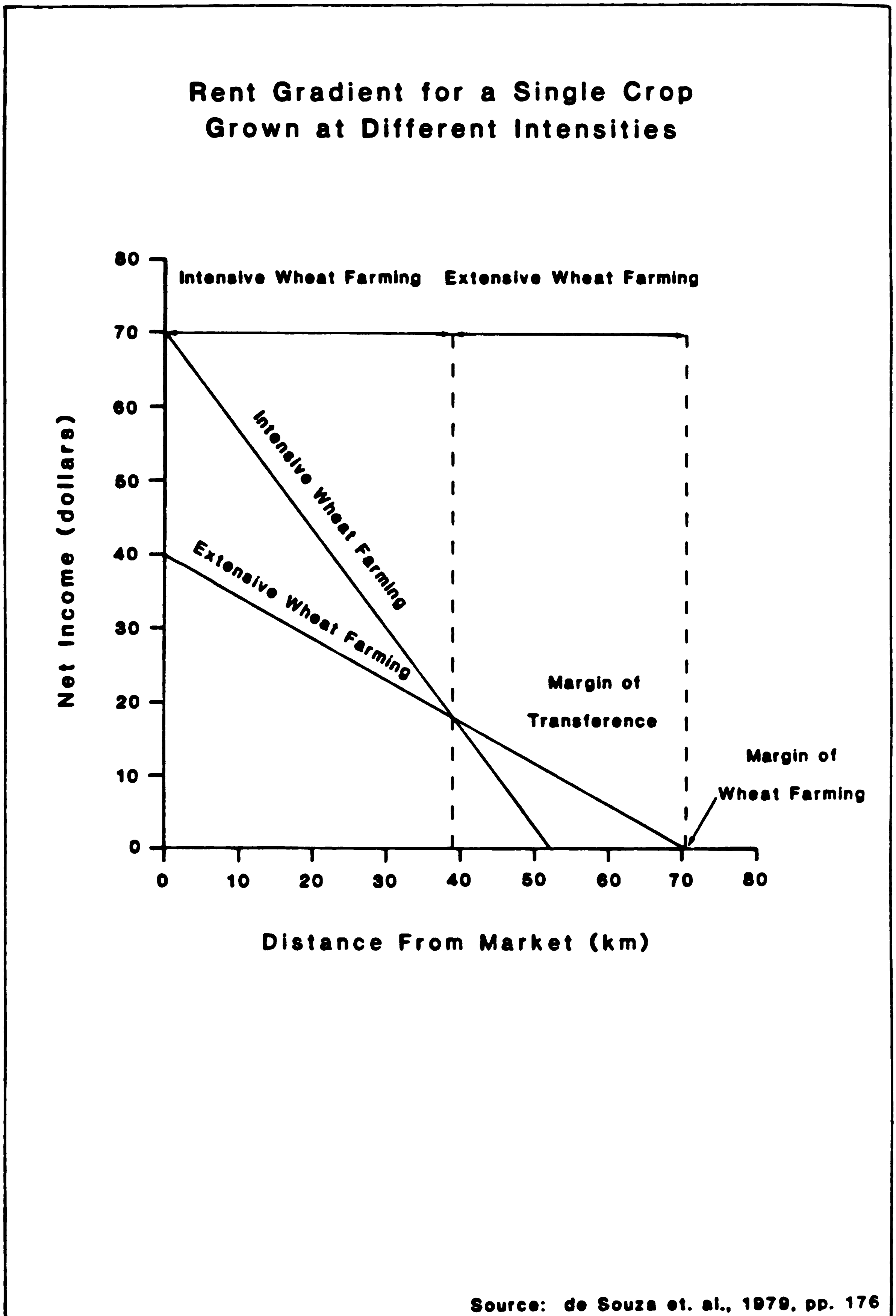

Rent Gradient for a Single Crop
Grown at Different Intensities
Intensive Wheat Farming
Extensive Wheat Farming
Intensive Wheat Farming
Extensive Wheat Farming
Margin of
Transference
Margin of
Wheat Farming
Net Income (dollars)
Distance From Market (km)
0
10
20
30
40
50
60
70
80
Source: de Souza et. al., 1979, pp. 176

Figure 6

of land organization for multiple crop use. Agricultural activities were ordered according to the economic principle of the highest and best use, as measured by their location rent at each distance from the central market. Von Thunen's crop model primarily concerned the role of transportation costs in allocating agricultural land to different uses at varying distances from the market (Figure 7). Thus the first zone around the market was employed for intensive uses requiring considerable care and frequent travels to market. The second and third zones were allocated to agriculture producing bulky, heavy, and hard-to-transport products. Zones more distant from the market were allocated to more easily transportable products (Barlowe, 1978, p. 276).

Empirical evidence in support of Von Thunen's model.--Von Thunen's model has been controversial since its inception. Researchers of agricultural land use have discussed, analyzed, modified, and tested it in a variety of environmental contexts and applied it at international, national, regional, and local levels. The following empirical applications have attempted to determine whether intensity of land use and land values actually do decrease in practice as one moves outward away from the central market and, if so, what farm practices and patterns of agricultural land use tend to evolve.

Jonasson (1925) argued that northwest Europe can be regarded as one major urban center that acts as a market for much of the worldwide agricultural production, especially for an inner agricultural zone of horticultural and perishable crops.

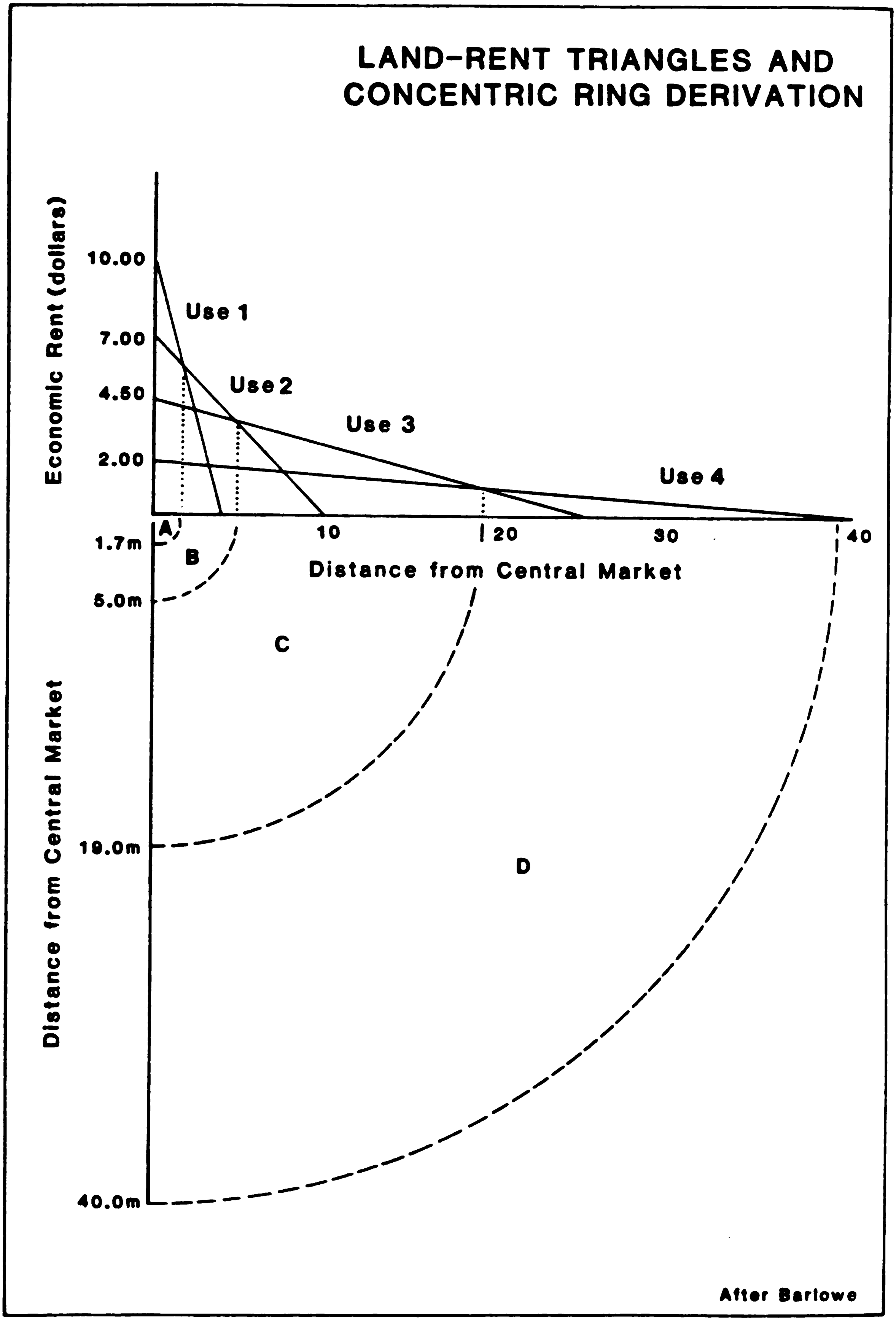

LAND-RENT TRIANGLES AND CONCENTRIC RING DERIVATION
Economic Rent (dollars)
10.00
7.00
4.50
2.00
Use 1
Use 2
Use 3
Use 4
A
B
C
D
10
20
30
40
1.7m
5.0m
19.0m
40.0m
Distance from Central Market
Distance from Central Market
After Barlowe

Figure 7

Peet (1969) proposed a type of agricultural land use system similar to Von Thunen's crop model but extended this approach to include a dynamic element. He pointed out that under conditions of rising demand in the central markets and reductions in transportation costs, there will be a rapid outward expansion of farming into the uncultivated wilderness. Using data on imports into Britain in the nineteenth century, Peet analyzed worldwide zones of agricultural production, applying Von Thunen's model on an international scale to explain the expansion of commercial agriculture. He considered Britain, Western Europe, and the Northeastern United States as a world urban-industrial nucleus and demonstrated the existence of a system of agricultural land use similar to Von Thunen's model. Peet described a central market area surrounded by a series of large concentric agricultural zones, but attributed the outward expansion of these zones to growth in food and raw-materials demands in the urban market, rather than to land rent and transportation costs.

Horvath (1969) tested Von Thunen's model at a regional level in Ethiopia and found strong empirical evidence of the model's land use patterns. Forest plantations (for firewood and building materials) and vegetable production were shown to be in close proximity to the central market in Addis Ababa. The area of mixed farming lying beyond the forest and vegetable zone was shown to be experiencing intensification and commercialization.

Chisholm (1969) cited many examples of Von Thunen's zones around the central markets in Spain, Italy, and Pakistan. He found that in the villages surrounded by infertile soil, the land immediately adjacent was intensively tilled, while the more fertile valleys some distance from the village were either extensively cultivated or unused. Chisholm also found that net profits declined as distance to farm plots increased. His findings indicate that farmers find it worthwhile to increase inputs of labor on land near their farmsteads.

Dunn (1954) observed that farms located near a central market are smaller than those farther from the city. His model was based on classical theories of agricultural land use wherein farms nearer the market are intensively cultivated, while those farther away are extensively cropped.

Muller (1973) applied Von Thunen's model, on a national level, to the United States. Finding that the spatial distribution of agricultural land use conformed to the model, Muller concluded that the effects of distance have shaped the macro-geographical patterns of the United States and that Von THunen's model is valid both as an organizational construct and as an analytical tool in the further development of location theory.

Griffin (1973) tested Von THunen's model in Uruguay and found that, in general, the Von Thunen model agreed with the actual intensity of agricultural land use.

Crossley (1976) applied Von Thunen's model to the supply rings for the beef-processing industry in England and concluded that agricultural rent declined as one moved away from the central market. His findings also indicated that near the market, high cattle prices were necessary to cover the high cost of intensive production. Farther from the market, cattle prices were lower because the production costs were lower.

Najm (1982) studied agricultural land use patterns in the Benghazi area of northeastern Libya in relation to farm location, types of land tenure, levels of government assistance, and farmer characteristics. Assuming a relationship between cultural factors and land use patterns around Benghazi, Najm found that the greater the distance from Benghazi, the larger the size of the farms. Close to Benghazi, farms were intensively cultivated with cash crops, whereas grains and grazing occupied a large proportion of the farm land farther away from the city.

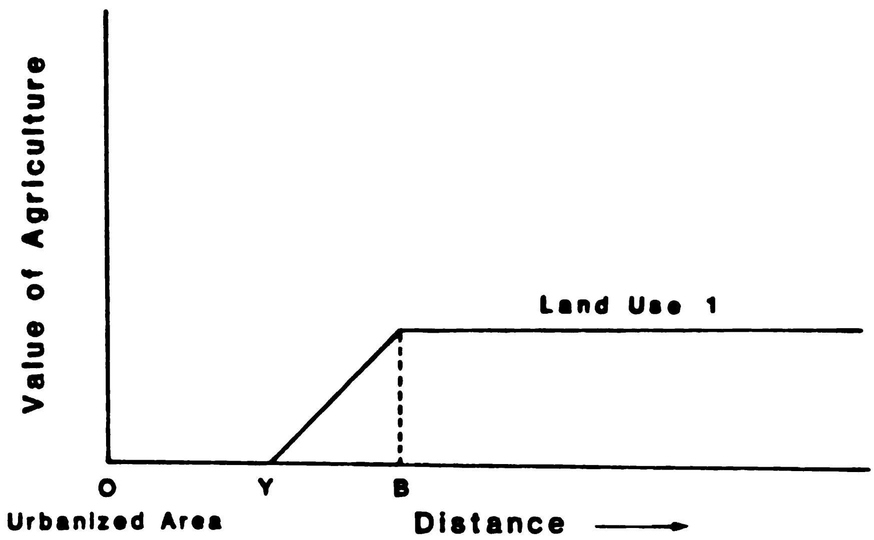
The Effect of Urban Sprawl on Agricultural Land Use Patterns

To explain agricultural land use patterns near urban areas, Sinclair (1967) developed a model from empirical observations in the United States. Assuming that in many advanced industrial countries the forces determining agricultural land use near urban areas reflect urban expansion, he found that the nearby agricultural pattern is often one of increasing intensity with distance from the city, quite the reverse of the pattern developed by Von Thunen. Sinclair's model, therefore, reflects degrees of urban influence in high land prices near urban cities, high land taxes, restrictive suburban zoning, uncertainty concerning speed and direction of urbanization, and nuisance stemming from nearby urban areas (p. 78).

The effect of distance from the central market is expressed in the following simple relationship: As the urbanized area is approached from a distance, the degree of anticipation of urbanization increases. As this happens, the absolute value of the land increases, and the relative value for agricultural use decreases. Consequently, the intensity of agricultural land use decreases. The result of this process is a basic agricultural land use pattern that is the reverse of Von Thunen's model (Sinclair, 1967, p. 78).

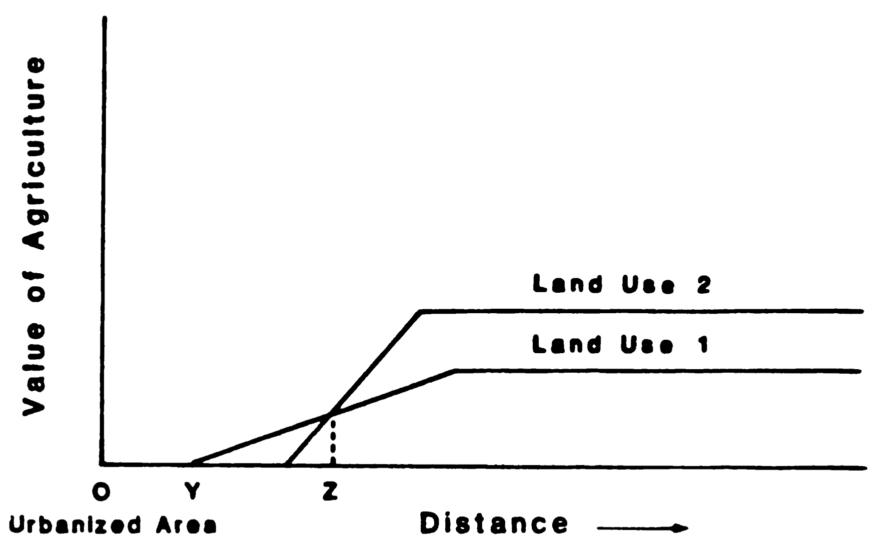
The relationship between distance and land use in Sinclair's model is illustrated in Figures 8 and 9. In Figure 8, a single use of agricultural land is measured in terms of V, defined as the "value of carrying out this type of agriculture." as O (the urbanized area)is approached, V decreases because the probability of urbanization increases. As the Y intercept, the V is entirely absorbed. With increasing distance from O, V increases until it levels off at point B, where there is no more anticipation of urbanization and its associated high land costs (Sinclair, 1967, p. 79)>

As Figure 8 illustrates, Sinclair extended his argument to two competing types of agricultural land use. The first land use (1) prevails in zone yz but, because its V-slope is less steep than that of the second land use, (2) its advantage ceases at point z. Outward from this point, land use (2) is more advantageous. The factor governing the steepness of the V-slope is the intensity of agricultural investment. Land use (2) is a more intensive type of agriculture, which pays off in greater agricultural returns at a distance from the



Relationship of Value for Agriculture and Distance from Urban Area

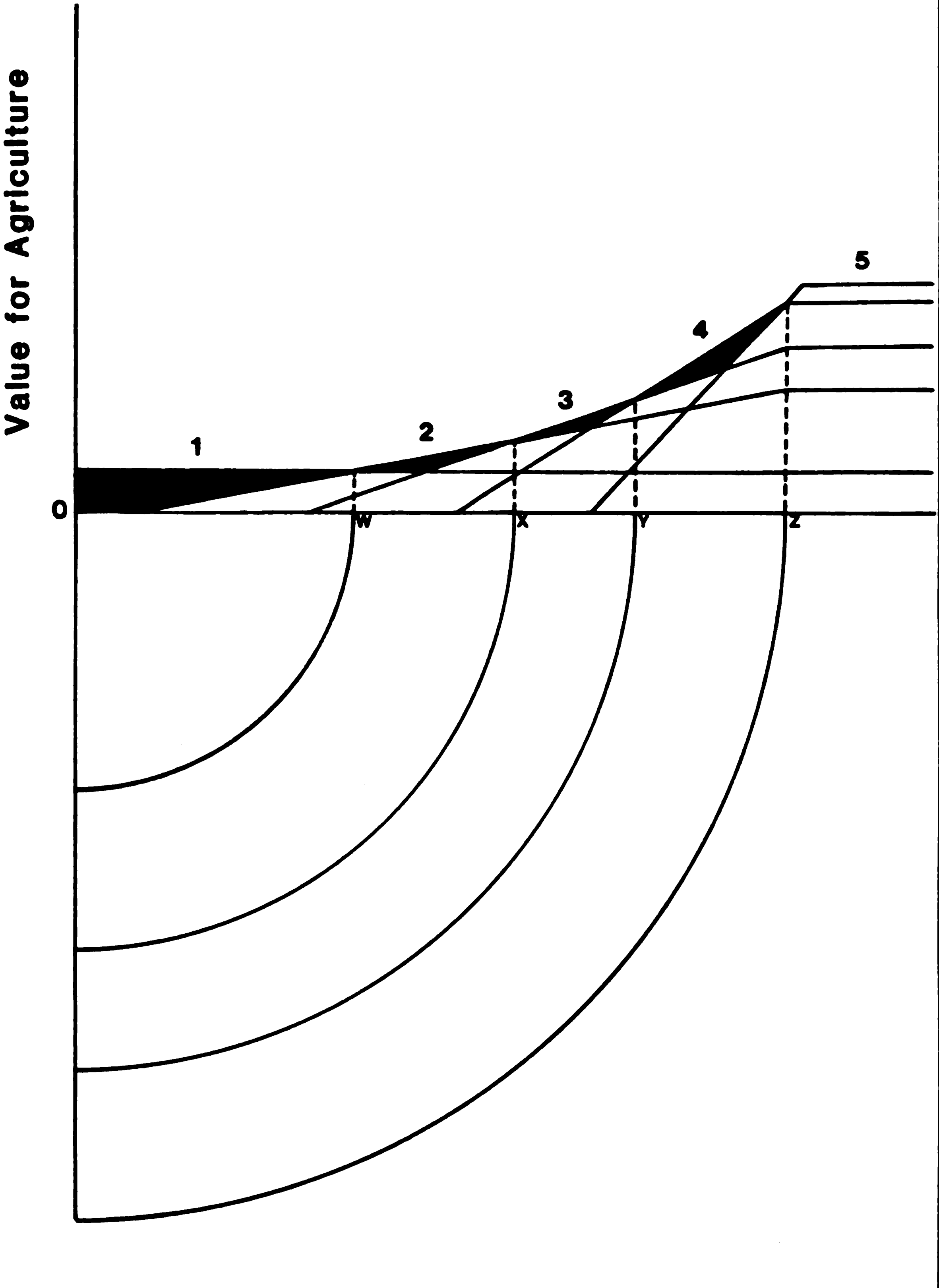
Relationship of Value for Agriculture and Distance from Urban Area for Two Competing Land Uses



Source: Sinclair, 1967, pp. 79

Figure 8

Variations in Zonal Patterns in the Land-Use Model of Sinclair



Source: Sinclair (2) 1967, p.80

Figure 9

city. As the city is approached and the likelihood of urbanization increases, the value of such intensive investment in farming declines rapidly. Sinclair argued that, at point Z, it does not pay to carry out this type of farming, but it is still economically feasible to carry out land use (1) agriculture, which requires a smaller investment (pp. 79-80).

Figure 9 illustrates various intensities of agricultural land use. Land use (1), the least intensive, prevails in Zone OW, more intensive land use (2) in Zone WX, land use (3) in Zone XY, and so on. Land use (5) extends to an undetermined distance (N) from the central market, that is, the city, because it is outside the area where urban land prices can be anticipated. According to Sinclair, this would be a regional type of agriculture governed by factors other than the direct influence of the urbanized area. With O as the center and OW, OX, OY, OZ, etc., as the radii, a series of rings, corresponding to Von Thunen's rings, can be drawn (p. 80).

Patterns of Agricultural Land Use Developed by Boserup

Boserup (1965) classified agricultural land use based on intensity into five systems, including forest-fallow cultivation, bush-fallow cultivation, short-time fallow cultivation, annual cropping, and multicropping. She noted a distinct relationship between population density and the intensity of agricultural land use, so that with an increasing population pressure there is a shift from more extensive to more intensive systems of rural land use, particularly in the underdeveloped regions of the world.

> In some parts of the world, cultivators in the forest-fallow system have been unable to find sufficient secondary forest. They have had to recultivate areas not yet bearing fully grown forest. Thus the forest has receded and been replaced by bush. Again, in bush-fallow areas, the cultivators have changed to short-time-fallow systems or annual cropping with or without irrigation. In densely populated regions, there has been a rapid spread of multicropping. (Najm, 1982, p. 52)

Boserup's model has been criticized by many researchers, especially economists who noted that her study dies not take into consideration the income of the population or the elasticity of land in many parts of the world. Population growth, in some regions, may not affect agriculture without also changing per capita income. Boserup's position was that subsistence agricultural communities are dynamic and subject to continual changes in agricultural technology because of the population growth or pressure (Najm, 1982, p. 52).

In summary, the organization and the spatial distribution of agricultural land use are seldom determined by a single factor. Rather, a variety of physical, cultural, and institutional conditions interact to affect land use characteristics. Soil fertility and market attraction generally exert the strongest influence on agricultural land use patterns in a given area, while other factors also affect the geographical distribution of rural land use patterns, as well as the use of agricultural lands (Griffin, 1972, p. 145).

The Literature on the Assarah Region

A search for the literature specifically on the agricultural land use in the Assarah highland region revealed that there is hardly any work in existence other than Al-Husseiny and Murgham's "Slope Forms and Land-Use in Assarah of Ghamid" (1977) and Al-Shomrany's "Type, Distribution, and Significance of the Agricultural Terraces in Assarah, Southwestern Saudi Arabia."

Al-Husseiny and Murgham identified three categories of rural land use, dominating Assarah of Ghamid. The first of these categories is the agricultural land. With regard to this category, this study indicated that because of the ruggedness of the region and the absence of any vast tracts of level land, agriculture is practiced along the fertile small wadis. As the demand for agricultural land increased, slopes of hills and mountains were cut into artificial terraces. This study characterized the lower- and upper-slope terraces as distinctly different. The lower-slope terraces tend to be larger, more accessible, and more productive than the upper-slope terraces. Besides, the lower-slope terraces are devoted to a more intensive irrigable farming, while the upper-slope farms are given to dry and less intensive cultivation.

The second category was described as the vegetational cover. This study observed that the Assarah region has the richest vegetational cover in Saudi Arabia. Al-Husseiny and Murgham pointed out that

> The unterraced slopes of the interfluve are left to natural vegetation which varies in thickness and kind according to the

> positive or negative human effect. Natural vegetation is thick only in places where it has been protected privately or communally. The most common trees that grow naturally here are Acacia sp. and juniperus procera. There are also wide ranges of bushes, shrubs, and grasses. (Al-Husseiny & Murgham, 1977, p. 183)

Murgham (1973) in his study of "Change and Development in a Rural Context" observed two distinct features of the vegetation in the Assarah region.

1. It seems that Assarah has had, in the past, a continuous woodland formation similar to those remaining patches. Murgham quoted Assulloke (1971), who listed, for example, 39 such patches of woodlands in Ghamid and Zahran subareas, that these woodlands vary in development from a real forest canopy to more dense bushes and measure in extent from about 10 km^2 to less than 1 km^2.

2. With respect to the slopes, the north- and the west-facing slopes seem to have thicker vegetation cover than the east- or the south-facing slopes. This investigator believes that this phenomenon is due to the daily afternoon summer cloud formation common in the area (Plate 3).

The third and last category is the settlements, of which villages form the dominant units of these settlements. These villages are generally located either along the slopes or on the top of the mountains--a phenomenon best described in the following words:

> Villages which are the salient settlement form, are always situated on high grounds where they could be protected against enemy attacks in the past, so as to save flat land sites for farming. (Al-Husseiny & Murgham, 1977, p. 183)

Al-Shomrany (1980), on the other hand, described the agricultural land use patterns in the Bashut district (the Assarah of

(a) The relationship between the north and northwest slopes and vegetation cover

(b) The relationship between the slope facing the east and the thinness of vegetation

Plate 3

Shomran) into four categories of rural land use. The first category is the cultivable land, which constitutes 37% of the total surface area in Bashut. This estimates into account all actively cultivated and abandoned terraced land. The actively cultivated land is further classified into the irrigable terraces and the dry terraces. The actively used agricultural land is estimated to be 18.2% of the total area, while the abandoned land forms 19.1%.

> Pastural land is the second major land use type in the Bashut area. Pastures occupy the rough terrain located on the west and east sides of the study area. They cover an area of approximately 36% of the total land surface. (Al-Shomrany, 1980, pp. 98-99)

The third category is the forests, which claim an area approximating roughly 14% of the total land. These forests are a mixture of privately and publicly owned forests. The trees in the forests are large and dense, though bushes and shrubs form a sizable undergrowth. Juniper Procera, Acadia Seyal, and Olea Chrysophylla are the most important trees that grow there.

The fourth category of Bashut agricultural land use has been described as follows:

> The villages, roads and trails comprise about 12% of the land in Bashut. The villages were built in areas unsuitable for agriculture, immediately adjacent to the farm land. In the recent past, the encroachment of the arable land has become pronounced. Houses are constructed along the terrace margins and the new highway was laid out along the eastern side of the active terraces. The loss of cultivable land must be evaluated in terms of the gains that have accrued from the new highway. (Al-Shomrany, 1980, p. 101)

Al-Shomrany identified many land use problems, the foremost of which is the fragmentation of the agricultural holdings. The second problem is related to the shortage of water supply. Agriculture in the

Bashut district in particular and in the Assarah region in general depends on the rainfall, which is erratic and unpredictable.

> Climatically, the study area is subject to erratic and unpredictable rainfall. The rains are highly variable and may come too early or too late for the agricultural process. The scarcity of rain has usually led to the abandonment of farming and consequently of terraces. (p. 104)

Other problems are soil erosion, the migration of the young farmers to the cities, poor transportation facilities, and the absence of agricultural services and research. All these problems are identified as an obstacle to high agricultural productivity (Al-Shomrany, 1980, pp. 104-105).

CHAPTER III

RESEARCH METHODS

Introduction

The major objective of this study is to examine the agricultural land use patterns with relation to the physical, locational, and socioeconomic factors in the Assarah region. This study attempts to answer, among several others, the following two most important questions with regard to the study area: (1) What physical, locational, and socioeconomic factors usually influence the agricultural land use in the region? and (2) What role do these factors play in influencing the farmers to grow what they grow on their terraces?

To answer these questions in depth, primary data were collected from a sample of respondents selected from among the Assarah farmers. The Al-Alayah-Bashut district in the central part of the Assarah region was selected as a representative area. The criteria used in selecting this area as representative of the Assarah region are discussed in the following pages of this chapter.

The purpose of this chapter is to provide details on the study methods used in the present research. The chapter includes sections on the research hypotheses; the sampling design, including the selection of the study area, the organization of the survey, and the sampling procedure; data-collection methods; the data-collection instrument; and the methods of data analysis.

The Research Hypotheses

Based on this researcher's own study, knowledge, and experience of the study area, the following research hypotheses, divided into physical, locational, and socioeconomic categories, were proposed for testing:

Hypotheses Relating to the Physical Environmental Factors

Hypothesis 1: The physical environmental factors are more important in affecting agricultural land use than the locational factors such as distance from the village.

This hypothesis suggests that the physical environmental factors such as climate, topography, soil, and water supply play a major role in determining the type and patterns of agricultural land use in the study area--much more than any other factors (Barlowe, 1978; Symons, 1979).

Hypothesis 2: There is no significant relationship between the soil depth and the type of agricultural land use.

This hypothesis indicates that since each type of agriculture requires certain characteristics of the soil, one would expect that a difference in the soil type parallels the depth of the soil, hence a difference in agricultural type.

Hypothesis 3: There is no significant relationship between the angle of the slope and the type of agricultural land use.

This hypothesis indicates that the association between agricultural land use and the degree of slope inclination could be both positive and negative. On flat land, a gentle slope tends to create soil of sufficient depth and proper drainage to permit large-scale crop enterprises. On the other hand, steep slopes, particularly in mountainous regions, may permit other types of enterprises, such as small-scale farming.

Hypothesis 4: The farmers' perception of the physical hazards arising out of the natural environment is related to their experience of the recent events.

This hypothesis suggests that the recency of the hazards of the natural environment has a more profound effect on the farmers' perception than does the severity of the event itself.

Hypotheses Relating to the Locational Factors

Hypothesis 1: The geographical distribution of the agricultural land use patterns around the villages generally shows a similarity to the Von Thunen agricultural land use model.

Concerning the major assumptions raised in the Von Thunen model, certain similarities of the study area to that model show village-type settlements, with relatively primitive transportation, homogeneous population, and uniform climate.

Hypothesis 2: The intensity of cultivation is inversely related to the distance of a farm from the village; that is, the greater the distance from the village, the less intensively and more extensively a farm is cultivated.

This hypothesis assumes a positive relationship between the intensity of agricultural land use and the distance of a farm from the center of the village. Since most of the intensively cultivated irrigable land is devoted to perishable and cash crops, one would expect such intensive agricultural land use to be located near the village.

> Hypothesis 3: As the distance from the local markets increases, a smaller percentage of the farm acreage is used for vegetables and fruits and a greater percentage is used for grain cultivation.

Given the primitive nature of transportation facilities in the study area, and since vegetables and fruits are considered the most perishable crops and are highly demanded by the market, one would expect a negative relationship between distance from the market and the percentage of a farm's acreage devoted to such cash crops.

Hypotheses Relating to Socioeconomic Factors

> Hypothesis 1: Income from agriculture is lower than the income from other jobs in other sectors of the economy.

This hypothesis indicates that since the discovery of oil in Saudi Arabia, many new jobs have been created--mainly in urban centers. These new jobs have attracted workers from their traditional jobs, and agricultural workers are no exception. Such availability of jobs has made it more lucrative for people to work in any other jobs except agriculture in the Assarah region in particular and in the rest of the country in general.

Hypothesis 2: The migration of the farmers is directly related to the high wages paid for jobs in the urban centers.

Because in most less-developed countries a majority of the highly paid jobs are concentrated in the major urban centers and most of the developmental aspects of the rural areas are ignored, one would expect the existence of major factors attracting rural people to migrate to major urban centers. The Assarah region, the present area of study, is no exception.

Hypothesis 3: Poor transportation facilities discourage the production of cash crops.

Because of the ruggedness of the topography of the Assarah region and the long-standing failure to develop most of the rural areas in the country, the study area in particular has received little attention, particularly in the last few years. Transportation facilities are no exception; compared to other facilities, transportation is still in the rudimentary stages of development. Thus one would expect that such a poor transportation system would interrupt the flow of products from the farm to the market.

Hypothesis 4: The farmers engaged in the traditional farming are unwilling to use modern agricultural technology.

This hypothesis suggests the unwillingness of the majority of the farmers to use modern agricultural technology. Because the dominant methods of cultivation ~~in the study~~ area are considered traditional and the isolation of the region discourages the diffusion of innovations, such new technology is still not accepted as a means of improving agricultural production in the Assarah region. One would expect the rejection of such new technology to be a prevalent characteristic of farmers in the region.

Hypothesis 5: The cost of farm input exceeds the revenues from the farm output.

This hypothesis indicates that the high cost of input factors, such as wages, transportation cost, and the prices of fertilizer, as well as low demand for locally produced agricultural commodities in comparison to imported goods, would exceed the revenues that the farmers expect to obtain.

Hypothesis 6: It is cheaper for the farmers to buy imported food than to produce it on the terraces.

Because of the abundance of imported subsidized agricultural commodities, the farmers of the representative area in particular and of the Assarah region in general have found it more economically feasible to buy such imported agricultural commodities than to produce them locally.

Hypothesis 7: The farmers perceive that the low productivity is directly related to the fragmentation and the smallness of their holdings as well as to the poor agricultural extension services and shortages of labor.

Because of certain physical characteristics of the Assarah region (rugged terrain), as well as certain human characteristics (population density and land tenure system), one would expect small-sized farms in the region. It is commonly known in different parts of the world that such characteristics usually lead to low agricultural productivity.

The Sampling Design

The sampling procedure, the process of data collection, the organization of the survey, and the methods used in analyzing the data are discussed in detail in the following pages.

Selection of the Study Area

The Assarah highland region is located in the central part of southwestern Saudi Arabia and was selected for several reasons. First, this investigator's personal knowledge of and experience and familiarity with the Assarah region, its farmers and their traditions facilitated an understanding of the area. Second, the Assarah region is still dominated by subsistence and mixed agriculture, and the patterns of agricultural land use and their geographical distribution are more easily identifiable than in other regions within Saudi Arabia. Third, the change and development in the uses of the cultivable land in the region captured the attention of this investigator.

The Sampling Procedure

For reasons of money, time, and staff limitations, a more comprehensive study of the entire region from north to south and east to west was impossible. Instead, the Al-Alayah-Bashut district (Saraht Bal-Qarn and Shomran) in the central part of the Assarah highland region was selected as a representative area for this study. Other criteria for the selection of this area are:

1. Physiographically, the Bashut-Al-Alahah district represents the high altitude of the southern part of the region and the lower altitudes of the northern parts of the area (Figure 10, Plate 4).

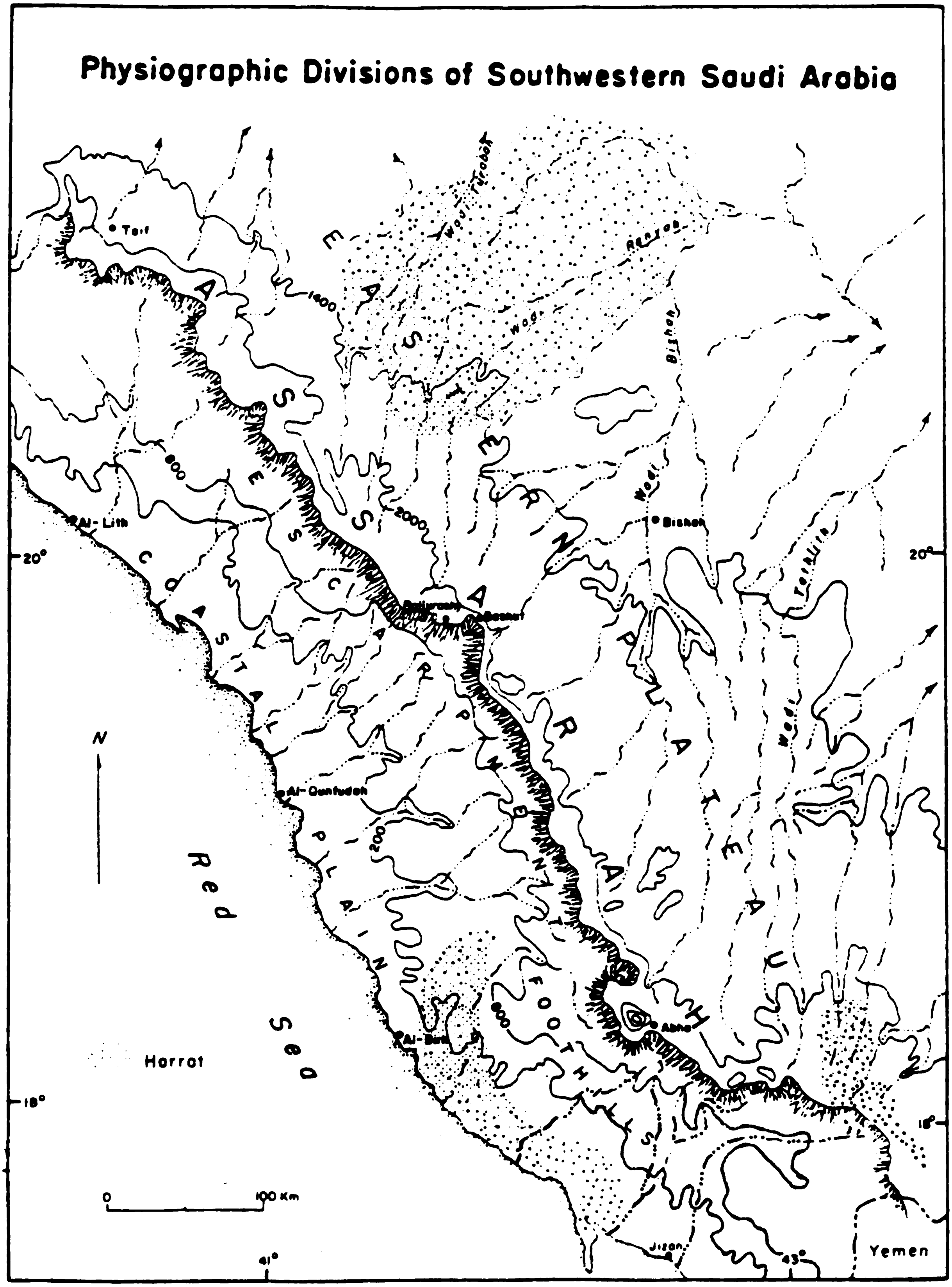
2. Climatically, the area is subject to both the summer monsoon, which dominates the southern part of the Assarah region, and the late winter and spring rainfall from the Mediterranean Sea, which dominates most of the Arabian Peninsula, including the northern part of the Assarah region.

3. This researcher hails from the Bashut district and is knowledgeable about the rural community and its physical and human dimensions.

4. The Bashut-Al-Alayah district still depends on agriculture for its livelihood.

5. Despite this district's practice of traditional farming, its farmers have become interested in commercial agriculture, especially near Al-Alayah, the largest town in the representative area of study.

A comprehensive sample, representative of the various aspects of this study, was obtained. The villages in the area were listed, and the total number of farmers in each village was obtained from the local departments of agriculture in Al-Alayah and from interviews with the heads of households and the elders of the communities. The area was divided into 16 major community locations, each consisting of three to about ten villages varying in size from 12 households to more than 250 households (Table 1, Figure 11).



Source: AL-Shomrany, 1980, p. 29

Figure 10

(a) A general north-south view of the Bashut district

(b) A general east-west view of the Bashut district

Plate 4

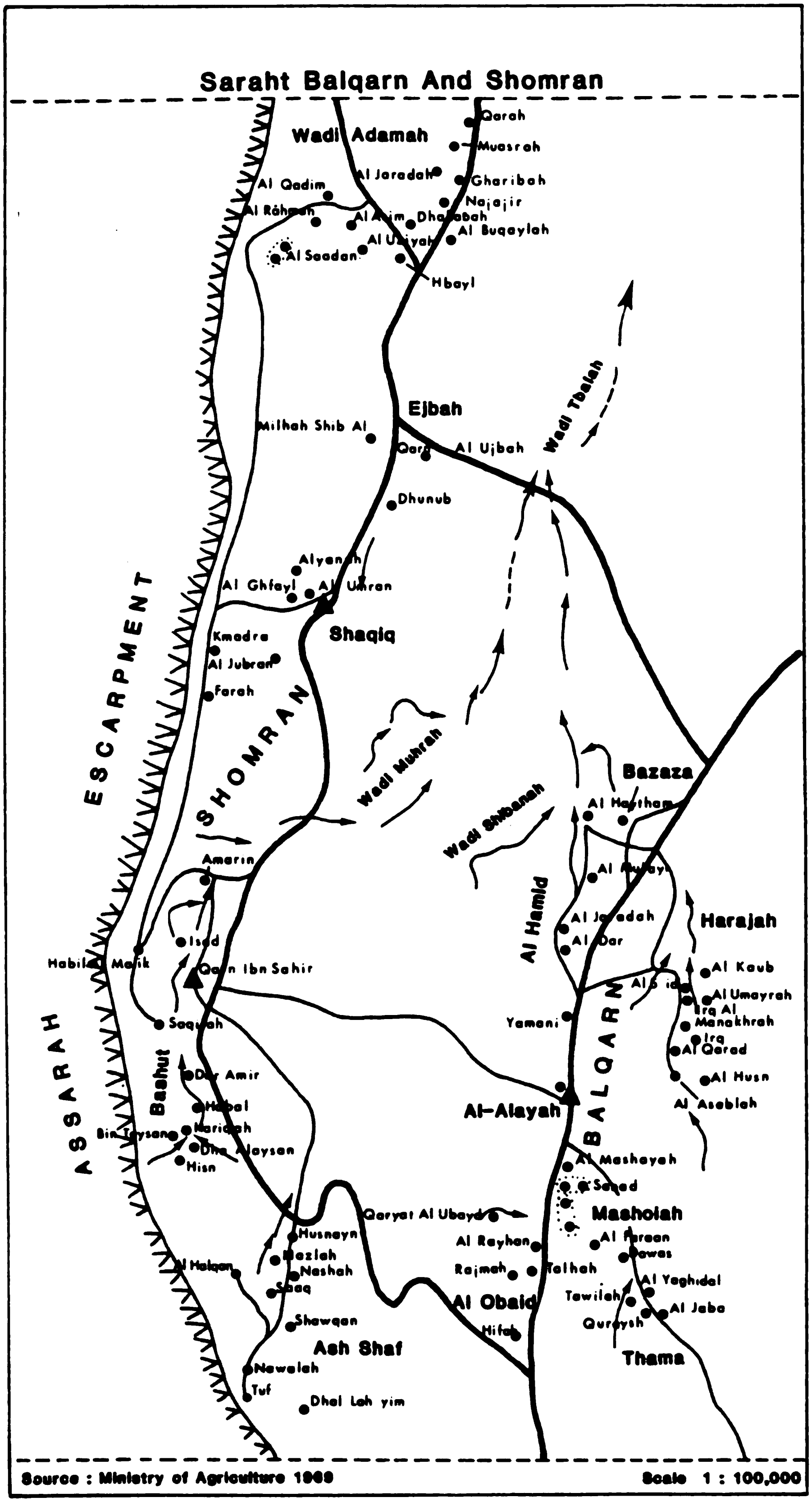

Saraht Balqarn And Shomran
Wadi Adamah
Qarah
Muasrah
Gharibah
Al Qadim
Al Buqaylah
Al Saadan
Hbayl
Ejbah
Al Ujbah
Wadi Tbalah
Dhunub
Al Ghfayl
Shaqiq
Kmadra
Farah
ESCARPMENT
SHOMRAN
Wadi Muhrah
Wadi Shibanah
Bazaza
Harajah
Al Hamid
Al Kaub
Al Umayrah
Al Qarad
Al Husn
Al Asablah
Yamani
BALQARN
Al-Alayah
Saqiyah
Habil
Bashut
Hisn
ASSARAH
Al Mashayah
Masholah
Qaryat Al Ubayd
Al Rayhan
Al Obaid
Al Yaghidal
Al Jaba
Tawilah
Thama
Husnayn
Nashah
Shawqan
Ash Shaf
Nawalah
Tuf
Dhal Lah yim
Source : Ministry of Agriculture 1969
Scale 1 : 100,000

Figure 11

Table 1.--The sample size and household distribution in the representative area by villages and subdivisions.

Villages and Subdivisions	Total Number of Households	Total Number Interviewed
Qarn Ibn Sahir	250	25
Al-Amir	300	30
Al-Saqifah	135	14
Al-Malik	200	20
Shaqiq	97	10
Al-Yanah	50	5
Ejbah	103	10
Wadi Adamah	205	20
Al-Shaf Balqarn	250	25
Al-Obaid	130	13
Mashaiah	102	10
Al-Alayah	250	25
Thama	110	11
Al-Hamid	140	14
Al-Harajah	104	10
Bazaza	101	10
Total	2,577	257

Source: The Department of Agriculture at Al-Alayah (1982) and the field survey by the researcher.

A problem was encountered in deciding on the correct sample size. In practice, if textbook procedures had been used in determining the sample size needed for this study, 3.45 percent (88 respondents) of the total number of farmers should have been interviewed. This number was felt to be too small. Instead, this researcher decided to interview 10 percent of the farmers residing in each village. This proportion was felt to be more representative of the total population of farmers in the Al-Alayah-Bashut district. According to Borg and Gall (1983),

> A problem that must be faced in planning every research project is to determine the size of the sample necessary to attain the objectives of the planned research. The general rule is to use the largest sample possible. The rule is a good one because, although we generally study only samples, we are really interested in learning about the population from which they are drawn. The larger the sample, the more likely is its mean and standard deviation to be representative of the population mean and standard deviation. . . . (p. 257)

Because the villages in the study area are of the cluster type and houses and streets have no numbers, the main mosque in each village was used as the focal point for the cluster. Interviews were conducted with 257 farmers who were chosen by means of random-number tables. Various visits were undertaken to each main mosque until the determined sample size in each village or community location was completed. Twenty farmers refused to be interviewed, and they were replaced by other farmers from their communities by means of random sampling. The initial random sample was considered representative of the Al-Alayah-Bashut district in particular and of the Assarah region in general, as shown in Table 1. Information was then collected through personal interviews guided by a questionnaire. The data collection was undertaken during the summer season of 1982.

The Organization of the Survey

This study was conducted during the summer months of June, July, and August 1982, led by the researcher himself. He was assisted by three local university students and a local worker, who were appropriately trained for a week before the survey, in making farm measurements, collecting the soil sample, and interviewing the respondents. The researcher's home town, in the central part of the

Bashut district, was used as the headquarters, located in one of the government schools. The interviews were conducted in the main mosque of each village and location. The researcher generally supervised the interviews and was readily available to solve unexpected problems. It was necessary to obtain permission from the local government authorities to conduct the study.

Data-Collection Methods

Basic reference materials from different governmental agencies were collected during the summer season of 1978; maps, aerial photographs, and relevant reports were obtained from different agencies including the Ministries of Agriculture and Petroleum. Additional field trips were made to the agricultural agencies in the cities of Bishah, Abha, and Baljurshy, within the region itself, to obtain information regarding the climate of the region and the services provided to the local farmers by the extension services.

A reconnaissance trip from north to south in the region, from the headquarters, was undertaken in the initial stages because of the absence of reliable scientific data and information, for observation and measurements. Information about the region's major physiographic features, the agriculture, and the land use patterns of the region was collected, primarily from interviews that were personally conducted and supervised by this investigator.

The farms were measured to collect reliable data about the agricultural land use of the study area in particular and the Assarah region in general. For each of the selected farms, the investigator attempted to examine and measure the farm's location from the village, its size and area, soil characteristics, the type of land use and its intensity, the types of irrigation or sources of water supply, the accessibility of the farms, the types of fertilizers used, and major problems relating to the management of agriculture.

Aerial photographs were used to map the patterns of agricultural land use in the area by cross-checking the selected photographs of the representative area. Base, land use, and other relevant maps for the Bashut and Al-Alayah districts were developed from the aerial photographs to compare the past patterns and the present ones.

The Data-Collection Instrument

A questionnaire was administered through a face-to-face personal interview for a cross-sectional survey. As the majority of farmers in the region can neither read nor write, three university students helped fill in the questionnaire addressed to the 257 randomly selected farmers, primarily in the main mosque area. The interviews covered the physical, locational, and socioeconomic dimensions.

The physical factors.--In this section of the questionnaire-interview, the effect of the following physical environmental features in relation to agricultural land use were addressed: (1) the physical features of the terraces with regard to a selected list of physical variables such as slope, soil, size, geographical location, water supply, and accessibility; (2) the patterns of agricultural land use with regard to a selected list of different types of agricultural land use for vegetables, fruits, grains, alfalfa, and multiple crops; (3) the intensity of land use, measured by the number of times the farmer plants crops during a year; (4) the role of slope, climate, distance, water supply, and accessibility in determining what the farmers grow on their terraces; and (5) the possible physical hazards to agriculture, by rating how much a variable determines what the farmers grow on their farms.

The locational factors.--In this section of the questionnaire, the following questions about the relationships between the patterns of agricultural land use and the locational factors were addressed: (1) the geographical distribution of the agricultural land use patterns, measured by the degree of the respondents' agreement or disagreement with a list of selected statements concerning distribution; (2) the patterns of agricultural land use in relation to the distance from the local markets, measured by the distance in kilometers from the farm to the local market; (3) the pattern of agricultural land use in relation to the distance from the village, measured by the distance in kilometers between the farm and the village; and (4) the allocation of the farm acreage to different agricultural land uses, measured in percentage of the farm area allocated to vegetables, fruits, alfalfa, grains, pastures and forest trees, and multiple crops.

The socioeconomic factors.--In this section of the questionnaire-interview, questions addressed concerning the income characteristics and migration of the farmers, transportation characteristics, modern agricultural technology, farm input-output relationship, imported food, fragmentation, government assistance, farm labor characteristics, and the social characteristics of the owner were: (1) the income characteristics of the farmer, measured in annual returns, in Saudi ryals, from the produce sold at the local and regional markets; (2) the migration of the rural population to the urban centers, measured by the number of persons from each family who left for the urban centers and by the responses of the interviewees to selected statements concerning whether they thought rural migration was important; (3) the transportation of the farm produce to the market, measured by the respondents' perception of the degree of agreement or disagreement with selected statements concerning general transportation characteristics; (4) the use of modern agricultural technology, measured by the farmer's willingness to use modern mechanized methods of farming; (5) the farm input-output relationship, measured by annual net returns, in Saudi ryals, from the farm; (6) imported food, measured by the degree of agreement or disagreement with a statement concerning whether imported food is cheaper than food produced on the terraces; (7) the fragmentation or smallness of the agricultural holdings, measured by the number of noncontiguous plots owned by a farmer and the distance in kilometers between each terrace and the farmer's house; (8) government subsidies and assistance, measured in Saudi ryals, the amount received by the farmer from the agricultural bank and whether he agreed or disagreed that the farmer usually receives assistance; (9) farm labor characteristics, measured by the number of people working all year round in agriculture; and (10) the social characteristics of the farmer, measured by the level of his education, the number of years he has spent in the village, and his age.

Methods of Data Analysis

Determining the existing land use patterns in relation to the physical, locational, and socioeconomic factors was the major objective of this study, and it was based on the analysis of data tabulated from the interviews. The degree of accuracy of the data was measured by the reliability of the sampling design and the method used to collect these data. The data were coded and analyzed at the Michigan State University Computer Center, East Lansing, Michigan.

The data analysis used four statistical techniques. The first technique, frequency distribution and means, was employed to analyze the actual land use patterns of the study area and to answer some of the hypotheses.

The second technique, the chi-square test of associations, was employed to analyze categorized data to determine whether a systematic relationship existed between the two categories of variables (Norman et al., 1975, p. 223). In this study, the chi-square test was used to determine if the physical, locational, and socioeconomic factors bore any relationship to the agricultural land use patterns. The results of the chi-square test are presented in cross-tabulation tables.

The third technique, the Pearson correlation analysis, was used to develop a single number that summarizes the relationship between two variables, yielding a correlation coefficient that indicates the strength or weakness of the paired association or relationship. In this research, the Pearson correlation coefficient was used to determine whether a relationship existed between the groups of physical and socioeconomic variables.

The fourth technique, factor analysis, was employed to reduce the data--that is, to determine what factors influence agricultural land use patterns and to locate clusters of related variables that are independent of the other clusters.

CHAPTER IV

THE ROLE AND PLACE OF THE AGRICULTURAL SECTOR IN THE ECONOMIC DEVELOPMENT OF SAUDI ARABIA

Before discussing the role of agriculture in the economic development of Saudi Arabia, it is useful to highlight several major issues and concepts that will appear frequently, either explicitly or implicitly, in this chapter. One is that there is no magic formula for rapid economic development. A development strategy that works well for one country may fail for another because of the physical, socioeconomic, and cultural differences. Second, development, appropriately viewed, is a complex interdisciplinary art rather than a narrow branch of economics. Economists, as well as government experts and agency advisors, have found that most obvious solutions to development problems in a particular country have failed because of social, cultural, or political realities or administrative limitations. Third, many development projects are undertaken not primarily for their long-term economic benefits but for their political expedience consequences. Policy makers, often enough, underwrite development projects with a view of reaping political rewards. Finally, the price mechanism, a powerful tool at the disposal of government policy makers, is manipulated in the produce markets to create incentives to attain development objectives. But such other manipulations as retail price controls of food items can actually retard development (Zuvekas, 1979, pp. 3-6).

Definition of Development

In the following few pages an attempt has been made to define the substantial essence involved in development by examining the meanings of such widely used terms as general development, economic growth, economic development, rural development, and agricultural development in the resource-development literature.

There is general agreement among economists, geographers, ecologists, sociologists, political scientists, anthropologists, and psychologists regarding a common meaning for the term general development, sometimes referred to as economic development, modernization, economic growth, socioeconomic transformation, or distributive justice (Mabogunje, 1981, pp. 35-50).

> In strictly economic terms, development for the past two decades has meant the capacity of a national economy, whose initial economic condition has been more or less static for a long time, to generate and sustain an annual increase in its gross national product at rates of perhaps 5 to 7 percent or more. . . . (Todaro, 1981, p. 68)

Thus, the term development is treated almost as a synonym for improvement (Seers, 1970, pp. 1-2). Mughram (1973) quoted Myrdal (1968) to define development as "the process whereby the real per capita income of a country increases over a long period of time" (p. 266).

Seers (1970) recommended basing the definition of development on reduction of the central problems of poverty, unemployment, and inequality:

> The questions to ask about a country's development are therefore: What has been happening to poverty? What has been happening to unemployment? What has been happening to inequality? If all three of these have declined from high levels, then beyond doubt this has been a period of development for the country concerned. If one or

> two of these central problems have been growing worse, especially if all three have, it would be strange to call the result "development," even if per capita income doubled. This applies of course to the future too. A "plan" which conveys no targets for reducing poverty, unemployment and inequality can hardly be considered a "development plan." (p. 3)

In short, the term development has been redefined by several new professional economists. The quotation below demonstrates how closely akin Todaro's (1981) view is to Seers':

> Development must, therefore, be conceived of as a multidimensional process involving major changes in social structures, popular attitudes and national institutions, as well as the acceleration of economic growth, the reduction of inequality, and the eradication of absolute poverty. . . . (p. 70)

<u>Economic Growth Versus</u>
<u>Economic Development</u>

The issues of economic growth and economic development become needlessly complex when experts use the terms interchangeably. We should make a distinction between them. Economists generally defined the term "economic development" as Mellor (1980) delineated: "<u>Economic development</u>" is a process by which a population increases the efficiency with which it provides desired goods and services, thereby increasing per capita level of living and general well-being" (p. 3). Or, according to Zuvekas (1979),

> <u>Economic development</u> is a more comprehensive term. Some economists have defined it as growth accompanied by change--changes in the structure of the economy, in the country's social structure, and in its political structure. Viewed in this way, economic development implies a decline in agriculture's share of the gross national product and a corresponding increase in the share of such sectors as manufacturing, utilities, financial institutions, construction, and government administration. Accompanying this shift in economic structure is a shift in the occupational structure of the labor force and an increase in the degree of education and training required for those who seek jobs. Not only do the types of jobs change, but so does their geographic distribution, with most new jobs found in urban areas. (pp. 8-9)

Mughram (1973) quoted Robinson (1972) to define economic growth as "the increase in aggregated products, either total or per capita, without reference to changes in the structure of the economy or in the social and cultural value systems" (p. 267). Furthermore, Zuvekas (1979) added:

> Economists generally use the term economic growth to refer to increases over time in a country's real output of goods and services--or, more appropriately, real output per capita. Output is conveniently measured by gross national product (GNP) on national income, though other measures could also be used. (p. 8)

The Objectives of Development

There is a consensus among researchers in the field of development that the major objectives of development are to effect positive changes in per capita income, labor yields, health standards, educational levels, and other social services (Mellor, 1980, p. 6). Todaro (1981) summarizes these major objectives of development as follows:

> We may conclude that "development" is both a physical reality and a state of mind in which society has, through some combination of social, economic and institutional processes, secured the means for obtaining a better life. Whatever the specific components of this better life, development in all societies must have at least the following three objectives:
>
> (1) To increase the availability and widen the distribution of basic life-sustaining goods, such as food, shelter, health, and protection.
>
> (2) To raise levels of living including, in addition to higher incomes, the provision of more jobs, better education and greater attention to cultural and humanistic values, all of which will serve not only to enhance material well-being but also to generate greater individual and national self-esteem.
>
> (3) To expand the range of economic and social choice to individuals and nations by freeing them from servitude and dependence, not only in relation to other people and nation-states, but also to the forces of ignorance and human misery. (p. 72)

Agricultural and Rural Development

Agricultural development should be distinguished from rural development, though some researchers have used the terms interchangeably. Agricultural development usually refers to the improvement of agricultural production in order to increase the standard of living of the farming population, through the economic exploitation of such available resources as land, capital, labor, and water. On the other hand, rural development, like the term integrated rural development, refers to positive changes (improvement) in education, health and nutrition, housing and allied social services, agricultural production, and standards of living of the rural people. Thus rural development involves reduced inequality in rural income distribution, reduced urban-rural imbalances in income and opportunity, and the capacity of the rural sector to sustain and accelerate the pace of these improvements over time (Lele, 1979, pp. 19-20). As Mabogunje (1981) explained, it does not only include but also goes beyond agricultural development:

> Rural development is concerned with improvement of the living standards of the low-income population living in rural areas on a self-sustaining basis, through transforming the socio-spatial structures of their productive activities. It should be distinguished from agricultural development, which it entails, and transcends, for that is concerned with only one aspect of their productive life. In essence, rural development implies a broad-based reorganization and mobilization of the rural masses so as to enhance their capacity to cope effectively with the daily tasks of their lives and with changes consequent upon this. (p. 94)

Conversely, the term rural resource development, narrowed to specifics, refers to actions or measures designed to encourage, promote, and secure desired uses of the natural, man-made, and human resources of nonurban or nonmetropolitan areas.

The Role and Place of
Agricultural Development

Agriculture plays multiple roles in economic growth and development, the most obvious of which is the production of food. The functions of these roles can be summarized under four categories:

1. providing more food and raw materials,
2. serving as a market for the products of the industrial sector,
3. supplying savings to other sectors of the economy, and
4. providing productive employment. (Zuvekas, 1979, p. 204)

The first role of agriculture stems from its essential and traditional function to keep a growing population alive. If the food supply increases at a lower rate than the population, then the nutritional standards will fall. Poor agricultural performance usually hinders growth and improvement in the rest of the economy and consequently limits the resources available to promote development. Food production contributes to the formation of human capital and as, indeed, many economists recognize that in the improvement in the quality and quantity of food is an investment in the sense that it promotes the quality and quantity of the labor force. In fact, malnutrition results in both the mental and physical improvement of the health of the labor force, and poor diets affect the general health of the population. As a result, workers with poor nutrition exhibit lower on-the-job productivity than a labor force with a good nutritive food supply. Another important aspect of food production is that an agricultural sector growing much more slowly than the general economy to meet the food demand can result in an inflationary pressure. In other words, if domestic food production does not grow at a rate equal to the population growth and if food imports are limited, then the prices of both the imported and domestically produced food will have the tendency to rise (Zuvekas, 1979, pp. 204-206).

> The need for food and the extremely low level of efficiency in agricultural production demand that most of the labor force and land resources in low-income countries be engaged in agriculture. In early stages of development, 60 to 80 percent of the population is engaged in agriculture, and 50 percent or more of national income is generated in the agricultural sector. Therefore, even though agriculture may use little capital per worker, it commands a high proportion of the total capital resources of such nations as well. (Mellor, 1980, p. 4)

The second role of the agricultural sector is to provide a market for the products of the industrial sector. Agricultural growth and development is expected to generate a demand for small industrial goods that farmers need for their own consumption, and for such agricultural equipment as tractors, diesel engines, pumps, and other allied agricultural implements (Gianaris, 1978, p. 121).

The third role of agricultural development is its importance as a source of savings. Many developing countries that are not blessed with such natural resources as petroleum, gold, and other minerals or tourist attractiveness depend on agriculture as their main source of income. It is believed that more than half of such countries' national income is likely to come from the agricultural sector and related services. If that is where the income is generated, that is where the savings potential will be. In this regard, Zuvekas (1979) added:

> Thus far, we have seen that a stagnant agricultural sector limits the possibilities for growth elsewhere in the economy by restricting the supply of foreign exchange, the quality of the labor force, the demand for manufactured goods, and the supply of savings. In the last few decades, poor agricultural performance has had another serious consequence for developing countries: rising levels of unemployment and underemployment. (p. 206)

The fourth role of agriculture in the process of development is to provide jobs for rural people and, at the same time, to provide a productive labor force to the industrial sector in particular and to the other sectors of a country in general. As Mellor noted, it is predicted that 60 to 80 percent of the population, especially in developing countries, is engaged in agriculture. It is also suggested that the small or middle-sized farm agriculture can absorb more labor than the large farm agriculture. More intensive cultivation and higher productivity may require more employment, especially on small farms where agricultural machinery cannot be easily used (Gianaris, 1978, p. 121). Further, Mughram (1973) alluded to the same economic fact:

> It is only natural that agriculture development gets, by far, the largest share of attention in the economic development literature on underdeveloped countries. Not only because agriculture is the occupation of the vast majority of the people, but also because in most underdeveloped areas the agricultural sector is looked upon as the main source of capital that is needed to power the various development programmes. (p. 269)

Objectives of Agricultural Development

The objectives of agricultural development which generally underlie agricultural programs in many of the developing countries can be summarized under the following heads:

1. An increase in production
2. Improvements in marketing
3. Changes in land tenure
4. A decrease in the disparity of income and wealth in the rural sector
5. The use of a part, but not all, of any increase in the production to raise the standard of living of the rural population
6. Inducing population shifts from the agricultural sector to industry; and
7. The encouragement of investment and reinvestment. (Meier, 1964, p. 291)

From the foregoing discussion it seems clear that agriculture is the most important sector in the general economic development of many underdeveloped countries. In contrast, industrial development represents the most important theme of economic development in many developed countries. In both underdeveloped and developed countries, financial resources are badly needed, especially in the early stages of development. These capital resources, in turn, influence the formulation of development objectives, policies, and their implementation. In this regard, there is a long-held belief that agriculture has traditionally provided such start-up or initial capital (Mughram, 1973, p. 272).

Economic Characteristics of Saudi Arabia

> The Saudi economic outlook is conservative in character and free in orientation (by freedom here is meant laissez faire). The conservatism cannot be more clearly illustrated than by noting that one of the objectives of development, as they are stated in the 1971-75 development plan, is to maintain the "religious and moral values" of the country. What is more is that this objective comes before raising the standard of living. . . . (Mughram, 1973, p. 273)

Briefly, the free-enterprise orientation of the Saudi economy is based on two major features: (1) a respect for private ownership and (2) an open trade policy wherein essential goods are imported free without any barriers in the form of customs, duties, or tariffs; physical quotas; or any other restrictions. Only nonessential goods are lightly taxed.

Saudi Arabia has a single-resource economy. The Saudi economy is based, 75 percent on average, on the oil revenues. Indeed, the dominance of oil in the country's foreign exchange, government revenues, and as a main source of growth in the national income is the most obvious characteristic of the economic system of the country. The government of Saudi Arabia is well aware of the dangers of depending on a single oil resource as the only source of income. Their concern about this situation has provided one of the objectives of the country's development plan, by diversifying sources of national income and reducing dependence on oil through increasing the share of other productive sectors in the gross domestic product" (Looney, 1982, p. 99).

During the period from 1965 to 1982, the economy of Saudi Arabia experienced significant structural changes. One major change was a relative shift to crude petroleum and natural gas, whose share of the nominal GNP reached its peak at 75 percent in 1975 and then declined to 56.4 percent during the rest of the decade in 1978. Another major change was a sharp increase in the oil prices, which resulted in significant reductions in the contributions of the nonoil activities to the economy (El Mallakh, 1982, p. 28).

> Indeed . . . , the following economic activities all increased their shares of real GDP between 1965 and 1978: (1) manufacturing other than petroleum refining; (2) electricity, gas and water; (3) construction; (4) commerce, restaurants and hotels; (5) services; and (6) other minerals. This occurred not only at the expense of crude-oil and natural gas production but also at the cost of reduced shares of other non-oil activities, such as agriculture, government services, and transport, storage and communications. (El Mallakh, 1982, p. 28)

Mughram (1973) used the term _dualism_ to describe the dichotomous nature of the Saudi Arabian economy. According to him, such dualism is displayed in many ways. On the one side there is the oil sector, which is technically advanced and capital intensive, and on the other the traditional, subsistence-level agricultural and pastoral sector. The crude oil and natural gas production generated about 90 percent of the government revenues in 1972-73, and in 1978 the oil sector still contributed 56.4 percent of the GNP. It did not, however, employ more than 1.4 percent of the labor force. The agricultural sector, in contrast, is believed to employ about 50 percent of the labor force while contributing only 8.5 percent to the GNP is 1965, 6.5 percent in 1970, and 1.0 percent in 1978. According to the information derived from Mughram's thesis, this dichotomy is apparent in the rate of growth of these two sectors. That is, while the annual growth rate of crude oil and natural gas was 8.2 percent, the growth rate in the agricultural sector was only 1.7 percent in the early 1970s and has slowed since then (El Mallakh, 1982; Mughram, 1973).

The Saudi economy is characterized by the dominant role of the government, which provides nearly all the essential public services. The public bureaucracy is involved directly in providing free education, health care, postal services, social security, and most of the means of public transportation. Beginning with the Second Five-Year Development Plan (1975-1980), the central Saudi government assumed the responsibility for the economic and social well-being of all Saudi citizens. It has thus expanded and upgraded public education, as well as public health care for all citizens, and concurrently developed a social security program capable of lifelong basic human services to all the Saudis. The government also subsidizes housing and many foods, and recreational and social programs are provided at no cost (Looney, 1982, p. 22).

Further, the economy and the government-sector services in Saudi Arabia are based increasingly on the industrial production and export of petrochemicals and natural gas. In other words, it is obvious that the oil industry dominates the structure of the Saudi Arabian economy and overshadows all other sectors. Related industrial establishments, such as mineral exploration, oil refining, and construction, are owned and operated by the government (Abduljawad, 1982, p. 133). In this regard, El Mallakh (1982) pointed out:

> The biggest project that Petromin is engaged in is the construction of the 1270-kilometer-long East-West Crude Oil Pipeline linking the Ghawar Field (the world's largest) the Red Sea port of Yanbu. Eventually the capacity of this pipeline will reach 3.5 million barrels per day (b/d). The eleven pumping stations that were built to push the crude through the pipeline to Yanbuy will be fueled by natural gas liquid (NGL), which is also supposed to reach Yangu, through a 1168-kilometer NGL pipeline. . . . (p. 5)

Industrial enterprises outside the oil sector are small scale and privately owned. Primarily light industries include some transportation activities, repair, construction materials, plastic products, bricks, tiles, metal and plastic furniture, paint, and chemical plants. The agricultural sector includes such light industries as intensive poultry production, dairy products manufacturing, and other food-product packing and processing. As the new industrial diversification proceeds further, it is hoped these enterprises will replace the traditional craft sector (Mughram, 1972, p. 276).

A lack of skilled and semi-skilled Saudi workers is considered one of the major problems of the economy of Saudi Arabia. It is not unusual to find that among the entire labor force employed in a Saudi industrial plant, not a single worker is an Arabic-speaking Saudi citizen. In fact, management is usually European and the work force is almost entirely from the Indian subcontinent or Southeast Asia (El Mallakh et al., 1982, p. 5). In this connection, Looney (1982) pointed out:

> If spending on infrastructural and industrial projects continues as planned in 1980, it will create a demand for 500,000 to 1,000,000 more foreign workers in the next five years (in addition to the 1.75 to 2.0 million who have arrived in the past five years). For a country with an indigenous population of only 4 to 6 million, the presence of 2 to 3 million foreign workers is in many respects rather risky politically, not to mention inviting criticism as to the wisdom of the kingdom's development strategy. (p. 111)

Another major characteristic of the Saudi Arabian economy is its capital surplus. This surplus of capital, due heavily to the oil revenues, makes development projects feasible because the capital needed for various essential outlays no longer limits development (Mughram, 1973, p. 276).

The Performance of the Saudi Economy

In recent years the Saudi economy has shown positive improvements. During the period from 1974 to 1980, the economy achieved its greatest rates of growth. In terms of the nominal GNP, the Saudi economy performed remarkably well during this period, growing at an annual rate of 26.7 percent. The explanation for this high performance may be found in the sharp increases in the oil revenues. During the previous four years, 1970 to 1975, the economy was highly inflated, so much so that the real rate of growth of GNP was much lower than the nominal GNP rates (El Mallakh, 1982, p. 34). The growth rate in the real GNP per capita from 1970 to 1980 indicated impressive increases of 12.1 percent. During the period 1964 to 1970, the rate of growth of real GNP per capita was 5.8 percent, considered quite a satisfactory rate of growth.

The concept of economic welfare as used here is synonymous with consumption per capita, which is used as a measure of the economic well-being of the Saudi population. The real per capita consumption since 1964 has indicated that the average Saudi citizen has enjoyed an increasingly improved standard of living. The annual growth rates of per capita consumption for 1970-1980 and 1964-1970 were found to be 9.9 and 8.5 percent, respectively, but in the years 1970-1976, a decline was recorded reflecting high rates of inflation that averaged about 20 percent (Looney, 1982; El Mallakh, 1982).

Gross capital formation (GCF) during the period 1964 to 1978 grew at a rate of 39.9 percent. During 1970 to 1978, the rate of GCF growth was 52.1 percent, a growth rate surpassed in no other sector during the period under discussion. The growth rate was made possible by the increased oil revenues that accumulated after 1972 and a development emphasis on infrastructure construction (El Mallakh, 1982, p. 35).

The Role of the Saudi Government in the Economic Development

The Saudi government plans a dominant role in the country's economic development and growth. As noted, the government takes direct responsibility for establishing, developing, managing, and subsidizing essential public services such as education, health, roads and highways, railroads, airlines, communication networks, electric power systems, social security, and agricultural development:

> The role of the Saudi Government in the development process of the country has essentially been to undertake policies which would diversify the economy and improve the standard of living of the population, without sacrificing the freedom of the individual and the private sector's ability to respond to the government's incentives within a free market system. (El Mallakh, 1982, p. 35)

With regard to the market system mechanisms in particular and even the economy as a whole, the government's policy is to interfere as little as possible, thus allowing the economy to function as a free-enterprise system. "Thus, the government of Saudi Arabia over the years has sought to influence the economy by means of several measures such as fiscal policies, participation in the oil industry in cooperation with other OPEC countries, and lastly, planning" (El Mallakh, 1982, p. 36).

The largest role that the Saudi government plays in economic activities is evident in government expenditure appropriations. "The annual budget serves as a means to appropriate government expenditures, as platforms on which to outline the government's tax, trade, financial and other policies, and as the medium through which development plans are executed" (El Mallakh, 1982, p. 36).

Planning for Economic Development

Efforts are underway in Saudi Arabia to improve the standard of living of all citizens. These efforts cannot be effective unless the government engages directly in the economic development of the country. Saudi Arabia has had three Five-Year Plans with definite development goals. The First Plan covered the period 1970 to 1975, the Second 1975 to 1980, and the Third Plan 1980 to 1985.

The general objectives of the national plans, which include economic and social development, have not fundamentally changed over the three Five-Year Plans. These objectives are to:

1. maintain the religious and moral values;

2. raise the standards of living and welfare of the citizens;

3. provide national security; and

4. maintain economic and social stability (Looney, 1982, pp. 98-99; Nasser, 1976, p. 86).

In other words, the means the government uses for achieving the above objectives have also not changed significantly, which consist of the following:

> 1. An increase in the rate of growth of the gross domestic product,
> 2. the development of human resources so that the several elements of society will be able to contribute more effectively to production and participate fully in the process of development, and
> 3. the diversification of the sources of national income and reduction of dependence on oil through increasing the share of other productive sectors in the gross domestic product. (Looney, 1982, p. 99)

The basic strategy of the Saudi national plans has been aimed at six objectives discussed by Nasser (1976) and Looney (1982):

1. Improving and expanding the country's physical and social infrastructure, while minimizing bottlenecks.

2. Increasing the earning capacity of the people by economic exploitation of the country's natural resources.

3. Creating an economic environment to which the private sector will respond positively with contribution to production.

4. Providing free education, medical care, and welfare services to all the society's population equitably.

5. Allowing uncontrolled migration for those workers who will contribute effectively to socioeconomic development in any part of the country.

6. Establishing a system of welfare payments for those citizens who cannot participate in production owing to circumstances beyond their control (Looney, 1982, p. 105; Nasser, 1976, p. 87).

The national plans have covered all aspects of economic life in Saudi Arabia including economic resources development, water, agriculture, mineral resources, construction, manufacturing, electricity, energy, human resource development, education and training, labor affairs, social development, health services, social and youth services, physical infrastructure, transportation, posts and telecommunication, and municipal and residential development. The First and Second Development Plans, 1970 to 1975 and 1975 to 1980, respectively, were implemented successfully. The GNP over the two Five-Year Plans grew at a rate of 13.5 percent and 8 percent, respectively--rates that are considered satisfactory. The actual expenditure on the Second Five-Year Plan was almost 200 percent more than planned during the First Development Plan. The Second Plan was more ambitious and almost nine times as large as the First Plan, in terms of the total expenditure. During the Third Development Plan, 1980 to 1985, the absorptive capacity of the economy has much improved. That is, the rate of increase in oil prices has been much higher than it was from 1970 to 1980; inflation was reduced to an average rate of 10.5 percent in 1979 and the bulk of the country's population has had a much higher standard of living since the beginning of the Third Five-Year Plan was launched in 1981 (El Mallakh, 1981, pp. 1-2).

> Developed planning in Saudi Arabia has been plagued by all the problems--with the exception of financial constraints--which traditionally face attempts to successfully implement plans in developing countries. In the Saudi case, the main bottlenecks have been inadequate administrative capacity, manpower shortages, and the inability of physical infrastructures to absorb the increased expenditures. . . . (El Mallakh, 1982, p. 37)

Since the key objective of this chapter is to look at the agricultural development in Saudi Arabia in general, and to emphasize the role of Assarah as an agricultural region in the general economic development of Saudi Arabia, the following discussion is limited to the agricultural sector, rather than including all the Saudi economic activities, which is clearly beyond the scope of this dissertation, though analyses of recent trends in the other sectors have been provided by other Saudi scholars, for instance, by Abdul-Hamid Bassam (1982) and others.

Agricultural Development in Saudi Arabia

In the past Saudi Arabia's primary source of income was derived from the agricultural sector. The country was self-sufficient in agricultural production, but this self-sufficiency was possible only at a very low level of subsistence. Over the decades since King Ibn Saudi built a nation out of the various desert tribes and before the discovery of oil, Saudi Arabia was among the world's poorest countries, a fact most of the outside world has now forgotten. Agricultural production in Saudi Arabia, then as now, included settled farming, forestry, range resources, fishing, and nomadic agriculture.

Most of these were carried out on a less modern scale than they are practiced now (El Mallakh, 1982, p. 79; Mughram, 1973, p. 277).

Geographically, agriculture in Saudi Arabia has generally been centered around the oases and Wadi channels scattered throughout the country where soil is fertile and shallow ground water and springs are available for such crops as grains, dates, fruits, and vegetables. The Assarah highland region, the area of this study, is unique in the agricultural sector of Saudi Arabia in the sense that agriculture in this region depends on rainfall, which sometimes exceeds 400 mm annually, and man-made terraces which provide a basis for agricultural development (Al-Shomrany, 1980, pp. 65-67). (See Figure 12.)

In recent years, as the economy of Saudi Arabia has expanded because of the oil revenues, the role of the agricultural sector as a source of income has declined. Traditional agriculture has decreased as many former farmers have moved to major urban centers where less arduous jobs and high wages are a major attraction. The relative contribution of agriculture measured in terms of output has declined. In 1974/75 agriculture contributed only 3.6 percent of the total real GNP, and in 1977/78 this fell to 3.2 percent of total real GNP (El Mallakh, 1982, p. 79).

Major Characteristics of Saudi Agriculture

Despite its reduced contribution to GNP and increased imports of food, agriculture continues to play a major role in the economic activity of the country. It is characterized by the following

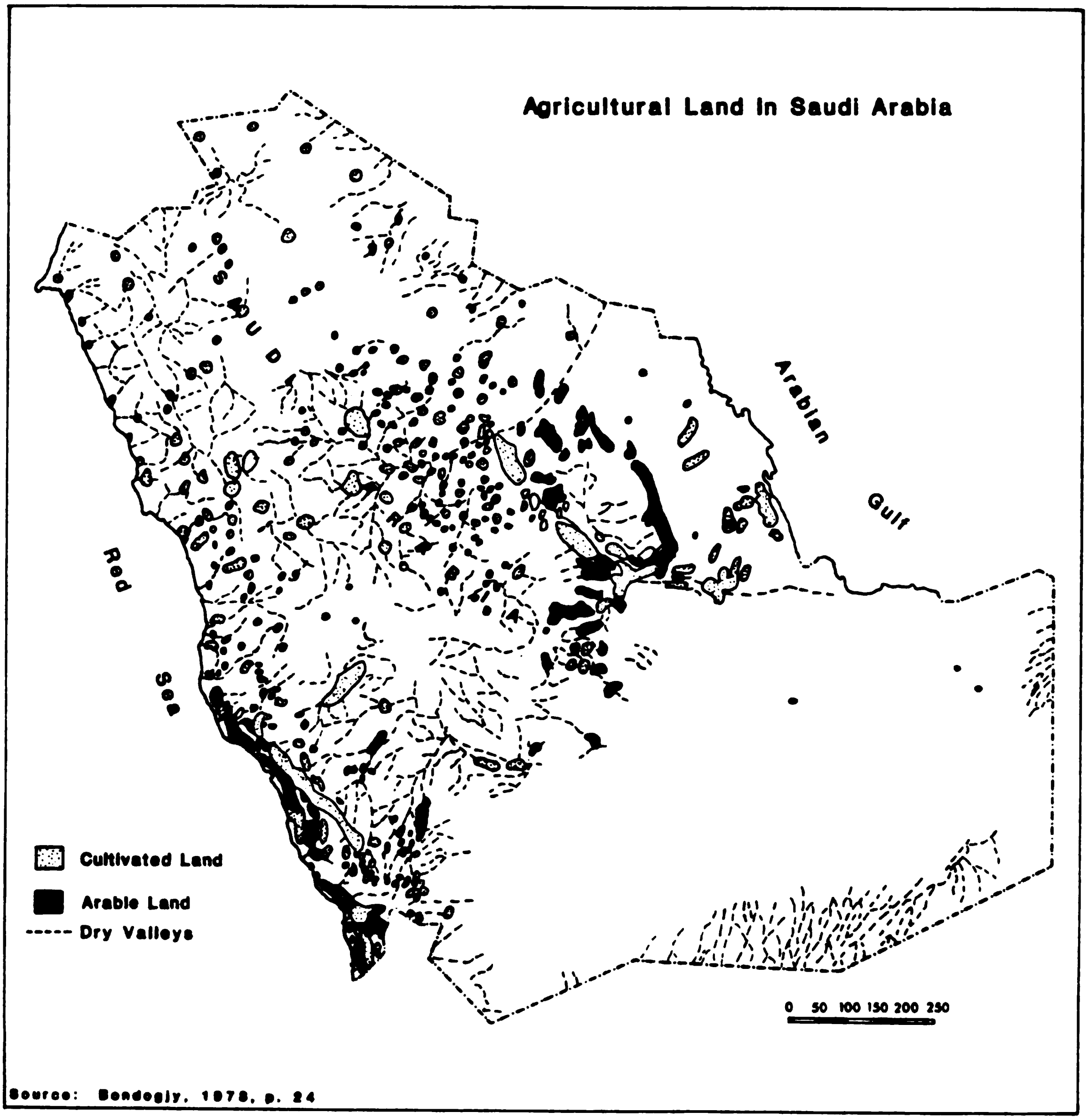

Agricultural Land in Saudi Arabia
Arabian Gulf
Red Sea
SAUDI ARABIA
Cultivated Land
Arable Land
Dry Valleys
0 50 100 150 200 250
Source: Bendegiy, 1978, p. 24

Figure 12

conditions which, to some extent, prevail throughout the Arabian Gulf and the Peninsula:

1. Agriculture in Saudi Arabia consists of small farms, the average size of which is under eight hectares. The average area of land irrigated per holding is less than one hectare. The smallness of these holdings is attributed to fragmentation caused by such factors as the limited agricultural land, the rugged topography, and the inheritance system.

2. Subsistence-level agriculture was the traditional mode of production. This type of agricultural production has been declining owing to an increase in the nontraditional agricultural production. Domestic consumption has not remained dependent only on domestic production, for oil revenues have made it possible to import agricultural produce (Mughram, 1973, p. 277).

3. Agriculture in Saudi Arabia is carried out around village-type settlements. In 1970, there were about 7,805 agricultural villages in the country, with total land holdings amounting to approximately 1.4 million hectares, of which only about 525,000 hectares were under cultivation. Of the area under cultivation, 121,000 hectares were artificially irrigated and 404,000 hectares were rain-fed. The number of agricultural villages has since declined sharply to 3,084 in 1975. The main cause was low real incomes from agriculture and increasing opportunities for well-pain employment in the other sectors of the economy (Looney, 1982, p. 142).

4. Recent studies indicate that Saudi Arabia has about 4.5 million hectares of arable land. These huge tracts of arable land can

be easily cultivated if adequate water supply can be made available to them (El Mallakh, 1982, p. 80).

5. The size of the land holdings is generally too small for economic cultivation. Modern agricultural machinery can hardly be used on these sized farms, especially in the Assarah region, because of physiographical factors.

6. The total number of people engaged in agriculture was estimated to be 695,000 persons or 40.4 percent of total Saudi employed population in 1975. By 1980 this number had declined to about 600,000 persons or 35 percent of the country's labor force (El Mallakh, 1982, p. 80).

7. The decline of traditional agriculture has followed a corresponding decline in livestock grazing. Pastures and grasslands are almost nonexistent in Saudi Arabia because most of the land in the country is too dry to support more than intermittent livestock grazing.

8. Generally, the agricultural sector in Saudi Arabia has been less successful than other sectors of the Saudi economy. During the period from 1960 to 1970, the average annual growth of agricultural production was 1.6 percent of constant price. During the First Five-Year Plan (1970-1975), this figure rose to 3.6 percent annually, and during the Second Five-Year Plan (1975-1980), agricultural output rose at an average rate of 5 percent annually. These increases were outstripped by the oil revenue increases, and the share of agriculture in the nonoil GNP dropped from 12.1 percent in 1970 to 2.4 percent in 1978 (Looney, 1982; El Mallakh, 1982).

9. The recent modern agricultural sector far from satisfies the domestic needs of the country's population, even at a subsistence level, and importation has proved the solution for the food shortages. In 1972, net imports of agricultural produce accounted for 45 percent of total food needs. In 1979 Saudi Arabia imported 4.98 million tons of food by sea alone, or about 60 percent of the total food requirements. Almost the entire supply of sugar, tea, rice, oils, wheat, meat, milk, and fruit for the country is imported (Looney, 1982, p. 142).

10. The development of agriculture and water resources has recently received a high priority in government policies. This interest in agricultural development is reflected in large increases in budgetary allocations of the agriculture and water resources. The government allocated SR 1.40 billion in 1975 in comparison to SR 8.25 billion in 1979 and SR 8.67 billion in 1980 (Looney, 1982, p. 142).

Constraints on the Agricultural Development in Saudi Arabia

Agricultural development to date has met with a relative lack of success. This has been due to diverse indigenous conditions, which include small landholdings, inefficient farming operations, dispersion of farms over an extensive land area, inadequate water supply, land tenure and water rights, poor use of technology, and a harsh climate, all of which have combined to hamper growth in the agricultural sector (El Mallakh, 1982, pp. 79-80).

<u>Policy Options for Agriculture in Saudi Arabia</u>

The government has a number of policy options in responding to this relative lack of success in developing the agricultural sector in Saudi Arabia. The following are among the most important and merit discussion here because of the varied perspectives they provide for future planning:

> It is in such perspective that the role of agriculture in future development can best be understood. It is true that the country does not very badly need the agricultural commodities to be produced internally, because such commodities can be imported. Yet there are grave dangers in adopting such policies and bypassing the agricultural sector simply because needs could be satisfied elsewhere. . . . (Mughram, 1973, p. 278)

The dangers or disadvantages of opting out of agricultural development efforts, because of the relative lack of success that has followed past efforts, may be summed up as follows:

First, the traditional system of agriculture in Saudi Arabia is declining and will continue to decline until a point is reached where the traditional system will be lost completely, while there are no efforts made to acquire an alternative system to turn to when the oil revenues from the nonrenewable resource have become scarce. In comparison to other oil-producing countries, this prospect may be a long way off in the future. Yet the delay in the long-term investment in the agriculture of a relatively arid country, like Saudi Arabia, is unwise.

Second, the abandonment of farming has led to the waste of the national agricultural wealth, like the soil resources, fields, trees, wells, ditches, dams, man-made terraces, and irrigational canals, which have to be maintained if they have to retain the potential for production. The abandonment of the human-made terraces in the area of this study provides one of the worse examples of national waste. The terrace soil that took a millennium to develop has been washed away in a few years because the terrace walls have been collapsing, accelerating excessive soil erosion owing to disuse and lack of maintenance.

Finally, more important than agriculture being a national economic asset, the sector represents people whose welfare and quality of life is beyond quantification. Herding a rural people into cities has not always proved to be to their as well as the country's ultimate advantage (Mughram, 1973, p. 278).

One policy option for agricultural development in Saudi Arabia is a long-term-objectives policy that aims at or implies the transformation of agricultural production patterns to a more up-to-date standard, with as little waste of the physical resources as possible. The economic and social cost of such efforts should be judged both in terms of short-term economic returns and long-term social and economic benefits (Mughram, 1973, p. 279).

Another policy option for a situation like that of Saudi Arabia suggests that the most suitable agricultural development policy is (1) to allow the importation of food at a level at which a good standard of health and nutrition can be maintained and the basic need for agricultural products is satisfied, (2) to encourage the gradual substitution of the domestic produce for imported agricultural commodities as much as possible, and (3) to concentrate efforts on developing national agricultural resources to their highest potential.

This may result in building some comparative advantage in a few agricultural commodities that might be produced on a large enough scale to reach a surplus that may later be exported. Dates, oil crops, and intensive livestock rearing hold up some such possibilities.

> Such long term policies imply a heavy investment in human resources and in speedy and efficient technological change. Given the capital surplus and assuming that a farsighted, responsible and stable political leadership continued to pursue such policies, there is a good chance that they might succeed. (Mughram, 1973, p. 278)

The medium-term objectives for agricultural development in Saudi Arabia present a fourth policy option. This policy option should concentrate on increasing agricultural productivity within the existing land and resource limitations and should include a vertical expansion of cultivation. Given the constraints of water, land, climate, and labor, it is apparent that horizontal expansion of agriculture in Saudi Arabia is limited in the short- and medium-term planning. The medium-term vertical expansion would involve terracing hilly terrain and the long-run objectives could focus on gradual, eventual horizontal expansion (Looney, 1982, pp. 150-51).

The Role of the Saudi Government in Agricultural Development

Given that the main objective of the government is to maximize the long-run wealth of the kingdom, it may be argued that one way to achieve this objective, at least partially, is to continue to transfer a relatively small, but expanded, part of its oil revenues to agriculture. The Saudi government has formalized its role in the development of agriculture through the well-defined policies contained in the three Five-Year Plans, which are directed toward reducing the country's dependence on food imports and developing the rural areas:

> The policies provide for the government to: (1) encourage private enterprise in food production, processing and marketing while confining its own activities to those into which private entrepreneurs are unable or unwilling to enter; (2) aim at a reasonable balance between the economic and social rewards available from agricultural activities in the rural areas and the rewards available from other economic endeavours in the urban areas; and (3) recognize future as well as present needs and both consumer and producer requirements in implementing agricultural programmes. . . . (El Mallakh, 1982, p. 91)

The government's strategy for achieving these national policies is based on the principles of:

1. The wise use of water resources.

2. Maximum feasible self-sufficiency in the production of farm machinery, seeds, fertilizer, and other inputs.

3. Encouraging the private sector to develop the facilities and services required for food processing and distribution.

4. The same guarantees for foreign investors in agriculture as for foreign investors in industry.

5. Provision by the public sector of the physical infrastructure and the safety and animal-health services required by the private sector in agriculture.

6. Expansion and distribution of the credit granted by the public as well as by the private sectors for the development of agriculture, including fisheries, forestry, grazing, and other agricultural activities.

7. Providing economic incentives and programs to stabilize prices or support farm incomes.

8. Protection of the environment from pollution due to agricultural activities (El Mallakh, 1982, p. 92).

Given that the main objective of agricultural development is to increase agricultural production at a rate consistent with national economic growth, it was proposed that the traditional small-holdings mode of farming be changed. The government in this regard has participated in two ways: First, they have encouraged the formation of cooperative farming societies that could be intensified at both the production and marketing levels. Cooperative farming enables traditional farmers to produce on economic-sized holdings, to buy agricultural input more cheaply, to use agricultural machinery more intensively and efficiently, and to acquire new techniques of production. The success of these farm organizations depends on the land tenure system, the level of education of the farmers, their traditional beliefs, and dedication and commitment of the management of the cooperative societies. Second, it has invited private farmers or individual Saudis, who have agricultural management training or experience, to enter into large-scale agricultural operations. The success of this program depends largely on the availability of easily secured agricultural credit. The government already provides substantial incentives, which include price guarantees, regular supply of agricultural inputs at subsidized prices, and improved agricultural infrastructure (El Mallakh, 1982, pp. 92-93).

> In line with the objectives of its agricultural policy, the Saudi Government has involved itself in several broad areas which directly or indirectly will tend to influence agricultural production in the country. These include: comprehensive water planning and irrigations; a programme to provide physical infrastructure to enhance agricultural production; subsidy of

> machinery, fertilizer, seeds and other agricultural inputs and price supports; provision of soft credit through the Agricultural Credit Bank; and finally, research and agricultural education. (El Mallakh, 1982, p. 93)

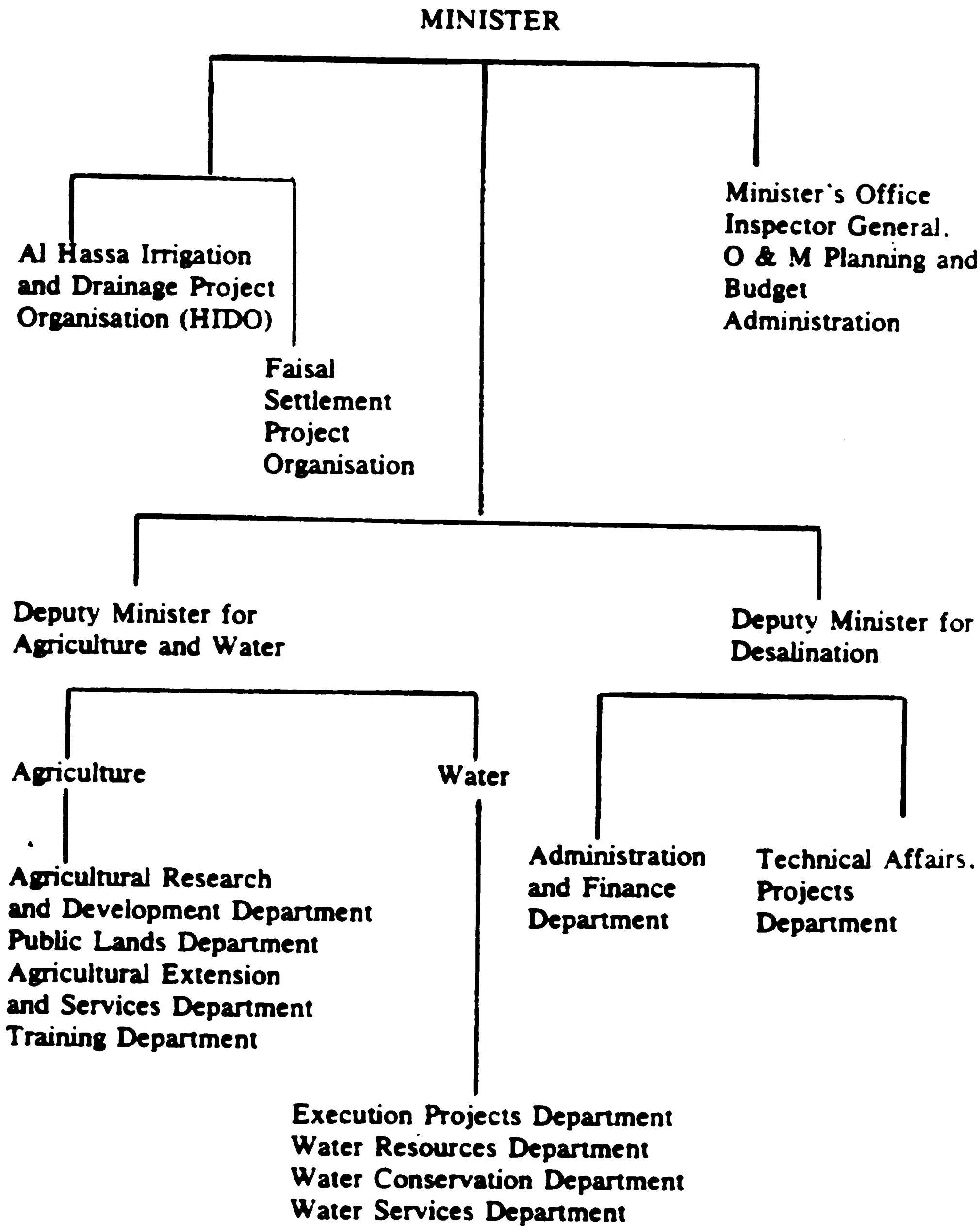
In the beginning of the First Development Plan (1970), the Ministry of Agriculture and Water has reorganized. New departments were created for the first time for animal resources, subsidies, statistical studies, and agricultural development. These new departments, as well as the existing ones, were headed by Saudi graduates in agriculture and economics. At the same time, the country as a whole was divided into 14 agricultural regions, each headed by a director who enjoyed a high degree of autonomy in areas under his control (Figure 13):

> In terms of giving direction to the development of agriculture, the government, "after considering the strategic importance of crops and livestock production, the need for water conservation, the relative value of crops in total agricultural production and potentials for rapid increase in yield," has identified a number of farming activities which should receive special emphasis. The crops targeted for increased production over the 1980-85 period are wheat, potatoes, dairy products and vegetables, as well as animal forage. (El Mallakh, 1982, p. 94)

In providing the physical infrastructure, the government has concentrated its efforts on rural road construction. New asphalt roads have been laid out throughout the countryside and have contributed positively to the agricultural production and marketing. These new paved roads have made it possible for farmers to export their farm commodities to the local and neighboring markets.

The use of fertilizers is increasing, but the quantity supplied does not meet the quantity needed and demanded. Farmers have recognized the importance of fertilizers in agricultural production and have begun to use large quantities, which has resulted in

ORGANISATION OF THE
MINISTRY OF AGRICULTURE AND WATER



Source: El-Khatib, 1974.

Figure 13

fertilizer shortages in the country. The shortages are believed to be related to the inability of the distribution network to respond effectively to the increased demand. An optimum use of fertilizers on irrigated agricultural lands has been estimated at 25,000 to 30,000 tons of nitrogen and a similar amount of phosphates.

Government incentives are provided for inputs as well as for output. For the former, the incentives include subsidies on fertilizers, animal feeds, seeds, machinery, equipment, and transportation. For the latter, they include supports for wheat, corn, dates, vegetables, and fruits. Incentives are also provided for the acquisition of land for agricultural purposes.

The role of the Saudi government in developing the agricultural sector is essential in the establishment of agricultural credit, research, and education.

> The Agricultural Development Bank (ADB), established to aid in the development of that sector, was founded in 1965; the institution is now well established with a respectable operating history. By 1980 it had branches in 11 cities, operating 52 local offices. The Bank extends three types of loans: (1) short-term loans for inputs on a seasonal basis, (2) medium-term credits for equipment, and (3) longer-term loans for the purchase and improvement of land. Starting from a modest first year operation of 714 loans totalling SR 4.4 million, ADB made 20,298 loans amounting to SR 585,688 million in 1978. (El Mallakh, 1982, p. 95)

The main objective of the Agricultural Development Bank is to encourage investment in the agricultural sector. This kind of investment will, it is hoped, lead to an increase in agricultural production and consequently to a greater degree of self-sufficiency. The Third Development Plan (1980-1985) emphasizes the development of the agricultural sector and provides for agricultural loans of SR 5 billion and subsidies of SR 2.5 billion. Individual farmers, agricultural cooperatives, and nomadic herdsmen are all eligible for the loans. Credit and funds are also available for businesses and corporations that are planning to or have already established dairy farms, fisheries, agricultural marketing, processing plants for cold storage and dairy products, and other allied industrial and agricultural operations.

Research and education are a prerequisite for the development of agriculture in Saudi Arabia. Intensive research is needed to provide information about soil, water distribution, pests, and the feasibility of adapting modern technology to Saudi conditions. Skilled agricultural manpower is needed to translate the plans of the Ministry of Agriculture and Water into reality for which training centers have been established by that Ministry to offer the needed services to Saudi farmers throughout the country. Two of these are already in operation in the Assarah highland region, one in Taif City in the north and another in Baljorashy City in the central region. The one in Taif specializes in range and forest management, while the Baljorashy training center's chief concentration is on fruit production, irrigation, and forest development.

Agricultural Development in the Assarah Region

The Assarah region, the study area for this dissertation, has a unique role to play in the national development of Saudi Arabia unmatched by any other region in the country. If the main object of agricultural development is to attain greater self-sufficiency in agricultural production and enhancement of the standard of living of the farming population through the economic exploitation of the available land and water resources, it would seem that the best strategy for regional development is to concentrate on a region with the most natural agricultural resources, and in Saudi Arabia Assarah is such a region (Nasser, 1976, p. 88). (See Figure 14.)

The Development Program for the Assarah Highland Region

Even though Assarah has the best agricultural potential, the agricultural development of the region is handicapped by many limitations, such as (1) the fragmented agricultural holdings, (2) the lack of any sizable flat terrain of land due to the rugged topography, (3) the irregularity of water supply, (4) soil erosion and terrace abandonment, (5) the declining interest in farming as an occupation, (6) the exodus of the younger generation to the cities, (7) the lack of effective agricultural extension and research, (8) poor transportation, and (9) a lack of agricultural marketing facilities (Mughram, 1973, pp. 280-81; Al-Shomrany, 1980, pp. 103-106).

No specific development program has been solely designated for Assarah, but Assarah has generally been in the development program for the southwestern region. The program proposes various projects for farming, water, forestry, grazing, fishery, soil, animal production, mining, industry, transportation, marketing, education, and health care.

Under the proposed program, the Assarah region was divided into seven zones for administrative purposes. Then, the statistical data and general information about the topography, soil and climatic

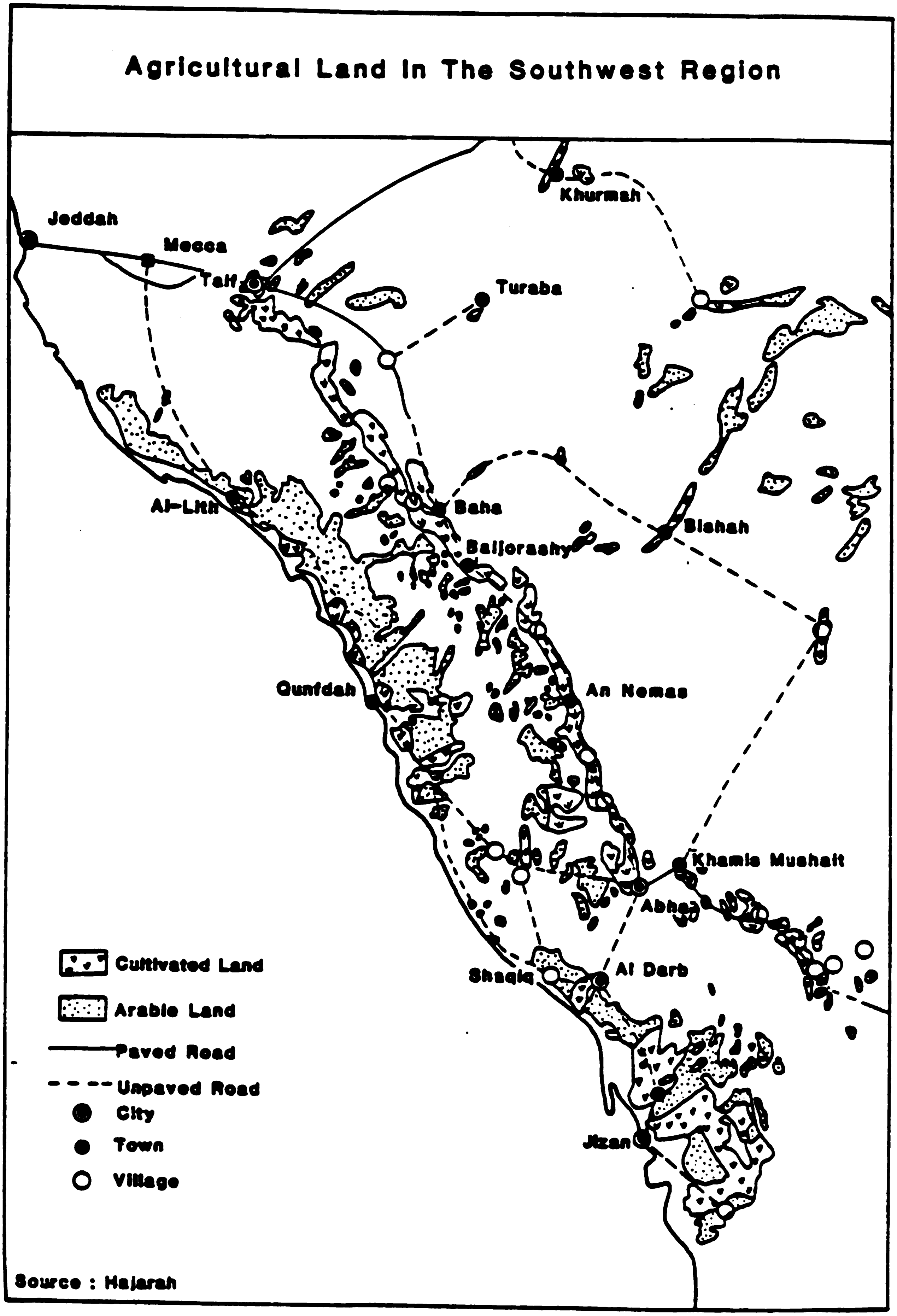

Agricultural Land In The Southwest Region
Jeddah
Mecca
Taif
Turaba
Khurmah
Al-Lith
Baha
Baljorashy
Bishah
Qunfdah
An Nemas
Khamis Mushait
Abha
Shaqiq
Al Darb
Jizan
Cultivated Land
Arable Land
Paved Road
Unpaved Road
City
Town
Village
Source : Hajarah

Figure 14

characteristics, vegetation, livestock, and agriculture were collected, during 1965-1970, by the Ministry of Agriculture and Water. The information collected about the agriculture included data about the farming areas, types of crops grown, prices of the agricultural products, export and import of food, the labor force, irrigation, agricultural machinery and equipment, and grazing land.

The Ministry of Agriculture and Water then established various agricultural departments throughout the region in such locations as Taif, Baljorashy, Al-Alaya, An Nimas, and Abha. These departments provide free services to those farmers who seek their assistance. During the Second Development Plan (1975-1980), the Ministry created several Agricultural Development Banks which provide the farmers with loans, subsidies, and agricultural machinery and equipment. The development of water resources has been designated as the top development priority, and the three Five-Year Plans contain proposals for many irrigational dams. At the present time, some of these dams have been constructed. Three of them have been completed in the Al-Alaya Bashut district, the representative area selected for this study. A new highway which runs through the region from north to south was constructed eight years ago and has contributed significantly to the economic development of the region as a whole. Formal education and health care have been made available to the majority of the region's population.

Prospects for Successful Agricultural Development in the Assarah Region

The Assarah highland region is characterized by a great density of man-made terraces. Literally millions of these terraces provide the base for future agricultural development. Through a lack of maintenance and virtual abandonment of them, especially because of the cheap imported food, thousands of them have been destroyed, and the cost of rebuilding them has become prohibitive. Among the most important functions: a well-maintained terrace (1) reduced soil erosion, (2) conserved water, and (3) segmented slopes into a series of flat surfaces suitable for crop cultivation. Interestingly enough, the farmers who are still working the terraces have always considered them an asset or a source of wealth.

Another resource that can contribute to successful agricultural development in the region is the tens of thousands of hand-dug wells, although many of these have also been abandoned and the capital and labor costs of rebuilding them have become very high. Crops grown on the irrigable terraces depend, during the most part of the years, on the water pumped from these wells either by traditional means or by modern techniques. Increased water supply for domestic use, which is excessive at this time, also depends on the water pumped from these wells. The weather in Assarah, too, is an asset to the farmers, but it makes the area attractive as a seasonal and recreational resort, making an additional demand on the water supply:

> The favourable climate is certainly outstanding. The relatively abundant rainfall makes some rainfed farming possible and enables a natural vegetation cover to grow. The cool summer weather will influence the future of Assarah most favourably. As the per capita income rises, more and more people from all over the

> country will be able to afford either a permanent summer residence or a temporary stay (holiday) in Assarah. (Mughram, 1973, p. 281)

Unlike many regions of Saudi Arabia, the Assarah region is characterized by its natural vegetational cover which subsists largely on rain. The demand for timber for domestic construction has been declining in recent years, owing to a shift to concrete materials, and provides the potential for afforestation of the area. In fact, the vegetational cover is an asset not only to the Assarah region but also for the country as a whole, since Assarah is the only region in Saudi Arabia where such a relatively thick natural vegetation is possible. In addition, the region has a mining potential:

> In recent years various mineral prospecting investigations have been carried out in many parts of the country. In Assarah there are many mining sites which have been exploited in the past, and new mineralized areas have been found. The economic feasibility for reworking the old mines and exploiting the new ones, though not great at the present time, could be vital in the future. (Mughram, 1973, p. 282)

Such mineral resources, when exploited in the future, will contribute to the national as well as regional development, diversifying the country's economic base. At the same time, new industries will be established locally in the Assarah region, providing job opportunities for the region's population and encouraging agricultural development because of the increased regional demand for agricultural produce.

As has been demonstrated, agricultural development in the Assarah region depends on the physical, locational, and socioeconomic factors. Apart from these determinants, agricultural development depends on the overall national demand for the agricultural commodities produced in the region, on the domestic needs of the region itself, and on the government policy regarding the importation of food items. However, the local and regional demand has been rising for such agricultural commodities as vegetables, fruits, dairy products, meat, eggs, and certain types of grain that cannot be imported:

> Assarah can no longer claim to be the best region for the production of cereals, but it can certainly claim to be the only region within the country where fruit such as apples, pears, soft fruit like peaches, apricots and plums can be efficiently produced. Other fruit such as grapes, figs, pomegranates are already established and renowned in Assarah. Nut trees are very successful in some areas of Assarah, the almond tree for example is part of the landscape. Experiments with other nut trees especially walnuts have proved successful. Such crops seem to have the highest potential in Assarah. In the second place, dairy farming may prove to be more advantageous here than elsewhere; with regard to vegetable and forage crops Assarah may be as good as any other agricultural region in the country. The advantage of more rainfall in this respect is partly cancelled out by the rugged terrain. (Mughram, 1973, p. 283)

As an agricultural region, Assarah has a large population, believed to be about one million inhabitants, most of them farmers. The per capita income in Assarah is believed to be rising, and it will continue to rise in the foreseeable future. This rise in per capita income has led to a rise in the local consumption of and demand for agricultural commodities.

Under the present socioeconomic conditions, Assarah cannot meet the bulk of its demand for agricultural commodities owing to an increase in the number of farms abandoned every year. Also, the young men who are needed to cultivate the land, now and in the future, are unwilling to work on farms in preference for better-paid jobs in the government sector. This exodus is limited not only to the Assarah region alone, but has affected manay other regions also, and suggests a need for reordering government priorities. It must be understood that the Assarah region is essential to the rest of the country as its economy is geared to the national economy. It is believed that the long-term, integrated rural development strategy concerning this region, both at the national and regional levels, would be a significant stride forward toward an end that matches the region's potential for agriculture with its demand for agricultural produce.

> In conclusion one can say that the role of Assarah will depend to a large extent on its particular physical attributes. . . . Thus its role will be to provide within the country the products and services which otherwise would only be obtainable abroad. It will most certainly be a summer resort for an increasingly growing number of middle and working class people who cannot or do not want to go abroad. Its agricultural future will have to depend on horticulture and some kind of intensive livestock husbandry if such a future is to be practical. It will certainly cease to be a granary for itself or for the rest of the country although cereal production will continue to be sizeable. (Mughram, 1973, p. 285)

CHAPTER V

CHANGE AND DEVELOPMENT IN AGRICULTURAL LAND-USE

One of the major themes of this dissertation is that, as a region, Assarah is undergoing many socioeconomic changes. The best approach to analyzing these changes would be to investigate the region as a whole. A holistic approach would reveal overall patterns of change and point out where local differences exist. Such a task is, however, prohibitively difficult under the present state of knowledge. Logistically and theoretically, it is even more so when only one individual is available for the task. If more research and materials were readily available, such a task would at least be attempted. Because of these limitations, however, this discussion must be limited to the highland part of the Shomran and Bal-Qarn districts in the hope that this small area will serve, in some ways, as a sample for the whole region. The highlands of Bal-Qarn and Shomran comprise the land occupied by two tribes, Shomran and Bal-Qarn. Specifically, it is now known as the Al-Alaya and Bashut districts.

From the recent development in this area in particular, and in the Assarah region in general, it is apparent that the area is undergoing transformation at a much faster rate than was previously possible. The change-over came slowly and gradually rather than abruptly and suddenly. If a particular period can be chosen to signal the start of the new trends, then the 1920s seem to be the most suitable period because the Assarah highlands region became a part of Saudi Arabia (Mughram, 1973, p. 159).

> In other words, the 1920's are not a divide between two different periods, but rather the start of a transitional period. The modern patterns, as opposed to the traditional, are at the moment in the making and have not developed full shape as yet. Also in view of the fact that life here was and still is dependent on agricultural production . . . emphasis [should] always be put on the agricultural aspect. (Mughram, 1973, p. 160)

Up to 30 years ago, community norms and activities in the study area and the Assarah highland region had remained nearly the same for centuries. Neither major events nor important foreign influences reached the area to cause major changes. The purpose here is to evaluate and describe the changes and developments in agricultural land use patterns of the area's human-made terraces. It is this researcher's intention to evaluate the utility of these agricultural terraces to the rural communities of the study area, in particular, and the Assarah highlands in general.

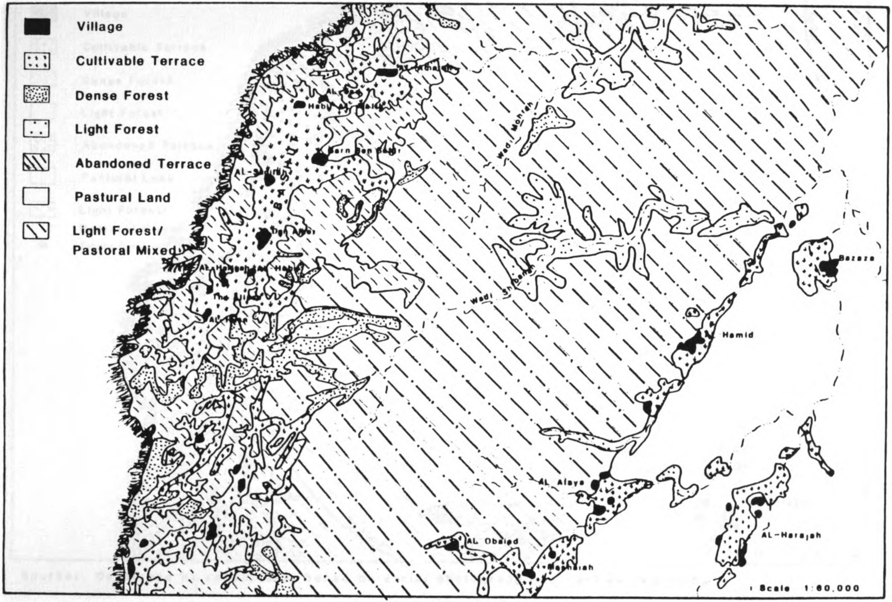
Land-Use Patterns

Interpretation of aerial photographs taken by the Ministry of Petroleum and Mineral Resources in 1953 illustrates that the major land uses in the study area in 1953 were crop lands, pastures, forests, and cluster-type villages. In 1978, this researcher examined agricultural land use patterns in the Bashut district and, after careful comparison with aerial photographs taken in 1953 and 1969, it was found that land uses in Bashut had hardly changed, except for the emergence of a few new clusters of houses and a new highway. Four years later (1982), the researcher found major changes and new developments in agricultural land use patterns. The most important phenomenon that distinguishes agricultural land use patterns today from those in 1978 and prior dates is the fast expansion of villages. The expansion and sprawl of the villages has encroached on agricultural land. Some new houses have been constructed on prime agricultural land, but the majority of these new houses are built on marginal lands. The new type of settlement is less clustered than the old cluster villages, and few are based on urban planning. Another major development is the construction of paved roads which connect the villages to each other, especially those villages and towns which are centers for government offices. A third change is that some localities have become important recreational areas. Owing to their natural beauty, they have attracted local as well as outside tourists, but they lack maintenance and public services. Other land use patterns, such as private forests, pasture lands, and prime agricultural lands, remain the same as before. Careful observation reveals that agriculture is declining, owing to many environmental factors that will be explained in the following chapter. (See Figures 15, 16, Plates 5, 6.)

General Aspects of Agricultural Land Use

The field survey carried out regarding the importance of agriculture in present land use patterns leads to the conclusion that agriculture is diminishing and that it is no longer considered the mainstay of the majority of the farmers in the study area or in the Assarah region in general. The results of interviews with farmers

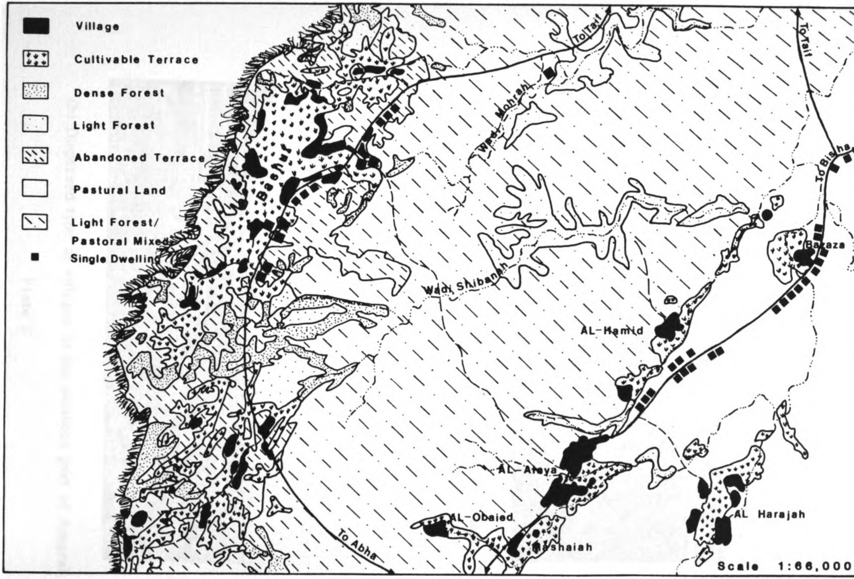
Land Use Patterns In Bashut - AL-Alaya Districts, 1953



Source: Developed by researcher, based on aerial photograph and field survey, 1982

Figure 15

Land Use Patterns In Bashut - AL-Alaya Districts, 1982



Source: Developed by researcher, based on aerial photograph and field survey, 1982

Figure 16

(a) Cluster type of villages in the northern part of Assarah

(b) Dispersed type of villages in the southern part of Assarah

Plate 5

(a) Encroachment of the marginal agricultural land

(b) Preservation of the irrigable agricultural land

Plate 6

indicate that in the 1950s, the majority of the farmers (84.8 percent) were cultivating all of their farms (Table 2). Twenty years ago this proportion had declined to 60.7 percent. In the 1970s, those who were cultivating all their holdings accounted for only 48.6 percent. In the present study, only 20.6 percent of the farmers interviewed are cultivating only half of their terraces, but at present at least 39.3 percent of the farmers were cultivating about half of their holdings. More interestingly, this study reveals that from 1950 to 1978, none of the farmers were cultivating less than 50 percent of their farms. Today there are at least 22.6 percent of the respondent farmers who are cultivating only 25 percent of their farms, and 1.2 percent have abandoned their terraces entirely. It was found that some farmers have reduced the acreage of their farms to 75 or 50 percent to be able to intensify agriculture. They have started to concentrate on cultivating three or four of their terraces and are intensifying agriculture by increasing inputs of fertilizer, labor, capital, and management. The majority of the farmers have, however, reduced the acreage of their agricultural land, not because they are intensifying agriculture, but because of the shortages of labor and water, low agricultural prices, lack of good transportation facilities, and physical hazards. These factors will be explained later.

A comparison between farms under cultivation during the summer seasons of 1978 and 1982 reveals that during the summer season of 1978 only 1.8 percent of the farmers interviewed were cultivating all of their farms. In 1982, those who were cultivating all of their terraces accounted for 20.6 percent. Those farmers who were

Table 2.--Fractions of terraces under cultivation during 1950, 1960, 1970, and 1982.

Fraction	1950 Frequencies		1960 Frequencies		1970 Frequencies		1982 Frequencies	
	Absolute	Relative	Absolute	Relative	Absolute	Relative	Absolute	Relative
All	218	84.4%	156	60.7%	125	48.6%	53	20.6%
3/4	38	14.0%	90	35.0%	107	41.6%	42	16.3%
1/2	3	1.2%	10	3.9%	25	9.0%	101	39.3%
1/4	..	..	..	..	..	..	58	22.6%
None	..	..	1	0.4%	..	..	3	1.2%
Total	257	100.0%	257	100.0%	257	100.0%	257	100.0%

cultivating 75 percent of their farms during the summer seasons of 1978 and 1982 were 29.9 percent and 16.3 percent, respectively. Those who were cultivating 50 percent or less of their terraces during the summer seasons of 1978 and 1982 accounted for 68.4 percent and 63.1 percent, respectively (Table 3). A careful examination of Table 3 might indicate that agriculture in the study area in particular, and in the Assarah region in general, depends on rainfall. During 1978, the late spring and early summer rainfall was unusually late, and many farms were still uncultivated at the time the survey was conducted. A month later, monsoon rains came and all the fields not cultivated earlier were planted with wheat and barley instead of the sorghum and vegetables usually grown there. It was not possible to interview the farmers again, so the researcher had to depend heavily on his own observations.

Table 3.--Fractions of terraces under cultivation during the summers of 1978 and 1982.

Fractions Cultivated	1978		1982	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
100%	5	1.8	53	20.6
75%	83	29.9	42	16.3
50%	96	34.4	101	39.3
25%	93	33.5	58	22.6
0%	1	0.4	3	1.2
Total	278	100.0	257	100.0

Farming practices.--Traditionally, farming practices in the area of study, in particular, and in the Assarah highland region, in general, have been highly developed. Farming techniques have generally been the most modern possible, under the prevailing physical and cultural conditions.

> The iron share plough was already in common use. Ploughing, cross-ploughing, smoothing and levelling were commonly practiced. Ploughing was also used for uprooting some leguminous roots such as alfalfa, whose roots were regarded as a nutritious fodder, and for unearthing root crops like onions and garlic. Also, a late summer and early autumn ploughing was practiced on the fallowed fields to uproot the weeds and loosen the soil in preparation for the next crop. Broadcast sowing of wheat and barley was practiced, especially before ploughing, while sorghum though still hand cast, was dropped grain by grain into the furrow by a man following the plough. (Mughram, 1973, p. 161)

For trees and vegetable crops, manual planting and cultivating methods were used by all farmers. Clearing the fields of stones before ploughing and weeding after cultivating were carried out thoroughly. Organic manure was used whenever possible. Soil fertility, conservation, and maintenance were taken into consideration by farmers all over the Assarah region. These terrace soils were man-made, by constructing artificial rocky walls and, as a result, men understood how to maintain and fertilize them and expanded and handed this knowledge down over the years. Double-cropping was often practiced, and three crops could sometimes be harvested in one year. This would not have been possible if the soil had not been in good condition. Mixed cropping and inter-planting were practiced with a wide range of crops. Barley and wheat, for example, were sown and harvested together more often than not. Varieties of sorghum were also sown, harvested, and consumed together.

These traditional methods of cultivation continued to dominate farming practices in the study area until the late 1960s, when the tractor was introduced into the Al-Alaya and Bashut districts, though in other localities in the Assarah region it had been introduced earlier. In the Ghamid district, for example, the tractor was introduced in the late 1950s. Bulldozers, too, were used to move, level, and reclaim land (Mughram, 1973, p. 204)

In the area of study, the tractor was first introduced by the S. A. Department of Agriculture, which has its main office in Al-Alaya. In other local districts, like Ghamid, individual farmers were first introduced to tractors when they rented them from private firms in Taif. The establishment of an agricultural extension service unit in the area was itself a sign of improvement, although some farmers did not understand its role and function at the time. Even now, there are farmers who are reluctant to ask for help or advice from the agricultural agents and are unaware of their existence or function. When the tractor plough was introduced to the study area through the agricultural unit in Al-Alaya, it did not meet with as much acceptance as the bulldozer because it could not easily be used on small, uneven, rocky holdings that were widely scattered all over the area.

> A significant and very promising cultivation technique which was unknown in the region is furrow irrigation cultivation. This was first introduced in Baljorashy by farmers who had lived in Jordan, and simultaneously through the agricultural unit. The technique is superior, from the point of view of plant growth, to the traditional basin technique with regard to vegetable growing and it is being adopted for this purpose. (Mughram, 1973, p. 206)

Irrigation has, by necessity, been an ancient practice in the study area, and the farmers in the area have come to depend, besides rainfall, on the underground water from numerous man-made wells and on the runoffs channeled into their terraces. The latter depends entirely on rainfall, to the extent that the farms served by runoffs are classified as rainfed terraces, rather than irrigable lands. Actually, water is raised from the well to a high elevation and channeled into small canals to the field, where the terraces were laid out in small basins. These basins are then served by a system of small interconnecting channels, branching off from the main canal, that ran through the middle of a terrace.

During the last 30 years, the traditional methods of irrigation have given way to new gasoline and diesel water pumps. While the basic irrigation method has remained dominant even until today, the first water pump in the Bashut district was installed at the earliest in 1957. In the district of Ghamid, the water pump was introduced by a farmer in 1955. The advantages of the water pump have been so convincing that the majority of the farmers who can afford them have installed one. Most of the early pumps were under ten horsepower, but in recent years, signs of increasing pump capacity are in evidence. The problem with the high-power water pumps is that they lower the water table much faster if water is pumped excessively and affect the variability of hydrological connections between wells. In some places, overpumping one well may easily dry up other wells. These problems have not yet occurred, locally or regionally, because of the reductions in farming that preceded the pump installations.

> Indeed the main reason delaying such danger is the fact that the use of water pumps was preceded and accompanied by a general acreage reduction and agricultural contraction, not only because young men have migrated to the towns but also because

> supplementary income has gradually become attainable from non-agricultural activities, this having the influence of rendering farming less essential to many a family. This has given a chance to those who are still totally or partially dependent on agriculture to go drawing water with less competition. (Mughram, 1973, pp. 208-209)

Types of crops.--The types of crops grown in the study area in particular and in the Assarah region in general include varieties of winter wheat and barley which are sown separately together. The varieties of wheat are the hard wheat types; some were drought resistant. The main summer crop is sorghum, which is characterized by its compact and covered head or seed cub. Vegetables are limited to some wild annual plants, of several varieties, mostly growing as weeds among other crops. The varieties of vegetables used by a small number of farmers include tomatoes, potatoes, onions, and garlic. Fruit tree culture is more advanced than vegetable farming, and there are several varieties of white and black grapes, apricots, small green peas, pomegranates, peaches, and figs. Fruit trees are a part of the farm vegetation on the majority of farms. Alfalfa is the most important fodder crop in most parts of Assarah. Nearly every family has at least a part of one of its terraces devoted to alfalfa at all times and restricted alfalfa acreage for its own domestic use. Only in the villages near the market is some yield sold in the market. In recent years, new varieties of grains, vegetables, and fruits have been introduced in the study area. American maize was introduced in the early 1970s as a summer irrigated crop interplanted with other crops or planted in small plots. Its advantage over sorghum is that its grain is wrapped in a protective husk, protecting it from birds. The sorghum acreage is not reduced as a result of maize introduction because sorghum is still superior to maize in many respects. It is soft and easy to prepare, and it is well established in the local eating habits. The popcorn variety of maize was also introduced in the region, and it is gaining ground as a luxury cash crop. In recent years, new varieties of wheat have been introduced from North America and Australia and grown during the summer and are found to give high yields per acre. They are less drought resistant than the local varieties, but their grains seem to shed more easily during harvest. These new varieties were introduced by individual farmers in the course of their own experimentation. Due to the general decline in the grain crops in Assarah, because of the competition from imported grains, the new varieties hve not been widely used. The conclusion that grain crops are on the decline is derived from the data collected by the researcher during the summer of 1982. Examination of Table 4 reveals that 98.8 percent of the farmers interviewed were food grain producers during the 1950s. During the 1960s and the 1970s, this proportion declined to 57.2 percent and 39.7 percent, respectively. In 1982, it was found that only 1.5 percent of the farmers still concentrated on the food grain production (Plate 7).

Vegetable and fruit farming is more encouraging. There is a high demand for these products in the local as well as the regional markets, although farmers are sometimes not pleased with the market prices, especially during the harvest seasons.

In the study area, as well as in the Assarah region, there have been new varieties of vegetables and fruits introduced in recent years by private farmers and the government agricultural extension

Table 4.--Types of crops grown in the study area, 1950-1982.

Food Items Produced	1950 Frequencies		1960 Frequencies		1970 Frequencies		1982 Frequencies	
	Absolute	Relative	Absolute	Relative	Absolute	Relative	Absolute	Relative
Food grains	254	98.8%	147	57.2%	102	39.7%	4	1.5%
Vegetables	2	0.8%	7	2.7%	12	4.7%	67	26.1%
Fruits	1	0.4%	2	0.8%	2	0.8%	26	10.1%
Multiple	..	..	101	39.3%	141	54.9%	160	62.3%
Total	257	100.0%	257	100.0%	257	100.0%	257	100.0%

(a) Irrigable terraces devoted to vegetables and sorghum during the summer season

(b) Dry-field terraces devoted to wheat and barley during the winter season

Plate 7

services. The new varieties include okra, eggplant, molokhia, spinach, white turnip, cabbage, carrots, beans, leeks, radishes, and others. Table 4 shows that only 1.2 percent of the farmers interviewed were cultivating vegetables and fruits during the 1950s. During the 1960s and 1970s, farmers raising vegetables and fruits accounted for 3.5 percent and 5.5 percent, respectively. Since 1982, this proportion has increased to 37.2 percent, indicating considerable new interest in vegetable and fruit farming. Multiple crops grown include grains, alfalfa, vegetables, and fruits. None of the farmers interviewed was interested in cultivating multiple crops 30 years ago. Twenty years and ten years ago, 39.3 and 54.9 percent, respectively, of the farmers were cultivating multiple crops. At present even more farmers (62.3 percent) are concentrating on multiple crop agriculture (Table 4, Plates 8, 9).

Table 5 provides a comparison between the types of crops grown during the last 30 years and those crops grown today. Food crops were grown by the majority of the farmers (97.3 percent) during the 1950s, 1960s, and 1970s. At the present time, grain crops have declined precipitously; only 0.8 percent of the farmers interviewed still grow grains. Vegetable and fruit agriculture was limited to a small number of farmers (1.6 percent) during the last 30 years, and at the present time 36.2 percent of the farmers are involved in vegetable and fruit cultivation. Multiple crops of food grains, alfalfa, vegetables, and fruits were grown by only 1.2 percent of the farmers during the 1950s and 1960s. During the 1970s, an increase in the demand for vegetables and fruits spurred their cultivation. Currently, about 63 percent of

(a) Multiple cropping in the irrigable terraces during the summer season

(b) Single cropping (sorghum) in the irrigable terraces during the summer season

Plate 8

(a) Cultivation of grape, fig, and peach trees in the Bashut district

(b) Pomegranate cultivation in the Al-Alayah district

Plate 9

the farmers interviewed are concentrating on vegetable and fruit production. Conclusions derived from Table 5 are that grain production has declined steeply, while vegetable and fruit production has increased, owing to stiff competition from imports and to other reasons previously mentioned.

Table 5.--A comparison between the crops grown in the study area 30 years ago and the crops grown in 1982.

Food Items Cultivated	1960		1982	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
Food grains	250	97.3	2	0.8
Vegetables	2	0.8	67	26.1
Fruits	2	0.8	26	10.1
Multiple	3	1.2	162	63.0
Total	257	100.0	257	100.0

Crop types in terrace farming for the summer seasons of 1978 and 1982 are illustrated in Tables 6 and 7. During the summer of 1978, types of land uses included sorghum, which accounted for 27.9 percent of the total agricultural land; wheat and barley, grown on no more than 10.9 percent of the fields examined during field work; alfalfa, 2.9 percent; fruits and vegetables, 1.9 percent; private forest and mixed crops, 43.8 percent; and fallow fields, 12.6 percent. During 1978, a few farmers specialized in vegetable and fruit cultivation, while the majority were grain producers (Table 6).

Table 6.--Types of crops on the agricultural terraces, summer 1978.

Types of Land Use	Absolute Frequency	Relative Frequency
Sorghum	161	27.9
Wheat and barley	63	10.9
Alfalfa	17	2.9
Fruits and vegetables	11	1.9
Forests and mixed crops	253	43.8
Fallow	73	12.6
Total	578	100.0

Source: Al-Shomrany, 1980, p. 103.

During the summer of 1982, agricultural land use types were vegetables, fruits, grains, and multiple crops. Table 7 illustrates the prevailing relationship between the types of agricultural land use and the types of terraces. Vegetables were grown only in irrigable terraces where soil is deep and fertile and artificial irrigation is easily achieved. Information derived from the primary field data indicates that irrigable terraces were allocated between different types of land use as follows: vegetables, 2.0 percent; fruits, 2.7 percent; grains, 19.8 percent; and multiple crops, 75.5 percent. Dry field terraces were allocated to: fruit trees, 5.1 percent; grains, 89.1 percent, depending on the precipitation; and multiple crops, 5.9 percent. Forest terraces were dominated by mixed crops of different varieties of wheat, barley, and sorghum, 47.8 percent; fruit, 17.2 percent; and multiple crops including lumbering juniper trees, 35.0 percent.

Table 7.--Types of crops on the agricultural terraces, Summer 1982.

Types of Land Use	Irrigable Terraces		Dry-Field Terraces		Forest Terraces	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
Vegetables	5	2.0%	0	0%	0	0%
Fruits	7	2.7%	11	5.1%	44	17.2%
Grains	51	19.8%	229	89.1%	123	47.8%
Multiple	194	75.5%	15	5.8%	90	35.0%
Total	257	100.0%	257	100.0%	257	100.0%

In summary, irrigable terraces were allocated to vegetables, fruits, and good varieties of wheat and sorghum; dry terraces were allocated mostly to grains; and private forest terraces were allocated to mixed crops. Tables 5, 6, and 7 reveal that vegetable and fruit cultivation is increasing, especially in the villages located near the market, due to demand for this kind of product.

> Nursery cultivation, though not entirely new, is gaining more importance as the shift toward tree and vegetable crops is increasing, both for the purpose of in-the-farm transplantation and for sale. For the latter purpose the agricultural unit played a leading and significant role. (Al-Shomrany, 1980, p. 206)

Products sold from the farms.--Concerning products sold from the farms, it should be understood that the agriculture of the Assarah highlands region is subsistence farming. In the past, farmers have exchanged some of their farm products for other products from neighboring regions. In recent years, some farmers have started to sell some of their farm products for cash in the local markets. The data collected during field work indicate that in 1978, 28.4 percent of the farmers interviewed were selling some of their products (Table 8).

Table 8.--Frequency of farm products sold in 1978.

Category	Absolute Frequency	Relative Frequency
Products sold	79	28.4
Products not sold	199	71.6
Total	278	100.0

By 1982, this proportion had increased to 52.5 percent, indicating an increase of 24.9 percent over what it was in 1978. Products sold included vegetables, fruits, and lambs (Tables 8 and 9). The conclusion to be derived here is that subsistence agriculture is declining and commercial farming increasing.

Table 9.--Frequency of the farm products sold in 1982.

Category	Absolute Frequency	Relative Frequency
Products sold	135	52.5
Products not sold	122	47.5
Total	257	100.0

Farm animals.--Traditionally, each family in Assarah had to have some farm animals in order to form a viable farming unit. The kind and number of animals depended on the size of the household, the size of their land holdings, and other customary rights that they had. By and large, the average family had a milk cow, two oxen, a camel or a donkey, and a small flock of sheep and goats. Traditional farming in this region was mixed in nature; cultivation, terracing, afforestation, and animal husbandry complemented each other as one integrated system. These components were so interdependent that improvement or decline in any one of them affected the others. In recent years the number of animals has significantly decreased, due to several factors: (1) migration of some of the family labor force, so that the family can no longer keep large herds of animals; (2) droughts have been experienced in the study area, which have affected agriculture and animal production; (3) the introduction of agricultural machinery had reduced the need for draught animals like cattle; and (4) general economic improvement in the lot of some families has made the keeping of animals economically less attractive.

Table 10 shows that 97.3 percent of the respondents raised some animals, a few sheep and a cow, on their farms. Those farmers who no longer raised animals accounted for 2.7 percent.

Table 10.--Farmers raising animals versus those not raising animals, 1982.

Category	Absolute Frequency	Relative Frequency
Yes	250	97.3
No	7	2.7
Total	257	100.0

The kinds of animals raised by farmers interviewed during the summer of 1982 were sheep, 41.2 percent; goats, 3.1 percent; cattle, 54.1 percent; and chickens, 0.4 percent (Table 11).

Table 12 indicates the reasons for raising animals. Some farmers raise animals for domestic use, mainly milk and meat (65.0 percent); other farmers raise animals for commercial purposes (25.3 percent). Those farmers who still used draft animals on the farm accounted for 2.3 percent, and those who raised animals for other purposes accounted for 7.4 percent.

Table 11.--Kinds of animals raised in the study area, 1982.

Category	Absolute Frequency	Relative Frequency
Sheep	106	41.2
Goats	11	3.1
Cattle	132	54.1
Others	1	.4
Total	250	100.0

Table 12.--Purposes for which the animals on the farm are raised.

Use	Absolute Frequency	Relative Frequency
Domestic	162	65.0
Commercial	63	25.3
Draft	5	2.3
All	17	7.4
Total	250	100.0

The majority of the farmers interviewed indicated that they usually raise and graze their animals on their farms (71.6 percent); some have started to feed their animals at the farmstead, buying some grains and some alfalfa from the local markets (1.9 percent). Those farmers who still graze their animals outside their farms accounted for 15.6 percent; those who graze their animals both on the farm and on the grazing land outside the village were 10.9 percent (Table 13, Plate 10).

Table 13.--Places where the farm animals graze.

Grazing Places	Absolute Frequency	Relative Frequency
On the farm	181	71.6
Outside the farm	38	15.6
On both	27	10.9
At the farmstead	4	1.9
Total	257	100.0

Table 14 illustrates that 46.3 percent of those farmers who raise animals have sufficient veterinary care from the local Department of Agriculture unit. On the other hand, there are 53.7 percent of the farmers who have insufficient veterinary care for their animals. Indeed, some of them have never heard of the Department of Agriculture unit, while others still use traditional veterinary care and have no interest in more modern animal care.

(a) Sheep and goats grazing on the public land

(b) Sheep and goats grazing on private uncultivated terraces

Plate 10

Table 14.--Veterinary care for the livestock.

Veterinary Care	Absolute Frequency	Relative Frequency
Sufficient	115	46.3
Insufficient	135	53.7
Total	250	100.0

In summary, cattle in general and dairy cows in particular are declining, but at a lesser rate than other animals, mainly because farmers still need them for milk and butter. In recent years, new grocery stores have been established in the large towns and villages, and milk and butter imported from other regions have been easily available to the local people. The introduction of refrigerators and refrigerated trucks has contributed to these new developments. Frozen chicken is also imported and sold locally.

> Saudi Arabia as a whole used to be self-sufficient in meat production with a surplus for export. Nowadays a large and ever-increasing number of live animals and meat are imported. It is interesting to note that meat production within Ghamid and Zahran still maintains a good surplus which is sent to Jeddah-Mecca-Taif areas and that is true of all the Assarah region south of Taif. The small number of nonlocal animals which are slaughtered are more than outweighed by the district surplus which flows to the towns. (Mughram, 1983, pp. 220-21)

In recent years, an important development has taken place in poultry farming. A variety of poultry species have been introduced to the study area. Pigeons, rabbits, ducks, and turkeys have been brought to the region. New varieties of chickens were also brought for meat as well as for egg production. The real improvement to be noted here is the adoption of the battery farm techniques, which have been established in many places in the region, like Baljorashy and Al-Alaya districts. This kind of development was encouraged by a high demand for chicken meat and eggs.

In tracing the trends and changes in farming in the study area in particular, and in Assarah in general, it should be noted that they are both positive and negative. Positive changes can be summarized as follows: (1) an increase in commercialization of agricultural products, (2) a continuous rise in the use of various farm machinery, (3) an increase in intensive farming and a corresponding decline in extensive farming because of the decline of traditional agriculture as a source of income, (4) specialization in vegetable and fruit production owing to rising demands for these products, and (5) a rise of entrepreneurial agriculture such as agribusiness on a small scale, usually associated with hired labor and increased specialization and mechanization.

The negative changes include (1) diminution of acreage for grain crops like wheat, barley, and sorghum due to the abandonment of marginal agricultural land (the high-slope and high-elevation terraces) and (2) a general decline in agriculture and in its value and importance as an occupation. Many farmers prefer to migrate to urban centers or stay in the villages and favor guaranteed nonagricultural income to labor and economic risk of agricultural work. Additionally, (3) soil erosion is on the rise due to an increase in the abandonment of terraces and their lack of maintenance.

CHAPTER VI

AGRICULTURAL LAND USE PATTERNS IN RELATION TO THE PHYSICAL, LOCATIONAL, AND SOCIOECONOMIC FACTORS IN THE ASSARAH REGION OF SAUDI ARABIA

The Assarah region is one of the most important agricultural areas in Saudi Arabia. Despite the flow of money from the oil sector, the economy of the region is dependent largely upon the agricultural and livestock production. A wide variety of grains, fruits, and vegetables are grown in Assarah every year. This pattern of agricultural land use is the result of an interaction of a number of factors, which play important roles in determining and conditioning the type, distribution, and economy of the land use. These factors, indeed, constitute the physical, locational, and socioeconomic determinants of the pattern of the use of land in the region.

This chapter presents a detailed analysis of the agricultural land use patterns in the highlands of the Bal-Qarn and Shomran regions (the Al-Alayah-Bashut districts), in particular, and in the Assarah highlands, in general. Furthermore, the effect of the physical, locational, and socioeconomic factors, mentioned in the foregoing passages, on the spatial patterns of agricultural land use is emphasized in this chapter.

The Physical Environmental Factors

With regard to the physical environmental factors, Al-Shomrany (1980) pointed out:

> At the outset, it was recognized that the "geogrpahic factors" of climate, topography, and soil condition determine the spatial distribution of the land use patterns of a region. Topography forms the basis for the classification and evaluation of land, the slope angle generally determines the nature of use to which the land is put. The climate of a region--in the absence of a technology to compensate for its limitations--directly affects the capability of land for agriculture. Soil depth, fertility and texture determine the productive possibilities of both dry and irrigable land. Shallow soil is generally incompatible with successful agriculture unless the condition is suitably modified by technology and other means. (p. 94)

The topography of the study area is rugged, and the altitude in most places exceeds 2000 meters above sea level. The typical inclination of the slopes in the Assarah region varies from 15 to 20 degrees. Some areas have a slope inclination of less than 5 degrees, while others have an average slope of more than 30 degrees.

Morphologically, the soil of Assarah can be divided into two types--that is, the soil that formed under natural conditions and the soil that formed under the conditions of human exploitation of the land. It is observed that the depth of the soil is inversely related to the angle of the slopes. In the areas of gentle slopes, between 0 and 10 degrees, the soil depth sometimes exceeds 6 meters. The soil in the study area on slopes between 5 and 15 degrees is found to be between 2 and 4 meters in depth, whereas areas with steep slopes of 20 degrees and more have a shallow soil profile of less than 1 meter.

The texture of the soil can largely be characterized as clayey, clayey loam, sandy clayey loam, and sandy loamy. The climate, especially the precipitation, temperature, humidity, and evaporation, is controlled by the topography and the relief of the region. The annual mean temperature is about 15 degrees, and the annual rainfall recorded is about 400 mm (Al-Shomrany, 1980, pp. 23-75). These physical facts of life in the region play a determining role in the agricultural land use of Assarah (Figures 17, 18).

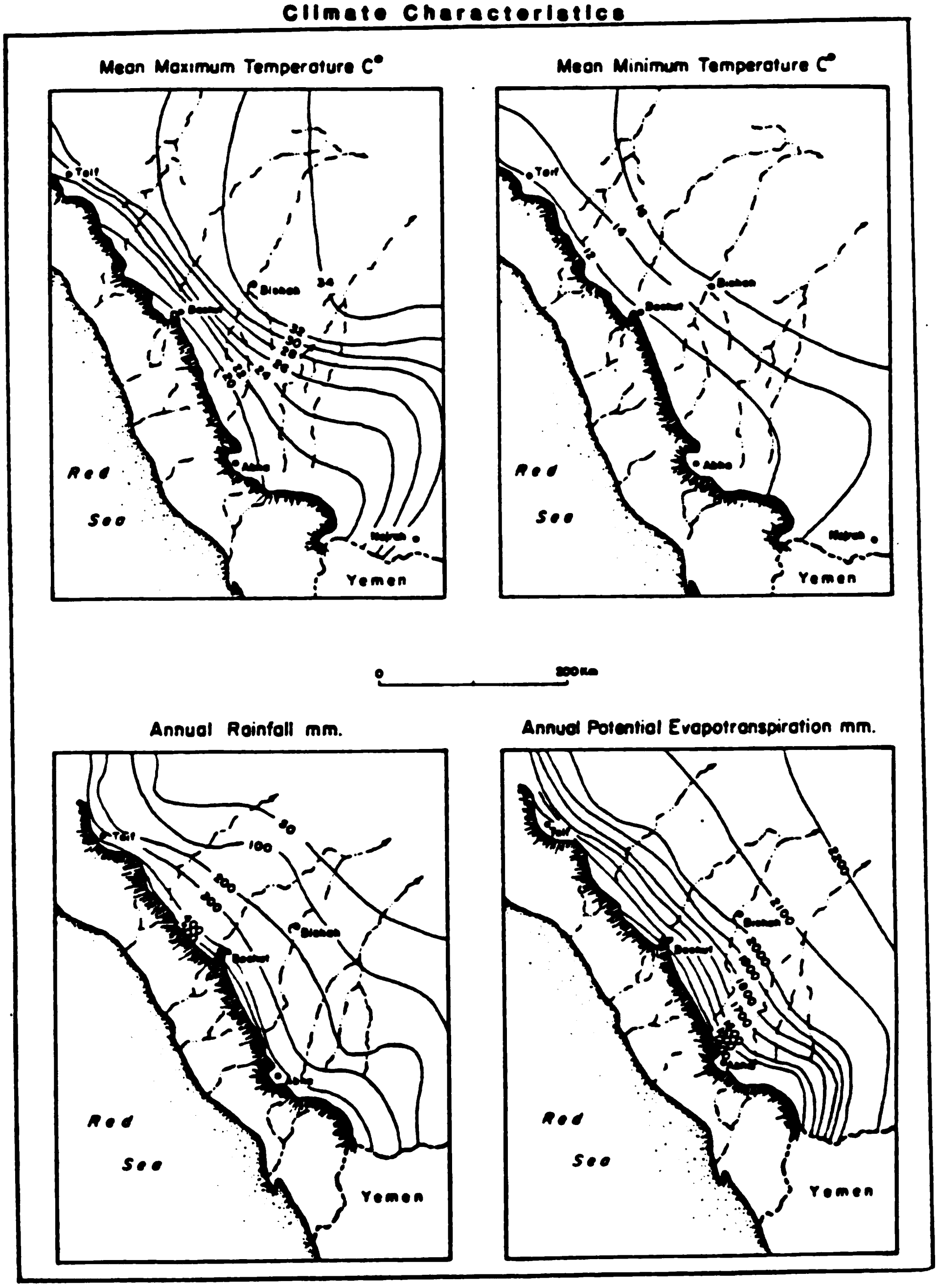
This study attempts to bring into sharp relief the sharply pronounced effects of these facts, indeed, so much so that what the farmers grow on their terraces is determined by these physical factors. In fact, the characteristics of size, soil, slope, water supply, and location of the terraced farms are a direct result of the physical environment and other factors that will be discussed later in this chapter.

Physical Characteristics of Agricultural Terraces

Man-made terraces form the most conspicuous agricultural landscape of Saraht Bal-Qarn and Shomran in particular and the Assarah region in general. Indeed, stepped slopes are in evidence everywhere in the regions. In fact, terracing seems to be the only solution to the agricultural needs of the people and, perhaps, is the best alternative for a successful cultivation of crops and permanent farming activities in the topographically and climatically marginal landscape (Al-Shomrany, 1980, p. 107).

The agricultural terraces of the study area can be further classified into lateral terraces, accounting for 23.7 percent of the total terraced areas; contour terraces, comprising 26.1 percent of the

Climate Characteristics



Source: AL-Shomrany, 1980, p. 56

Figure 17

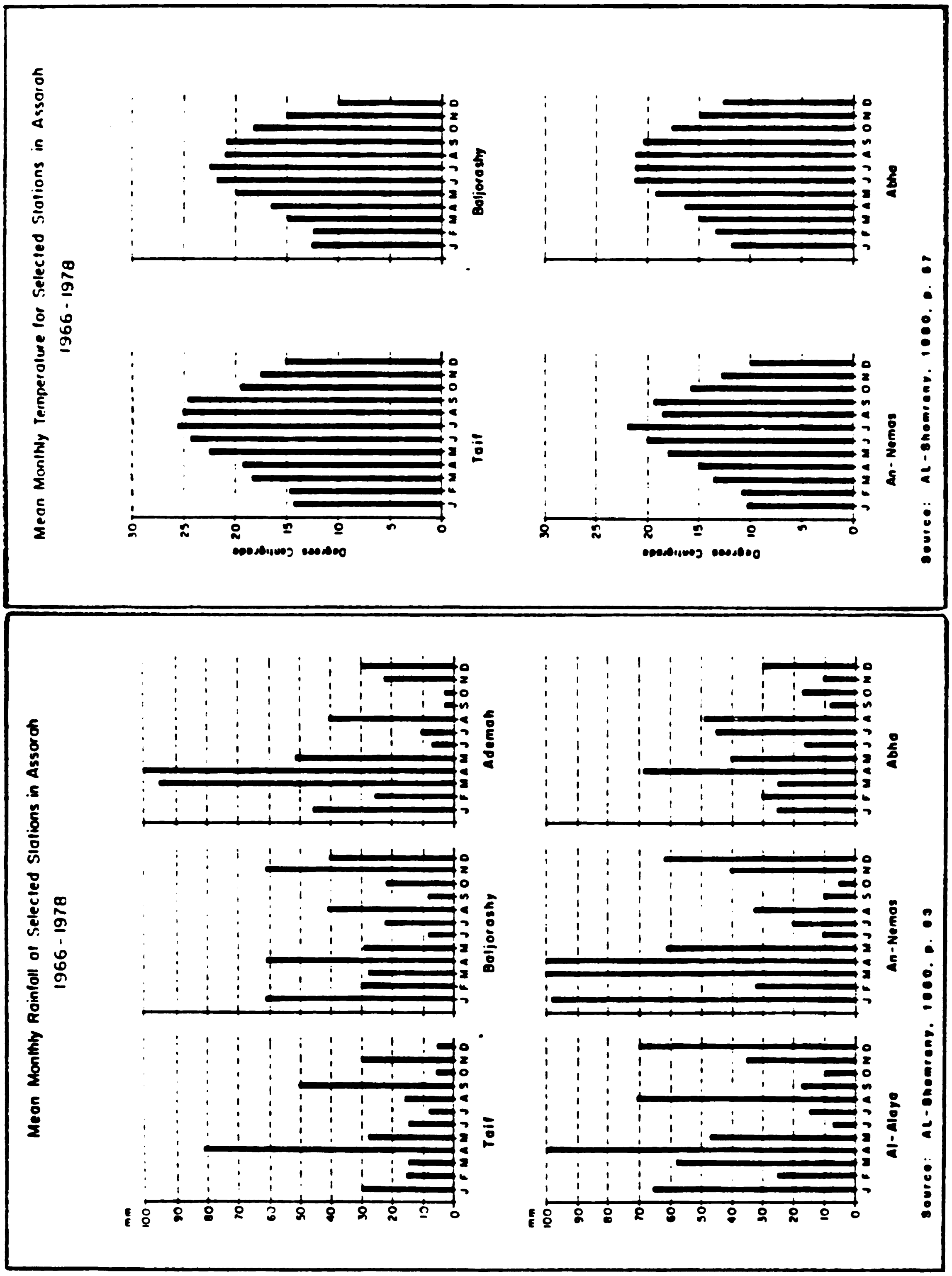

Mean Monthly Temperature for Selected Stations in Assarah
1966 - 1978
Degrees Centigrade
Taif
Baljorashy
An-Nemas
Abha
J F M A M J J A S O N D
Source: AL-Shamrany, 1980, p. 87
Mean Monthly Rainfall at Selected Stations in Assarah
1966 - 1978
mm
Taif
Baljorashy
Ademah
Al-Alaya
An-Nemas
Abha
J F M A M J J A S O N D
Source: AL-Shamrany, 1980, p. 83

Figure 18

total; and cross-channel terraces, constituting the bulk of the area with a total of 51.2 percent. (See Table 15a, Plates, 11,12).[1]

Based on the examination of the major physical factors influencing the patterns of agricultural land use, it was found that there is a significantly definite relationship between the type of terraced agriculture and the physical environmental factors, which include the angle of the slope, soil characteristics, farm size and location, water supply, and the accessibility to and from the market (see Table 16).

Furthermore, 78.6 percent of the farmers interviewed during the fieldwork have most of their irrigable terraces in areas of gentle slope with 0 to 10 degrees of inclination. The farmers who own irrigable terraces in the areas of moderate slopes of 11 to 20 degrees account for 21.4 percent of the interviewees, but none of them owned an irrigable farm of slopes above 20 degrees (Table 16a).

However, most dry-term farms are found on moderate slopes ranging from 10 to 20 degrees. Almost 69 percent (68.9 percent) of the farmers reported that most of their dry farms were located on the moderate slopes. About 30 percent (30.7 percent) of the dry terraces are found on gentle slopes, while only 0.4 percent are found on steep slopes (Table 16a).

Privately owned forested terraces abound in the study area, and they are generally found along moderate and gentle slopes. About

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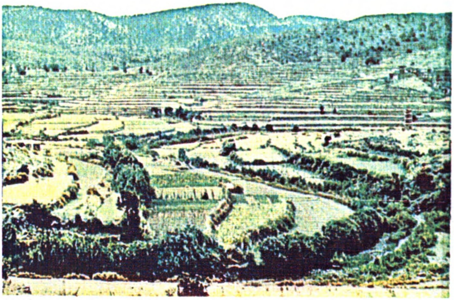
[1]For more details about the terrace classification, see S. A. Al-Shomrany, "Types, Distribution, and Significance of Agricultural Terraces in Assarah, Saudi Arabia" (M.A. thesis, Michigan State University, 1980), pp. 107-64.

Table 15.--Terrace classification according to the selected criteria based on the sample size of 578 terraces.

Criteria of Classification	Types of Terraces	Absolute Frequency	Relative Frequency
a) Terrain	Lateral terraces	137	23.7%
	Contour terraces	145	26.1%
	Cross-channel terraces	296	51.2%
b) Slope angle	Gentle-slope terraces (0°-10°)	475	81.8%
	Moderate-slope terraces (11°-20°)	62	11.6%
	Steep-slope terraces (20° and above)	38	6.6%
c) Soil depth	Deep-soil terraces (less than 4 m)	228	39.5%
	Moderately-deep-soil terraces (2-3 m)	240	41.5%
	Shallow-soil terraces (1 m and less)	110	19.0%
d) Size in local units (1 asa=60 m^2)	Small terraces (1-10 asa)	152	26.3%
	Medium terraces (10-30 asa)	123	21.3%
	Large terraces (more than 30 asa)	303	52.4%
e) Water supply	Irrigable terraces	232	40.1%
	Dry-field terraces	342	59.9%
f) Land use	Mixed-farming terraces	240	41.5%
	Term-farming terraces	233	40.3%
	Tree-crop terraces	105	18.2%

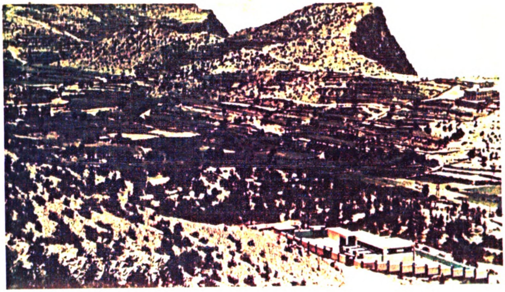
Source: Al-Shomrany, 1980, p. 126.

(a) Cross-channel terraces on the gentle and moderate slopes



(b) Lateral and contour terraces of gentle and moderate slopes

Plate 11



(a) Contour terraces of moderate and steep slopes

(b) Irrigable terraces of gentle and moderate slopes

Plate 12

Table 16.--Physical characteristics of agricultural terraces.

Factors	Physical Characteristics	Irrigable Terraces		Dry-Field Terraces		Forest Terraces	
		Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
(a) Slope	Gentle (0°-10°)	202	78.6%	79	30.7%	59	23.0%
	Moderate (10°-20°)	55	21.4%	177	68.9%	183	71.2%
	Steep (> 20°)	0	0.0%	1	0.4%	15	5.8%
(b) Soil	Deep (< 1 m)	257	100.0%	221	86.0%	219	85.2%
	Shallow (> 1 m)	0	0.0%	36	14.0%	38	14.8%
(c) Size	Large (>30 asa)	176	68.5%	83	32.3%	59	23.0%
	Medium (10-30 asa)	81	31.5%	161	62.6%	155	60.3%
	Small (< 10 asa)	0	0.0%	13	5.1%	43	16.7%
(d) Location	Near villages (0-2 km)	223	86.8%	129	50.2%	59	23.0%
	Far from villages (> 2 km)	34	13.2%	128	49.8%	198	77.0%
(e) Water supply	Sufficient	216	84.0%	193	75.1%	198	77.0%
	Insufficient	41	16.0%	64	24.9%	59	23.0%
(f) Accessibility	Accessible	127	49.4%	198	77.0%	206	80.2%
	Inaccessible	130	50.6%	59	23.0%	51	20.8%
Total		257	100.0%	257	100.0%	257	100.0%

72 percent (71.2 percent) of the farmers interviewed had their forested terraces located on moderate slopes, while less than that number, 30 percent, had their forested terraces on slopes characterized as gentle. Only 5.8 percent of the private forests are accounted for on steep slopes, mostly among the margins of the irrigable or dry farms (see Table 16a, Plate 13).

Based on the data collected by this investigator and analyzed against different criteria, it was found that 81.8 percent of the Assarah terraces were built on gentle slopes. The moderate- and steep-slope terraces account for only 11.6 percent and 6.6 percent, respectively (see Table 15b).

Based on the soil-depth criterion, it was found that all the farmers interviewed have their irrigable terraces only in places of a deep-soil profile. Both dry and forest terraces, too, have a deep-soil profile. In fact, 86.0 percent of the respondents have their dry terraces in the deep-soil areas, though the forested terraces generally have a deeper soil profile than the dry terraces. About 85 percent (85.2 percent) of the farmers interviewed supported this conclusion, though shallow-soil profiles are characteristics of both dry and forested terraces. Fourteen percent of the farmers interviewed own shallow-soil dry terraces, and 14.8 percent of them own forest terraces on shallow soils (see Table 16b).

Actual measurements of soil depth in the field by this researcher have revealed that 39.5 percent of the farms have a deep-soil profile of more than 4 meters. The fields which have a moderately deep soil profile of 2 to 4 meters account for 41.5 percent

(a) A private forest on the cross-channel terraces

(b) A public forest of Juniperus Procera in the low slope areas

Plate 13

of the terraces. Shallow-soil terraces were found to be only 19.0 percent of the total examined during the fieldwork. Furthermore, deep-soil terraces seem always to occupy areas along the valleys and at the gentle slopes at the foot of the hills and mountains, which usually have a moderate to a steep-slope inclination (see Table 15c).

The agricultural terraces of the representative area in particular and the Assarah region in general can be grouped, according to their size, into small, medium, and large terraces. For the purposes of this classification, a large terrace is defined to have 30 or more asas in the area, while an averaged-sized terrace must average 10 to 30 asas and a small-sized less than 10 asa in area. Interviews with farmers of the areas have revealed that 68.5 percent of them own large irrigable terraces, 31.5 percent medium-sized irrigables, and none small-sized. Further, this study reveals that 62.6 percent of the farmers own medium-sized dry farms and 60.3 percent forested terraces of medium size. At the same time, large-sized dry and forested terraces are still found in the areas. The farmers who own medium-sized dry-farm and forest terraces account, respectively, for 32.3 percent and 23.0 percent, but small-sized dry and forest terraces occupy only a small part of the agricultural land. Only 5.1 percent of the farmers interviewed indicated that they owned small-sized terraces, and 16.7 percent private forest terraces (see Table 16c).

An examination of Table 15d reveals that over half of the terraces (52.4 percent) in the study area are of large size; medium- and small-sized terraces occupy 47.6 percent of the total cultivated land, of which the medium-sized terraces form 21.3 percent, while the small-sized terraces occupy 26.3 percent of the land under cultivation now.

With regard to the location of the terraces from the villages, it has been found that 86.8 percent of the farmers interviewed own their irrigable terraces near their villages. The distances between the terraces and the vilages range from a few meters to a maximum of 2 kilometers. In the area the irrigable terraced land is characterized by gentle slopes, deep and fertile soil, and the availability of water for irrigation. The farmers who have their irrigable land located at more than 2 km from their villages form only 13.2 percent of the total farmers interviewed by this investigator. Most dry-field terraces are located at the margins of the irrigable terraces and generally occupy most of the hill and mountain sides. About 50 percent (50.2 percent) of the farmers interviewed have their dry terraces near their villages, and 49.2 percent of them have their dry terraces located in areas at least 2 to 3 km from their villages. The majority of the private terraces are located at greater distances from the villages. Seventy-seven percent of the farmers have their forest terraces at 3 or more km from their villages; yet some farmers have their forest terraces adjoining their dry-field terraces (32 percent) (see Table 16d).

Broadly, agricultural terraces of Assarah can be divided into irrigable and dry terraces. For the purposes of this study, irrigable terraces are described as depending on both precipitation and underground water supply used by modern water pumps or by traditional methods, while dry terraces depend solely on the precipitation and run-off which always accumulate in small streams during the rainy seasons. Field measurements carried out by this researcher in 1978 revealed that 40.1 percent of the terraces are irrigable, while 59.1 percent of the agricultural terraces form dry fields (see Table 15e).

This survey indicates that 84 percent of the farmers interviewed have sufficient water supply for their crops on their irrigable terraces. This is true because these terraces, as has been mentioned before, depend on underground water as well as precipitation. Those farmers who do not have sufficient water supply to grow crops on their irrigable terraces formed only 16 percent of the total farmers. These shortages of water supply are attributed to the fact that some wells are not deep enough to store water for use, especially during the dry summer season. However, the water supply for dry-field terraces is sufficient for winter wheat, alfalfa, and barley, but the water supply for summer agriculture is inadequate owing to the fact that the rainfall in the summer is irregular and scarce. The majority of the farmers (75.1 percent) interviewed have indicated that they have sufficient water supply for their dry terraces, while 24.9 percent of them complained of insufficient water supply. Forest terraces have similar water problems to those found on dry fields except that forest trees can survive without water for a much longer period of time than agricultural crops because the soil of the forest terraces is always sufficiently moist to support the trees during periods of water shortages or drought, as the shaded forest soil is protected from rapid evaporation. Almost 78 percent (77.6 percent) of the farmers interviewed, who occasionally cultivate their terraces, have indicated that they have sufficient water supply, while 23 percent have complained that their crops suffer from inadequate water supply (see Table 16e).

One important environmental factor that needs to be emphasized is the fact that the irrigable terraces are poorly accessible to roads wide enough for tractors and trucks to reach them.

Of the farmers interviewed, 49.4 percent located near the accessible roads indicated that their irrigable terraces are accessible only through the cooperation of their neighboring farm owners who let them pass through their properties. On the other hand, 50.6 percent of the farmers have no access to the main arteries of roads owing to the narrow connecting roads and a lack of cooperation between the neighboring farmers. However, dry and forest terraces are more easily accessible than irrigable ones, as they are located far away from the villages and near open spaces owned by the state. Those farmers owning accessible dry and forest terraces respectively account for 77 and 80.2 percent of the total farmers interviewed. Dry terraces as well as forest terraces with inaccessible locations, based on the information collected from the field, were respectively 23 and 20.3 percent (see Table 16f).

The Role of the Physical Environmental Factors in Influencing Agricultural Land Use Patterns

The First Hypothesis

> Hypothesis 1: The physical environmental factors are more important in affecting agricultural land use than the locational factors such as distances from villages.

The physical environmental factors, indeed, play a major role in determining what the farmers would grow on their farms. The investigation regarding the importance of the physical environmental factors into the current land use patterns leads to the conclusion that the climate characteristics, water supply, and soil play a very important role in influencing what the farmers grow on their farms. An overwhelming majority of the farmers interviewed (91.4 percent) indicated that the climate has a very important role to play in the agriculture of the region. Farmers, for example, concentrate on the wheat and barley production during the winter and early spring seasons. Vegetables, fruits, and sorghum are sown in the early summer season and harvested in the early autumn.

The soil and water supply play an equally important role in influencing the farmers to grow what they usually grow on their terraces. The farmers interviewed who consider water supply and soil a very important physical factor to their crops constituted 79 percent of the total. About 72 percent (72.4 percent) of them thought that distance and accessibility factors are not very important in influencing them in what to grow. Only 28.4 percent consider distance and 27.2 percent accessibility as very important. Most respondents indicated that slope, distance, accessibility, and soil are important factors in influencing them to grow what they usually grow on their farms. About 41 percent (40.5 percent) considered slope, 39.3 percent distance, 37.4 percent accessibility, and 26.8 percent soil important in their decision regarding what to grow on their terraces. Besides slope, distance, and accessibility factors were considered slightly important and/or not important in influencing farmers to grow what they grow on their farms. Almost 57 percent (56.8 percent), 32.3

percent, and 35.5 percent, respectively, considered slope, distance, and accessibility to be not important and/or slightly important in their decision about what to grow on their farms. The means and the standard deviations of the factors mentioned indicate that the climate, soil, and water supply are the most important physical factors influencing the farmers to grow what they usually grow on their farms, while slope, distance, and accessibility have no major role to play in influencing the farmers to grow what they usually grow in their fields. These analyses of the responses lend a strong support and confirm the first hypothesis. The physical environmental factors do indeed appear to be more important in affecting agricultural land use than the locational factor from villages (Table 17).

The Second Hypothesis

> Hypothesis 2: There is no significant relationship between the soil depth and the type of agricultural land use.

The soil texture of the study area is generally clayey and clayey loam on terraces that occupy near-flat surfaces. More specifically, the western part of the representative area is characterized by the clayey and clayey loamy soil, while the eastern part is dominated by the sandy clayey loamy and sandy loamy soil. The soil of Bashut in particular and of the Assarah region in general is fertile. It contains a high level of exchangeable base materials, particularly calcium, magnesium, and potassium. The level of nitrogen and phosphorus is low for such immature soils. The soil fertility is enhanced annually by adding organic manure made of animal, plant, and crop wastes (Al-Shomrany, 1980, pp. 39-47).

Table 17.--The role of the selected physical environmental factors in influencing the farmers to grow what they grow on their agricultural terraces.

Factors	Mean	Std. Dev.	Very Important		Important		Slightly/ Not Important	
			Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
Soil	1.284	0.469	186	72.4%	69	26.8%	2	0.8%
Climate	1.086	0.280	235	91.4%	22	8.6%	0	0.0%
Slope	2.696	0.761	7	2.7%	104	40.5%	146	56.8%
Distance	2.121	0.930	73	28.4%	101	39.3%	83	32.3%
Water supply	1.331	0.737	203	79.0%	33	12.8%	21	8.7%
Accessibility	2.206	0.980	70	27.2%	96	37.4%	91	35.5%

Sample number = 257

Relative frequency = 100%

Average mean = 1.79

Average standard deviation = 0.69

> According to field measurements of soil depths, the deepest soil development is found in basin-like areas on the man-made terraces. The soil is thickest at footslope terraces and becomes increasingly shallow toward the upper slope terraces, and here stoniness and rockiness are more pronounced. (Al-Shomrany, 1980, pp. 39-47)

There is a significant relationship between the soil depth and the type of agricultural land use. Intensive mixed farming on irrigable terraces is concentrated in areas of deep fertile soil where water is easily available. Field measurements reveal that 63.2 percent of the intensive mixed farming is concentrated in fertile areas with soils more than 3 meters in depth, which sometimes exceeds 6 meters. By and large, major agricultural land use patterns are concentrated in the deep soil areas. Extensive dry-term farming, for example, is concentrated in areas of deep soil, forming 34.4 percent of the total, but 65.2 percent of the extensive dry-term farming is concentrated in areas of 1 to 3 meters in soil depth. This type of agricultural land use depends solely on the precipitation and runoff, which is usually diverted through artificial canals to the terraces. Tree farming, including private forests, is concentrated in localities of shallow soil and forms 61.8 percent of the total. This is true only of those forest or tree terraces that are located at the margins of dry-term farming areas along the side slopes of the hills and mountains. The private forests, which usually occupy cross-channel terraces, have highly fertile and very deep soil profiles of more than 3 meters. It is evident that there is a significant relationship between the soil depth and the type of agricultural land use. Hence, it is clear that the data do not support the hypothesis, which is consequently rejected. However, there does exist a significant relationship between the soil depth and the type of agricultural land use (Table 18).

Table 18.--The Assarah agricultural land use patterns with respect to the soil depth.

Soil Depth/ Types of Land Use	<1 meter	1-3 meters	>3 meters	Raw Total
Intensive mixed farming (irrigable)	2 1.8%	15 13.0%	223 63.2%	240 41.5%
Extensive dry-term farming	40 36.4%	75 65.2%	118 34.4%	233 40.3%
Tree-crop farming	60 61.8%	25 21.7%	12 3.4%	105 18.2%

Chi-square = 284.90801, with 4 degrees of freedom

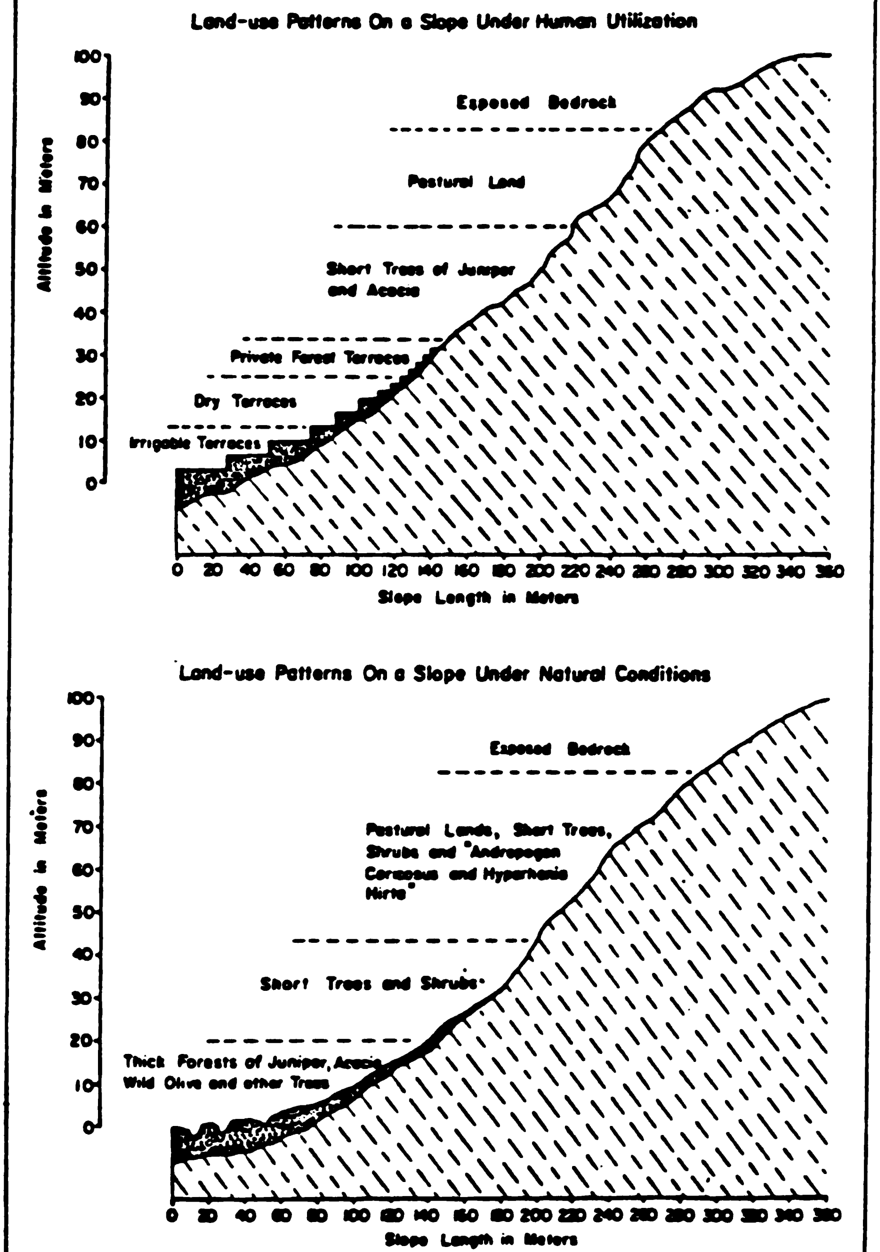
Significance level = .0001

The Third Hypothesis

Hypothesis 3: There is no significant relationship between the slope inclination and the type of agricultural land use.

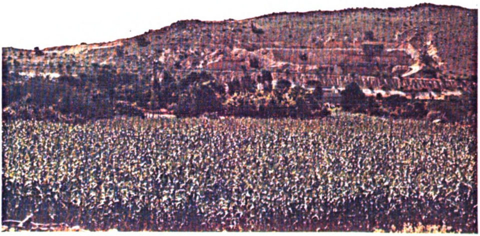
There is a significant correlation between the agricultural land use patterns and the angle of the slope. Field measurements show that the agriculturally viable terraces in the study area are on the near-flat surfaces of 0 to 10 degree slopes. During the fieldwork, it was found that the average slope does not exceed 3 degrees for the majority of the irrigable mixed-farming terraces that occupy the level land of the basin-like areas. Dry-term farming is concentrated in areas of concave slopes around the foothills. This type of land use has been observed to have an average slope of about 6 degrees, though some terraced areas of 10 degree angle are well-pronounced in the Assarah region. Another type of dry-term terraces are found to occupy areas of moderate slopes of 10 to 20 degrees. By and large, this type is located along the side slope of hills and mountains. A third group of terraces, dry as well as forest terraces, is located in areas of steep slope of 21 to 30 degrees. Field measurements reveal that some of these terraces are abandoned, while some are still being actively cultivated (Al-Shomrany, 1980, pp. 124-31).

Information derived from Table 19 indicates a very significant relationship between the type of agricultural land use and the angle of inclination of the slopes. Irrigable mixed farming of intensive cultivation is concentrated in the level lands of gentle slopes forming 50.5 percent of the total. More specifically, it has been found that 81.8 percent of all agricultural terraces under cultivation today are located in areas characterized by gentle slopes of 0 to 10 degrees. Dry-term farming is concentrated in areas of moderate and moderately steep slopes. Field measurements reveal that 56.7 percent and 73.7 percent of dry-term farming is concentrated in areas characterized, respectively, by moderate and moderately steep slope inclinations. Forest land use in respect of the slope inclination is concentrated in areas of moderate slopes forming 41.8 percent of the total and in places of moderately steep slope inclinations forming 26.3 percent of the total. These findings reject the null hypothesis: There is a significant relationship between the slope inclination and the type of agricultural land use at a very high level of significance (see Table 19, Figure 19, Plate 14).



Source: AL-Shomrany, 1980, p. 85

Figure 19



(a) Land-use patterns on a slope under man-made conditions (Bashut)

(b) Land-use patterns on a slope under natural conditions (Bashut)

Plate 14

Table 19.--The Assarah agricultural land use patterns with respect to the slope inclination.

Slope/Land Use	Gentle	Moderate	Steep	Raw Total
Mixed farming	239 50.5%	0 1.5%	0 0	240 41.8%
Term farming	167 35.3%	38 56.7%	28 73.7%	233 40.3%
Forest farming	67 14.2%	28 41.8%	10 26.3%	105 18.2%
Column totals	473 81.6%	67 11.6%	38 6.8%	578 100.0%

Raw chi-square = 94.92798 with 4 degrees of freedom

Significance level = .0001

The Fourth Hypothesis

> Hypothesis 4: The farmers' perception of the physical hazards arising out of the natural environment is related to their experience of recent events.

The Assarah region, the study area selected for this dissertation, is characterized by a rugged terrain and a shortage of cultivable land; yet the land is rich in agricultural tradition which includes, for example, the art of terrace construction, conservation of the unique natural resources and water, divining underground water reservoirs, and planning.

> Despite all these efforts, farmers work long hours all year round to eke out a living. They are confronted with some formidable environmental hazards like drought, hailstorms and disease. A serious drought during the sowing season may ruin the crop. This has made the farmers fatalistic and they tend to attribute such natural calamities as drought and disease to the will of God. However, this pessimism is counterbalanced by an unshakable faith. Despite temporary setbacks, the farmers always look forward to a

> high-yield harvest. The farmer's attitude is summed up in the local saying "Law hassab Azzaraa ma Zara," that is, if they brooded over such natural calamities, they would have no time for farming their land. This explains why the Bashut farmer has survived a relatively harsh environment and has continued to retain his love for the land. (Al-Shomrany, 1980, p. 79)

Individuals and populations tend to differ in their responses to a given environment. Different responses may be attributed to different abilities to respond to an environment, or to different perceptions of the environment. In other words, some individuals and populations achieve more in an environment, some achieve less; some adjust easily to the environmental extremes, others adjust only with difficulty (Sonnenfeld, 1974, p. 42).

With regard to the farmers' perception about the physical hazards of the natural environment of the Assarah region in general and the representative area in particular, it has been found that recent hazardous events are perceived by the farmers as a source of serious problems to what they grow on their farms. It is found that a majority of the farmers, 80.2 percent of them, consider winter frost and cold as the foremost problem endangering agricultural development. Another severe problem is hail and heavy thunderstorms which damage crops, wash away the soil, and destroy terrace walls. During the fieldwork, interviews with the farmers revealed that the study area had experienced very bad thunderstorms accompanied with heavy quantities of hail just two months before the interviews were conducted. Seventy-nine percent of the farmers interviewed regarded hail and heavy thunderstorms as the most hazardous acts of nature endangering the agriculture of the region, while crop and plant disease was considered by 65.4 percent of the farmers as a severe problem. During the fieldwork it was observed that many fruit trees and crops had withered and died because of disease. Many animals, especially cows, died of disease particularly during the summer and fall seasons of 1982.

Water shortages and inaccessible locations were considered severe problems respectively by 49.0 and 54.5 percent of the farmers interviewed. Steep slopes by 46.7 percent of the farmers, rolling land by 43.2 percent, soil erosion by 42.8 percent, irregular rainfall by 41.2 percent, and shortages of fertilizers were considered moderately severe problems. Fifty-three percent of the respondents consider shallow soil, poor tilth, poor drainage, and short farming seasons _no problem and/or a slight problem_ (Table 20, Plates 15, 16).

Both the normal distribution of the responses of the farmers interviewed (Table 21) and the frequency analysis of their responses (Table 20) to the physical hazards indicate that storms, crop and plant disease, water shortages, irregular rainfall, and inaccessible location are the most severe problems facing the agricultural land use of the Assarah region. Other hazards fall below the average mean and are perceived as no or a slight problem to the agricultural development of the region. In fact, the perceptions of the farmers are consistent with the other physical hazards mentioned previously. That is, they perceived the most recently experienced physical hazard such as winter frost and cold, hail and thunderstorms, crop and plant disease, and shortages of water as the foremost problems endangering the agricultural land use of the representative area in particular and of the Assarah region in general.

Table 20.--Farmers' perception of the physical factors hazardous to agriculture.

Types of Hazardous Physical Factors	No Problem		Slight Problem		Moderate Problem		Severe Problem		Total	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
Soil erosion	46	17.9%	41	16.0%	110	42.8%	60	23.3%	257	100%
Shallow soil	70	27.2%	137	53.3%	49	19.1%	1	1.0%	257	100%
Poor stony soil	60	23.3%	139	54.1%	56	21.8%	2	0.8%	257	100%
Poor tilth soil	130	50.6%	57	22.2%	40	15.6%	30	11.7%	257	100%
Poor drainage	165	64.2%	45	17.5%	20	7.8%	27	10.5%	257	100%
Steep slope	26	10.1%	67	26.1%	120	46.7%	44	17.1%	257	100%
Inaccessibility	7	2.7%	13	5.1%	97	37.7%	104	54.5%	257	100%
Rolling landscape	14	5.4%	56	21.8%	111	43.2%	76	29.6%	257	100%
Short farming season	49	19.1%	157	61.1%	40	15.6%	11	4.3%	257	100%
Winter frost and cold	1	0.4%	3	1.2%	47	18.3%	206	80.2%	257	100%
Water shortages	10	3.9%	31	12.1%	90	35.0%	126	49.0%	257	100%
Irregular rainfall	3	1.2%	58	22.6%	106	41.2%	90	35.0%	257	100%
Shortages of organic fertilizers	41	16.0%	71	27.6%	105	40.9%	40	15.6%	257	100%
Crop and plant disease	2	0.8%	8	3.1%	79	30.7%	168	65.4%	257	100%
Hail and thunderstorms	1	0.4%	1	0.4%	52	20.2%	203	79.0%	257	100%

(a) Agricultural land-use patterns in irrigated areas with adequate water supply (Bashut)

(b) Irrigable and dry terraces uncultivated because of the shortages water supply (Bashut)

Plate 15

(a) Excessive soil erosion on the abandoned agricultural terraces

(b) Diminished soil erosion due to the management of land

Plate 16

Table 21.--The means and standard deviations for the hazardous physical factors.

Physical Factors	Mean	Standard Deviation
Soil erosion	2.716	1.016
Shallow soil	1.922	0.697
Poor stony soil	2.000	0.696
Poor soil tilth	1.883	1.058
Poor drainage	1.646	1.009
Steep slope	2.708	0.869
Inaccessibility	3.440	0.716
Rolling landscape	2.969	0.856
Short farming season	2.051	0.719
Winter frost	3.782	0.467
Water shortages	3.292	0.827
Irregular rainfall	3.097	0.797
Shortages of fertilizers	2.560	0.938
Disease	3.607	0.591
Hail and thunderstorms	3.778	0.452

Mean = 2.78
Standard deviation = 0.78

Correlation Matrix Analysis for the Selected Physical Factors

This section presents the Pearson correlation analysis of the data. This analytical technique usually provides a single number which summarizes the relationship between two variables. The correlation coefficient indicates the degree to which variation (or change) in one variable is related to variation (or change) in another. Such variations, the Pearson correlation coefficients, are presented in Tables 22 and 23. The coefficients range from -1.0 to 1.0. The correlation coefficient 1.0 (indicated by the letter *r*) represents a perfect positive correlationship, and -1.0 a perfect negative correlationship. If the r value is zero, no correlationship exists

Table 22.--Correlation matrix for the role of the selected physical factors in agricultural land use.

Variables	Soil 1	Climate 2	Slope 3	Distance 4	Water Supply 5	Accessibility 6
Soil 1	1.0					
Climate 2	.171 (.003)	1.0				
Slope 3	-.352 (.001)	.067 (.141)	1.0			
Distance 4	-.180 (.002)	.026 (.338)	.338 (.001)	1.0		
Water supply 5	.127 (.021)	.042 (.252)	-.179 (.002)	-.142 (.011)	1.0	
Accessibility 6	.204 (.001)	.049 (.216)	-.015 (.404)	.071 (.129)	-.013 (.420)	1.0

N = 257

Significance level r = ± .103

Table 23.--Correlation matrix for the selected physical hazards to agricultural land use.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Soil erosion	1.00														
2. Shallow soil	-.335	1.00													
	.001														
3. Poor soil	.221	.578	1.00												
	.001	.001													
4. Poor tilth	.227	.412	.419	1.00											
	.001	.001	.001												
5. Poor drainage	.262	.415	.295	.704	1.00										
	.001	.001	.001	.001											
6. Steep slope	.264	.124	.071	.014	.198	1.00									
	.001	.023	.128	.413	.376										
7. Inaccessibility	.006	-.067	-.055	-.133	-.168	.320	1.00								
	.463	.141	.191	.016	.004	.001									
8. Rolling landscape	.891	.096	.007	-.090	-.067	.476	.309	1.00							
	.001	.063	.458	.075	.142	.001									
9. Short farming	.063	-.135	-.055	-.013	.046	-.064	-.021	.098	1.00						
season	.159	.015	.192	.419	.230	.154	.371	.059							
10. Winter frost	.116	.015	.060	.209	.192	.006	-.063	.051	.196	1.00					
and cold	.032	.401	.169	.001	.001	.460	.158	.206	.001						
11. Water shortage	.122	.287	.143	.320	.326	-.071	-.086	-.097	.074	.307	1..00				
	.025	.001	.011	.001	.001	.127	.086	.060	.126	.001					
12. Irregular	-.055	-.126	-.138	-.262	-.261	.024	.220	.176	.120	-.151	-.136	1.00			
rainfall	.190	.023	.013	.001	.001	.349	.001	.002	.040	.008	.015				
13. Fertilizer	-.087	.142	.156	.141	.136	-.264	-.136	-.221	-.094	.021	.136	-.074	1.00		
shortage	.004	.011	.006	.012	.015	.001	.015	.001	.195	.368	.015	.119			
14. Crop and	-.070	.157	.086	.195	.198	-.042	.004	-.017	-.008	.283	.308	-.042	.152	1.00	
plant disease	.133	.006	.086	.001	.001	.253	.476	.396	.448	.001	.001	.248	.007		
15. Hail and	.032	.103	-.025	.264	.212	-.026	-.060	-.089	.059	.214	.236	-.121	.138	.471	1.00
thunderstorms	.303	.050	.346	.001	.001	.338	.171	.079	.174	.001	.001	.027	.014	.001	

N = 257

Significance r = .103

between the variables. The better the fit, the larger the positive magnitude of r.

The second rows in the correlation-coefficient tables show the levels of significance. The level of significance in this study was .05, indicating that any relationship below .05 is statistically significant.

For this research, the Pearson correlation coefficient was used to analyze five variables in relation to each other (Table 22). Each one of these five variables was correlated with each of the remaining four. The variables included in the correlation analyses in Table 8 are: soil, climate, slope, distance, water supply, and accessibility. These five variables were chosen for two reasons: First, they are the most important physical factors that influence agricultural land use in the Assarah region; second, they provide the raw numerical (metric) data that can be analyzed by the Pearson correlation coefficient.

The Pearson correlation coefficients (Table 22) indicate that the most significant correlations found among the 257 farmers interviewed are:

1. A positive correlation between soil and climate (r = .171) implies that the climate is a dominant factor in soil formation. It influences the formation of soil mainly by precipitation. Rainfall helps keep particles of silt together. This compactness of soil makes the soil resistant to wind erosion. Chemical weathering in the soil C-horizon produces a thick soil profile. The only danger to the soil of the Assarah region comes always from erosion by runoff (Al-Shomrany, 1980, pp. 50-51).

2. A negative correlation between soil and slope (r = .352) indicates that as the angle of the slope increases, the soil profile gets shallower. In other words, soil depth increases as the slope gradient and the runoff decreases. Field measurements indicate that about 82 percent of the terraces have been constructed in areas of gentle slopes ranging from 0.5 to 10 degrees. Here, the soil profile is thick enough for crops to grow. In the upper slopes between 10 and 15 degrees, thet soil profile is shallow and the soil begins to form under natural conditions (Al-Shomrany, 1980, p. 50).

3. A negative correlation between soil and distance (r = .180) implies that as the distance between the bottom of the mountains and their summits increases the soil profile gets shallower. In other words, the larger the slope, the shallower the soil profile along the side-slopes. The soil profile is very thick at the foot of the mountains, and it gets thinner as one travels along the mountains' side-slope upward to their summits.

4. A positive correlation between soil and water supply (r = .127) indicates that a thick soil profile of clayey or sandy clayey loamy texture always contains large quantities of water. In the area of study the water supply for irrigation and domestic use is derived from localities characterized by thick soil profiles which are usually 6 to 10 meters in depth.

5. A positive correlation between soil and accessibility (r = .204) implies that accessible locations, which usually are flat or level, have a good quality soil of thick soil profiles. Inaccessible locations of steep slopes always have a shallow soil profile. In the

Assarah region agriculture is practiced mostly in localities characterized by accessibility to main roads, especially during the sowing and harvesting seasons.

6. A positive correlation between slope and distance (r = .338) indicates that as the angle of inclination increases, the distance too increases. Terraces located in places of steep slopes, usually in the upper part of the mountain-side slopes, are cultivated no more than once a year because they are very far from the lower slope's most cultivable, irrigable terraces and the villages which are usually located at the foot of the slopes near their most fertile low-slope terraces.

7. A negative correlation between slope and water supply (r = .179) shows that as the angle of the slope increases the supply of water decreases. Large water supplies are available at localities characterized by gentle slopes between 0 and 10 degrees. In Assarah, because of its rugged topographic terrain, water is always concentrated in basin-like areas of gentle slopes. This water is stored either naturally or artificially by modern or traditional means.

8. A negative correlation between distance and water supply r = .142) implies that as the distance from the valley course increases, the water supply diminishes. Large quantities of water are conserved in the alluvial soil of the valleys, and as one travels from the bottom of the valley toward the summit of the mountains the quantity of water supply decreases. In the Assarah region there are thousands of manually dug wells along the valleys and in localities of basin-like areas characterized by deep soil profiles and gentle slopes.

The Pearson correlation analysis was used also to find the relationship between 15 selected physical hazards to determine their effect on the agricultural land use of the Assarah highland region. Stated differently, each one of these variables was correlated with each of the remaining 14 variables, which include soil erosion, shallow soil profiles, poor soils, poor tilth, poor drainage, steep slopes, inaccessible locations, rolling lands, short farming seasons, winter frosts and colds, shortages of water supply, irregular and unpredictable rainfall, shortages of organic and chemical fertilizers, crop and plant disease, and hail and thunderstorms. These factors were chosen for reasons of their being the most important physical hazards that constantly hinder agricultural development in the Assarah region and the metric data being easily analyzable by the Pearson correlation method (Table 23).

The information tabulated in Table 23 provides the most significant correlations (r) found among the responses of 257 farmers interviewed, which are summarized as follows:

1. A negative correlation between soil erosion and a shallow soil (r = -.335) implies that as soil erosion increases the soil profile gets shallower. The obvious danger to the soil in the Assarah region comes from erosion by runoffs. Many areas within the region have lost their surface soil, and the bedrock is exposed. At the foot of these areas deep gullies are formed.

2. A positive correlation between soil erosion and poor soil (r = .221) shows that as soil erosion becomes more severe the soil

becomes poorer. Organic materials and soil particles are washed away by runoffs, resulting in a shallow, stony, and poor soil.

3. A positive correlation between soil erosion and a poor tilth (r = .227) indicates that as soil erosion increases, poor tilth also increases. In other words, increasing soil erosion by runoffs washes away large quantities of soil, leaving only a very coarse soil texture behind, which cannot be tilled or cultivated.

4. A positive correlation between soil erosion and poor drainage (r = .263) implies that as soil erosion increases due to excessive runoffs, poor drainage also increases. Heavy thunderstorms which usually come during a short period of time result in very destructive runoffs and provide the soil with the minimum amount of moisture, always considered inadequate for agriculture.

5. A positive correlation between soil erosion and steep slopes (r = .264) indicates that soil erosion increases as the angle of the slope increases. In the Assarah region there are many places of rugged terrains with very steep slopes. Soil erosion, usually caused by runoffs, is a very severe problem in such areas and agriculture is less successful in comparison with places characterized as flat or semi-flat.

6. A positive correlation between soil erosion and the rolling lands (r = .291) shows that soil erosion increases as the topography of an area gets more rugged. The Assarah region is the only rugged region within Saudi Arabia, and receives the highest amount of rainfall as compared to other regions within the country. It is no wonder,

therefore, if the soil erosion caused by the runoffs increases in Assarah due to its rugged terrain.

7. There is a positive correlation between soil erosion and the climate conditions during the winter season (r = .116). The Assarah region is believed to receive the highest amount of rainfall that lasts the longest during the winter season, which results usually in excessive soil erosion. Terrace walls collapse quite frequently during the winter season, and large quantities of terrace soil are washed away by the runoffs.

8. A positive correlation between soil erosion and shortage of water (r = .122) implies that as soil erosion increases the shortage of water increases. Soil erosion, caused always by excessive runoffs, results in a very low amount of water that sinks into the subsoil and consequently leads to shortages of water supply.

9. A negative correlation between soil erosion and shortages of organic fertilizers (r = -.087) indicates that as soil erosion increases the amount of fertilizers contained in the soil decreases. Soil erosion, caused mainly by runoffs, always has a negative effect on the fertility of the soil. Runoffs wash away organic materials from the soil either by carrying them away from the fields to uncultivated parts generally outside the region or by transporting new coarse materials on the top of the previous soil formations leading to low organic contents in the soil and consequently reducing the productivity of the soil, which leads to a low agricultural production.

10. A positive correlation between shallow soil and a poor tilth (r = .412) shows that as the shallow soil becomes more

pronounced, tilth of that soil becomes harder. A shallow soil of a very thin profile always becomes hard to plow or till. There are many places within the Assarah region of millions of abandoned terraces where soil has been washed away and what is left is no more than a very thin soil profile, which is hard to plow, surrounded by ruins of terrace walls.

11. A positive correlation between a poor soil and a shallow soil profile ($r = .578$) implies that as the soil profile gets shallower the soil gets poorer. It is obvious that a shallow soil profile is poor in comparison with the soil quality of other soil profiles of greater depth. A shallow soil profile has neither enough organic materials nor a thick soil profile for the crops to grow. This hazardous phenomenon is well-pronounced in the Assarah region, and it cannot be solved unless extensive efforts are undertaken to conserve soil and water for agricultural purposes.

12. A positive correlation between a shallow soil and poor drainage ($r = .415$) indicates that as the soil gets shallower the drainage becomes poorer. The Assarah region is rugged from a physiographic standpoint, and large areas within the region are dominated by very shallow soil profiles. It is obvious that if there is no deep alluvial soil, the drainage is very poor because the exposed bedrocks are barren with no soil cover. This phenomenon is seen as a major obstacle to agriculture in the Assarah region.

13. A negative relationship between the shallow soil and steep slopes ($r = -.124$) shows that as the angle of the slope increases, the soil profile gets shallower, too. In other words, the steeper the

slope, the shallower the soil. Steep slope areas are always exposed to heavy soil erosion by runoffs, which result in a very shallow soil profile having no significant contribution to the agricultural development of the region.

14. A negative correlation between the shallow soil and a short period of cultivation (r = -.135) implies that as the season of farming gets shorter, the soil profile gets thicker. With short farming seasons the soil is less exposed to tillage, which usually makes the soil particles very loose and prone to erosion either by runoffs or winds. If the soil profile is well-maintained, it can get thicker, which is important for successful agriculture.

15. A positive correlation between a shallow soil profile and shortages of water supply (r = .287) implies that as the shallow soil profile becomes more pronounced the shortages of water supply, mainly for agricultural purposes, increase. Within the region selected for this study there are areas of thick soil profiles concentrated mostly along the valleys and in the lower parts of the hills and mountains; some places, especially in the upper part of the hill and mountain side-slopes, have shallow soil profiles. The former are characterized by the adequacy of water supply, while the latter are characterized by being harsh with inadequate or scarce water supply. Agriculture, as a result, is concentrated in the areas of thick soil profiles and adequate water supply, while in the areas of shallow soil profiles, where water is scarce, agriculture depends only on precipitation.

16. A negative correlation between the shallow soil profile and irregular rainfalls (r = -.126) indicates that a shallow soil

profile gets shallower as the rainfall becomes more irregular. Sometimes the rainfall in the Assarah region is unpredictable and irregular. If accompanied by heavy thunderstorms, the rain washes away large quantities of soil in a short time, leaving behind a shallow stony soil profile. These serious soil wash-outs pose a serious threat to agriculture.

17. A positive correlation between a shallow soil profile and shortages of organic fertilizers ($r = .142$) indicates that as the soil profile gets shallower the organic content of the soil depletes. This is why shallow soils have a low productivity against the thick, fertile soils of high productivity.

18. A negative correlation between a shallow soil profile and heavy thunderstorms ($r = -.103$) indicates that as heavy thunderstorms increase, the soil profile gets thinner. The study area quite often experiences very heavy thunderstorms that cause heavy soil erosion, resulting in the heavy strain on the productive capacities of the terraces. Hail accompanying the thunderstorms causes heavy damage to standing crops in the Assarah highlands.

19. A positive correlation between poor soil and poor tilth ($r = .419$) implies that as the soil becomes poorer its tilth becomes harder. A poor soil implies a thin soil profile with a texture of very coarse materials. Tilling this thin soil becomes very difficult, if not altogether impossible, unless a good soil-management program is undertaken to conserve it from being washed away by runoffs and by sifting it from stones and shrubs.

20. A positive correlation between poor tilth and poor drainage (r = .295) indicates that as soil becomes poorer owing to a lack of organic materials and shallow soil profile, the drainage of that soil also becomes poorer.

21. A positive correlation between the poor tilth of the farm and the water shortage (r = .320) indicates that as water shortages increase, the soil tilth becomes harder or poorer. When soil moisture is completely lost through evaporation, the soil becomes harder to plow. This problem dominates only during the seasons of no precipitation. In the Assarah region, many farmers leave their terraces fallow for a season or even through a year owing to poor tilth caused by the lack of moisture in the soil.

22. A positive correlation between a poor soil and the water shortages (r = .143) implies that as the soil becomes increasingly poor, water shortages also increase. A soil is said to be poor if it has a very coarse texture, a shallow profile, and a shortage of organic materials. When these characteristics coexist in an area, it is evident that the water supply becomes very scarce. This problem is found to exist in many areas of the Assarah region, especially in the eastern part where the soil texture is mostly sandy and sandy loamy.

23. A negative correlation between a poor soil and irregular rainfalls (r = -.138) indicates that the soil becomes poorer as precipitation becomes more irregular. The soil usually depends on the organic content that runoffs often carry with them from the adjacent areas, but when the rainfall becomes irregular or comes in the form of heavy thunderstorms it destroys terrace walls, washing away completely

not only the manure but also large quantities of the soil. It is commonly observed in the Assarah region that after the terraces have been artificially fertilized, within minutes thunderstorms have washed the fertilizers away.

24. A positive correlation between a poor soil and a shortage of organic fertilizers (r = .156) indicates that as the amount of fertilizers decreases, the soil fertility decreases, too. In recent years the majority of the farmers have sold their farm animals, leaving their farms with no organic fertilizers. This shortage of organic manure has caused a decline in the fertility of the soil, which is easily measured in terms of the decrease in agricultural productivity of the farms. The supply of chemical fertilizers available is far below the demand. Besides, the farmers lack the knowledge to use chemical fertilizers without harming the crops.

25. A positive correlation between poor tilth and poor drainage (r = .704) implies that as the tilth gets more difficult, the drainage of the soil gets poorer. Poor soil tilth is associated with the soil of poor drainage. There are some areas within the Assarah region that have a clayey soil texture, yet others have shallow soil profiles and coarse soil texture. These two phenomena usually cause poor soil drainage. This is why there is a strong positive correlation between poor soil tilth and poor soil drainage.

26. A negative correlation between poor tilth and inaccessible locations (r = -.133) indicates that as the location of the farm becomes more inaccessible the tilth of the soil gets less poor. The majority of the Assarah terraces were constructed in basin-like areas

characterized by gentle slopes. Unfortunately, these terraces are in one way or another inaccessible, owing to the lack of wide feeder roads suitable for agricultural machinery. Their soil texture is clayey loamy and sandy clayey loamy. The soil profile is deep, and it contains an adequate supply of soil moisture that facilitates a very easy tilth, especially when modern agricultural equipment is used.

27. A positive correlation between a poor tilth and winter frost and cold (r = .209) shows that as winter frost and cold increase, the soil tilth becomes poorer. Assarah, the region selected for this study, is characterized by its high altitude, which exceeds in many places 2,000 meters above sea level. This high altitude experiences a large drop of temperature during the winter season. Sometimes the temperature drops down to zero. The region receives most of its moisture during the winter season. These climatic conditions produce a cold and wet soil, which makes the plowing hard, if not impossible.

28. A negative correlation between a poor tilth and irregular rainfall (r = -.262) implies that as the rainfall becomes more irregular, the soil becomes less tillable. The absence of precipitation during even one season results in a poor tilth of the soil. An adequate supply of soil moisture is required in order that the soil may become plowable. The absence of rainfall in the Assarah region for a short period of time, even for one season, leaves all the dry-term terraces fallow during that season because the farms cannot be easily tilled and cultivated.

29. A positive correlation between a poor tilth of the terraces and the shortage of organic fertilizers (r = .141) indicates

that as the shortage of organic fertilizer increases, the tilth of the soil becomes harder. Organic fertilizers contribute to the fertility of the Assarah soil in three different ways: (1) they loosen the soil, (2) they keep the moisture trapped in the soil for long periods of time, and (3) they add to the fertility of the soil. In other words, a lack of organic fertilizers in the soil makes tillage extremely difficult.

30. A correlation between a poor soil tilth and hail and thunderstorms (r = .264) shows that as hail and heavy thunderstorms increase, the soil tilth becomes impossible. During the spring season of 1982, the study area experienced one of the worst thunderstorms ever in the last century. The terraces were covered with hail 3 meters thick. Crops were totally destroyed, and the terraces remained covered with hail for more than a month. These occurrences bring agricultural activities to a standstill.

31. A correlation between poor drainage and water shortage (r = .326) implies that as poor drainage increases, water shortage increases, too. There are many places within the Assarah region where the land is rugged, slopes are steep, and the soil is shallow or clayey in texture. These factors combine to create a poor drainage. The moisture seeping into the subsoil is very limited, causing shortages of water needed for irrigation.

32. A negative correlation between poor drainage and irregular rainfall (r = -.264) indicates that poor drainage gets more severe as irregular rainfalls become unpredictable. Precipitation in the Assarah region is sometimes early and sometimes late. When it does come, it is

in the form of heavy thunderstorms. Precipitation of this type is of little value to agriculture. The amount of water seeping into the subsoil is limited, owing to poor drainage. In other words, poor drainage combined with heavy but irregular rainfalls lasting a short duration does not allow the soil to absorb an adequate amount of water that can be used in agriculture.

33. A positive correlation between poor drainage and hail and thunderstorms (r = .212) implies that as heavy thunderstorms increase in occurrence, poor drainage becomes more severe. Thunderstorms are usually accompanied by large quantities of hail, and a heavy rainfall causes very rapid runoffs, allowing little time for the soil to absorb adequate moisture.

34. A positive correlation between steep slopes and inaccessible farm locations (r = .32) indicates that as the angle of inclination increases, farm locations become more inaccessible. A majority of the agricultural terraces built on moderate and moderately steep slopes of 10 to 20 degrees are inaccessible to modern agricultural machinery.

35. A positive correlation between steep slope and the rolling landscape (r = .476) implies that as the terrain gets more rugged, the angle of the slope increases. Assarah is a rugged region as compared to other regions within Saudi Arabia. Some areas within the region form basins. The angle of inclination increases excessively when the topography becomes more rugged. There are places within the region that have slope angles of more than 35 degrees because of the

ruggedness of the terrain. These rolling lands always limit the arability of the lands, rendering them unproductive.

36. A negative correlation between steep slopes and shortages of organic fertilizers (r = -.264) indicates that as the steepness of slopes increases, the supply of organic fertilizers decreases. Organic fertilizers are made from humus and animal waste. Steep-slope areas are usually characterized by shallow soil profiles where few trees grow. Humus is found in areas known for their thick vegetational cover. Humus is carried by the farmers to their terraces, and some organic materials are transported by the runoffs.

37. A positive correlation between an inaccessible location and a rolling landscape (r = .309) implies that as the terrain becomes more rugged and rolled, the geographical location of the farm becomes more inaccessible. Man-made terraces were built mostly in gentle-slope areas for several reasons, among which accessibility is believed to be one of the determinants. After the full use of the level land, the farmers started to expand their holdings toward the moderate-slope areas, and the rugged terrains within the Assarah region were used only sparingly. Most of the abandoned terraces are found in such rugged areas, and today's farmer has no use for them again because of their geographic inaccessibility.

38. A positive correlation between a short farming season and winter frost and cold (r = .196) indicates that as the season of farming gets shorter, the frost and cold of the winter season become more severe. Frost and cold are two climatic hazards, detrimental to crops within the study area. Frosts and cold cause sudden drops of

temperature and kill crops during the summer season. The problem gets more severe when the winter season extends over a longer period of time. Wheat and barley are the two main crops grown during the winter season, but they do not grow well in cold weather and frost. The longer the farming season, the more successful agricultural production in that season. The opposite is also true: the shorter the farming season, the less successful agriculture owing to the cold weather and frost hazards.

39. A positive correlataion between the winter frost and cold and water shortages (r = .307) implies that as winter frosts and cold increase, water shortages also increase. A severe winter season, which is usually accompanied by frosts and cold, results in increasing shortages of water for agriculture. This is true only when the soil freezes. In the Assarah region, farmers always welcome the winter season because they look forward to winter precipitation for their winter crops. By and large, winter precipitation is adequate for winter crops.

40. A positive correlation between the winter frost and cold and crop and plant disease (r = .283) indicates that as winter frosts and cold get more severe, crop and plant disease becomes more hazardous to agriculture. This relationship between these variables is not strong, though the normal expectation is that disease would increase with severe frosts and cold. This researcher's experience points to the common observation that crop and plant disease is a physical hazard that destroys crops and plants any time of the year because of its unpredictability. The farmers of the region, based on their own

knowledge and experience, can easily distinguish different kinds of crop, plant, and animal disease. Some of these diseases are seasonal, while others are not.

41. A positive correlation between winter cold and frosts and hail and thunderstorms (r = .214) indicates that hail and thunderstorms become more severe as the winter frost and cold become more hazardous, as very cold weather with a drop in temperature usually freezes raindrops into stones of hail or snow. Hail and thunderstorms are far more pronounced during the spring season than during the winter season, and their effect on crops and fruits is always very severe.

Locational Factors

This section is concerned with the analysis of agricultural land use patterns of the representative area in particular and of the Assarah region in general with relation to the locational factors, especially distance. In this section, an attempt has been made to see if there is a similarity between the actual land use zones of the typical villages of the study area as determined by this study and those identified by the Von Thunen model. In particular, this investigation will focus on the importance and significance of the role played by distance from the local markets and villages--more specifically, with respect to the agricultural land use patterns.

The First Hypothesis

Hypothesis 1: The geographical distribution of the agricultural land use patterns around the villages generally shows a similarity to the Von Thunen agricultural land use model.

The Von Thunen model is not limited to the modern technological agriculture of the market-oriented societies, but it is discernible equally in the traditional agricultural systems, as well. Indeed, the subsistence agriculture with its homogeneity of transportation facilities, crops, and agricultural techniques shows the effects of the distance factor on the land use patterns even more strikingly than the modern technological agriculture.

Put in its simplest form, Von Thunen model assumptions are: (1) completely rational economic behavior and perfect competition, (2) an isolated state, (3) a single central city, (4) a village-type settlement, (5) an ethnically homogeneous population, (6) a uniform topography, (7) uniform soil fertility and climatic conditions, and (8) a relatively primitive transportation system (Barlowe, 1978, p. 276).

In the Assarah region, which forms a high, rugged terrain, agriculture is still essentially subsistence agriculture, and some of the Von Thunen assumptions are easily valid for the area. The area is indeed a village-type settlement and has relatively primitive transportation; the population is homogeneous and the climate uniform. However, the topography, soil fertility, and one-central-city environment of the area are totally different from what Von Thunen assumed for his model. In other words, the Assarah region as a whole does not completely fit into the illustrious model. This study, based on interviews with the farmers, interpretations of the aerial photographs, and personal observations and investigations, reveals that some agricultural land use patterns at the village level do lend themselves to a reasonable comparison with the zonal patterns demonstrated by the Von Thunen model. Yet it must be understood that not all villages display zonal patterns of agricultural land use consistent with the zones of the Von Thunen model.

The theoretical land use zones that ~~this~~ study has assumed to exist surrounding each village in the area of this study are: (1) horticulture and market gardening, (2) grain production, and (3) livestock raising. However, the actual land use zones, found by this research in the majority of the villages in the study area, are: (1) a zone of fruit trees and flowers, (2) irrigable land of intensive vegetable and fruit production, (3) irrigable lands largely given to intensive grain farming, (4) areas devoted to extensive dry-term grain cultivation, (5) a zone dominated by private forests and mixed grain production, and (6) a large zone of pastural lands for animal grazing.

The information tabulated in Table 24 provides an excellent insight into the land use patterns of the area: The majority of the farmers interviewed have strongly supported the first hypothesis. Ninety-six percent of the farmers agree (strongly agree and agree) that the first zone around their villages is dominated by fruit trees and flowers. Those farmers who agree (agree and strongly agree) that the second zone is devoted to irrigable intensive vegetable agriculture account for 56.5 percent of the farmers interviewed. Those who disagree with the agricultural land use patterns of the second zone constituted 30 percent of the total farmers interviewed. The farmers (99.6 percent) unanimously agree (strongly agree and agree) that the intensive grain-producing irrigable land forms the third zone. The majority, 96.1 percent, of the interviewees agree that zone 4 is

Table 24.--Geographical distribution of agricultural land use with relation to the distance from the local villages.

Types of Agricultural Land Use	Strongly Agree		Agree		Disagree		Strongly Disagree		Total	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
Zone 1										
Fruit (grapes, figs, peaches, etc.) orchard around the village	150	48.5%	97	37.7%	6	2.3%	4	1.6%	257	100.0%
Zone 2										
Irrigable intensive vegetable cultivation	49	19.1%	96	37.4%	77	30.0%	35	13.6%	257	100.0%
Zone 3										
Irrigable intensive grain production	179	69.6%	77	30.0%	0	0.0%	1	0.4%	257	100.0%
Zone 4										
Dry-term extensive grain production	115	44.7%	132	51.4%	8	3.1%	2	0.8%	257	100.0%
Zone 5										
Privately owned forests and grain/hay production	44	17.1%	86	33.5%	92	35.8%	35	13.6%	257	100.0%
Zone 6										
Livestock production and pastureland	189	71.6%	68	26.5%	2	0.8%	3	1.9%	257	100.0%

Mean = 1.76

Standard deviation = 0.69

devoted largely to less intensive (extensive) grain production. About 50.6 percent of the farmers interviewed agree that the privately owned forests and grain production dominate the fifth zone, while 35.8 percent disagree. Zone 6, which is characterized as pastural land used for grazing animals, is strongly recognized as the next zone by a majority of 71.6 percent of the farmers, and 26.5 percent of those interviewed simply agree with the 71.6 percent, but 2.7 percent of them either disagree or strongly disagree with the majority conclusion.

An investigation of the major land use patterns in the Al-Alayah and Bashut districts revealed that the majority of farmers own milk cows for domestic use. It is typical of the two districts to provide for the dairy products for domestic use in this fashion. This is why the fallow fields and adjacent rough lands of the two districts supported herds of cattle. During the wet seasons, peasants usually use alfalfa and other green dry forage to feed the animals when the herds cannot go out to graze. The majority of the villages, especially those of the Bashut district, are surrounded by grape groves and orchards of peach, apple, and fig trees. Farmers usually grow flowers for commercial and domestic use on their terraces that are located near the villages. Flowers sell well in the periodical markets, and what is not used commercially is consumed at home. All around the fruit orchards and groves run irrigable fields, which are cultivated twice a year. At times, some terraces have as many as three crops a year. However, most of these terraces have been diverted to vegetable cultivation in recent years for the local markets. Yet wheat and sorghum are still the dominant crops of these terraces. At the margin of these agricultural terraces are found terraces that are dry, yet arable. They yield only one crop, generally barley, that grows during the winter months only. The fringes of these dry terraces are occupied by private forests followed by community forests. Most rugged and rough lands and abandoned terraces are being used as pasture lands, a new pattern of agricultural land use.

In conclusion, it must be added that the geographical distribution and the agricultural land use patterns around the majority of the villages of the study area have shown a general similarity to the zones of agricultural land use of the Von Thunen model. The first hypothesis was, therefore, found valid and supported by the majority of farmers interviewed (Table 24).

The Second Hypothesis

> Hypothesis 2: The intensity of cultivation is inversely related to the distance of a farm from the village; that is, the greater the distance from the village, the less intensively and more extensively a farm is cultivated.

The agricultural production can be increased by a more intensive use of the land currently under cultivation and by the reclamation of new agricultural land. If the agricultural land is efficiently used, in the economic sense, an optimal production level per unit area, cost, and labor can be achieved, where marginal cost equals marginal revenue. Intensification of agricultural land use may involve the use of improved agricultural technology and practices, that is, the use of fertilizers, irrigation, and possibly double-cropping (Al-Shomrany, 1980, p. 116).

> When applied to land use, the term intensity refers to the relative amounts of capital and labor combined with units of land in the

> productive process. People speak of those types of land use that involve high ratios of capital and labor inputs per land unit as intensive uses. Those enterprises involving large land areas relative to the amounts of capital and labor used are described as extensive uses. (Barlowe, 1978, p. 155)

Information from Table 24 reveals that the spatial distribution of agricultural land use frequently changes with the distance from the village. Most of the intensive irrigable land (53.3 percent) is located within less than 1 km from the villages. Fruits, vegetables, alfalfa, and grains are intensively cultivated on this agricultural land. An input of labor and capital per unit of land on these terraces is higher than the input in extensive dry-term farms, which are located within 2 km of the village. In other words, an irrigable terrace of an area of 2250 m^2 usually requires no less than 1500 hours of labor each season of three months. The amount of organic fertilizer used is hard to measure in any given unit of weight. The cost can be estimated and is about 1500 Saudi riyals a year. Usually, the farmers use organic fertilizers on their irrigable terraces only once a year. It is estimated that a maximum of 700 Saudi riyals is spent on energy for a unit of land annually. The farmers usually irrigate their terraces at least five times during the summer season and twice during the wet winter season. Irrigable terraces are cultivated at least twice a year and sometimes three times (Table 25). During the winter season, the irrigable terraces are given to wheat production, while during the summer season the majority of them grow vegetables, fruits, and sorghum. The income per unit of irrigable land (2250 m^2) is high only on input-intensive farms. During the fieldwork this researcher found

Table 25.--Intensity of the annual agricultural land use based on the frequency of the crops cultivated on the irrigable, dry-term, and forest terraces.

Frequency of Crops Grown Annually	Irrigable Terraces		Dry-Term Terraces		Forest Terraces	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
One time	0	0	99	38.5%	221	86.0%
Two times	223	86.8%	154	59.9%	35	13.6%
Three times	34	13.2%	4	1.6%	1	0.4%
Total	257	100.0%	257	100.0%	257	100.0%

some farmers who make as much as 20,000 Saudi riyals a year from a farm of a unit of 2250 m^2.

The input per unit of labor and capital on a unit of a dry-term farm is much less than on the mixed-farming irrigable terraces. Organic fertilizer, the only source for fertilization of the soil, is used at least once every three years. The total hours of labor required for a dry terrace with an area of about 1886 m^2 is estimated to be 650 per season. The only source of water supply is precipitation. The annual rainfall is about 400 mm, and in some localities it exceeds 500 mm (Al-Shamrany, 1980, p. 62). The major crops grown on dry-term farms are wheat and barley. These terraces in general are cultivated once a year. Sometimes they are cultivated twice a year, depending on the season and the amount of rainfall. The income from a dry-term farm is low in comparison with the income from an irrigable field.

Privately owned forest terraces are located within a distance of 1 to 3 km from the villages. The majority of the farmers (80 percent) usually cultivate these terraces once a year only because the majority of them are located far away from the villages. In comparison to dry-term terraces, the forest terraces are more fertile, more accessible, larger in size, and have an adequate amount of soil moisture (Table 25).

In the context of the layout and the topography of the study area, it is logical and proper to view distance as an important factor in the study of the intensity of agricultural land use. Based on the interpretation of aerial photographs and field measurements, it was found that the greatest intensity of agricultural land use is located in areas close to villages. Farther from the villages, the intensity of land use generally declines. Data created from the interpretation of the aerial photographs reveal that about 95 percent of the agricultural land located within 1 km to the west of the Garn Ben Shair village in the Bashut district is under very intensive cultivation. This segment of the land is under mixed farming all year round. Wheat is cultivated during the winter season, sorghum and vegetables during the summer, and alfalfa and fruit trees all year round. This intensity of agricultural land use is attributed to (1) the fertility and depth of the soil, (2) the availability of a good reserve of underground water for artificial irrigation, (3) the size of the cultivable farms, and (4) the short distance between these fields and the villages enabling the family members to participate all through the year. Term farming is practiced only in 5 percent of the land and is located at the margin of the irrigable terraces (Table 26).

One km to the east of the village, four different types of agricultural land use characterize the land. Thirty percent of each farm is devoted to intensive mixed- and term-farming and pastures. Irrigable terraces of intensive agriculture, with a deep and fertile soil, are located in the center. Water supply from the underground reservoirs is adequate for artificial irrigation, especially during the summer season. At the margin of this center, term fields of less intensive agriculture dominate. Pastural land and abandoned terraces are dispersed in areas of high topographical relief at the margin of

Table 26.--Agricultural land-use patterns in relation to the distance from the village: a case study of the Garn Ben Sahir village in the Bashut district.

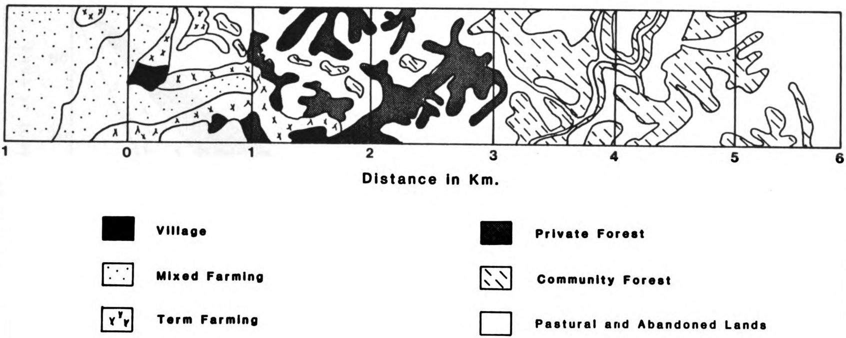
Distance from the Village (in km)	Types of Agricultural Land Use	Approximate Area (in km^2)	Percentage of the Total Area
0-1 West	Mixed irrigable farming	1.42	94.70
	Dry-term farming	0.08	5.30
0-1 East	Mixed irrigable farming	0.45	0.30
	Dry-term farming (rain)	0.45	0.30
	Private forest farming	0.15	0.10
	Pastural land	0.75	0.30
1-2 East	Dry-term farming	0.30	0.20
	Private forest terraces	0.45	0.30
	Pastural land	0.75	0.50
2-3 East	Private forest terraces	0.60	0.40
	Pastural land	0.80	0.60
3-4 East	Community forests	0.97	0.65
	Pastural land	0.53	0.35
4-5 East	Community forests	0.75	0.50
	Pastural land	0.75	0.50
5-6 East	Pastural land	1.20	0.80
	Community forests	0.30	0.20

the term fields. Private forests of small patches of juniper trees occupy about 10 percent of the land (Figure 20 and 21).

Pastural land and abandoned terraces occupy about 50 percent of the land located between 1 and 2 km east of the villages. The soil of this area is fertile and very deep, and the fields can be easily irrigated from the wells, which have now been abandoned. It seems that the distance from the main village has been largely responsible for their abandonment. These fields are cultivated once a year, and the inputs of capital and labor into them are lower than those into the active irrigable farms to the west of the villages. Table 26 and Figures 20 and 21 reveal that about 30 percent of the land located at the margins of the terraces committed to term-farming is given to private forests. Term-farming, however, becomes less pronounced toward the east, occupying only about 20 percent of the land. Such farms are invariably given to barley cultivation because of their distance from the village.

At a distance of 3 km, there is a total absence of active agricultural fields except for a wide tract of private forests, over 40 percent of the property, and pastural land, over 60 percent. Cattle grazing is a usual practice in this area and the area to the east. At a distance of 4 to 6 km to the east, the communal forests dominate. These community forests invariable occupy the sides of the valleys where the soil is deep and the moisture in the subsoil is plentiful. Pastural land is the widest here, and the grazing of mainly sheep and goats has dominated since a distant past. Soil erosion in this area is still a problem, but it is predicted that

Type and Intensity of Land Use With Relation to Distance From AL-Garen Village in Bashut District: West - East Cross Section



Source: Developed by reseacher, based on aerial photograph and field survey, 1982

Figure 20

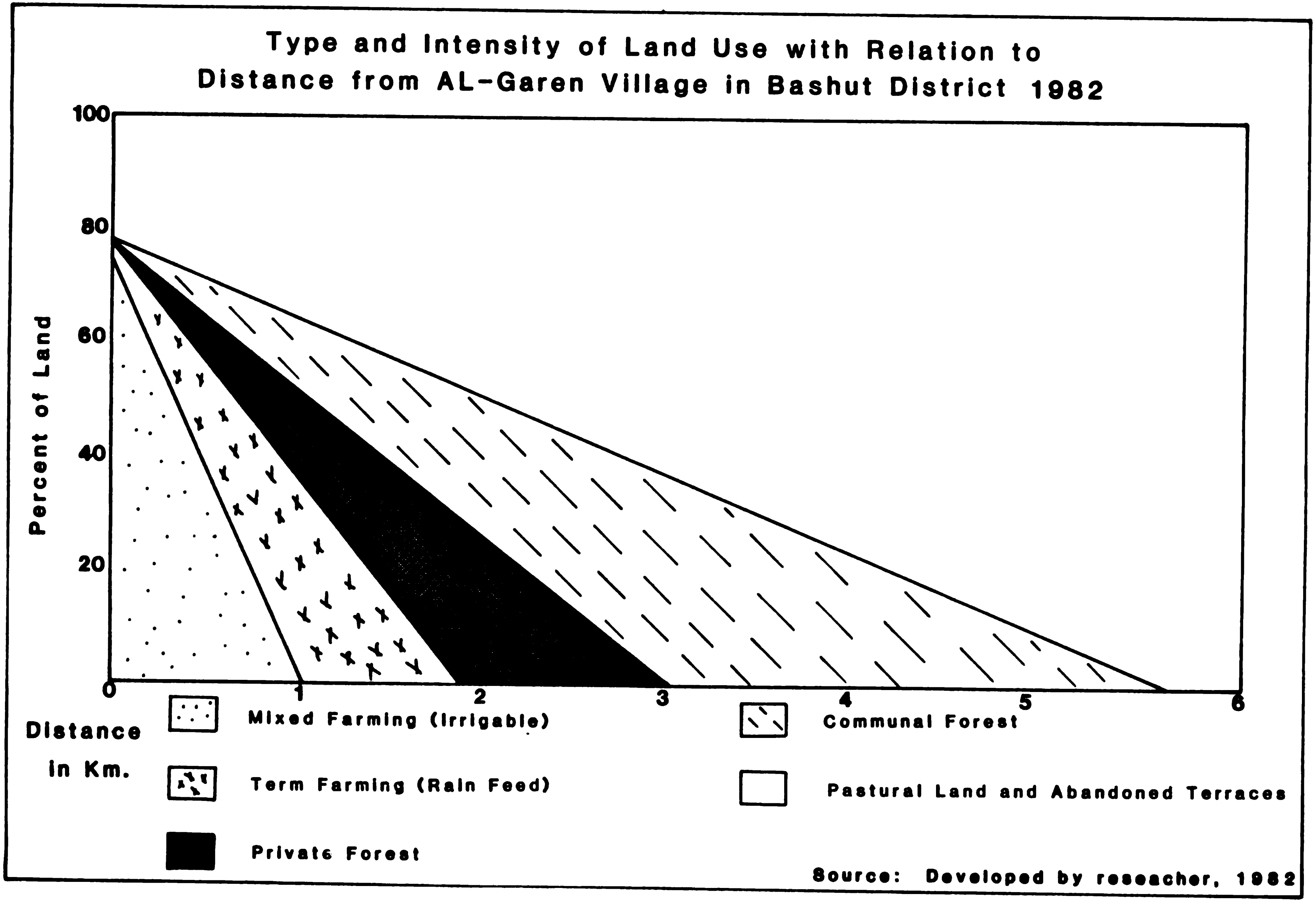

Type and Intensity of Land Use with Relation to
Distance from AL-Garen Village in Bashut District 1982
100
80
60
40
20
Percent of Land
0
1
2
3
4
5
6
Distance
in Km.
Mixed Farming (Irrigable)
Term Farming (Rain Feed)
Privat6 Forest
Communal Forest
Pastural Land and Abandoned Terraces
Source: Developed by reseacher, 1982

Figure 21

since grazing has now become nonexistent, there is a possibility that vegetation will be thicker and soil erosion by runoff will diminish (Table 26; Figures 20, 21).

An analysis of Tables 25 and 26 and of Figures 20 and 21 reveals that the intensity of agricultural land use is inversely related to the distance of a farm from the village, signifying that as distance of a farm from the village increases, the intensity of agricultural land use diminishes.

The seond hypothesis was also tested, based on the data collected during the field work. A cross-tabulation was made to determine whether there is a relationship between the patterns of agricultural land use and the distance of a farm from the village. The findings in general did not support the hypothesis for one reason or another. It is believed that fragmentation of agricultural land use is the major factor contributing to such a conclusion--that is, the rejection of the hypothesis. When the farmers were asked to respond to question 53--How far is your farm from your village?--the majority of the farmers interviewed emphasized only the distance between the village and their irrigable fields as the most important factor. They opined that the distance between their villages and their dry terraces was of little importance to them, as the cultivation of these farms was more extensive. In this regard, Table 27 provides some valuable insights that (1) the majority of the farmers (62.7 percent) specializing in the production of vegetables concentrate their production on the irrigable fields located no more than 1 km from the village. The same thing can be said for the

Table 27.--Agricultural land use in relation to the distance from the village.

Land Use	Distance						Raw Total	
	1/2 km		1-2 km		3-4 km			
	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.
Food grains	77	48.1%	80	50.0%	3	1.9%	160	62.7%
Vegetables	42	62.7%	23	34.3%	2	3.0%	67	26.3%
Fruits	17	65.4%	8	30.8%	1	3.8%	26	10.2%
Multiple products	0	0.0%	2	100.0%	0	0.0%	0	0.0%
Column total	136	53.3%	113	44.3%	6	2.4%	255	100.0%

Raw chi-square = 9.40093 with 6 degrees of freedom

Significance level = .1523

majority of the fruit growers (65.4 percent). The majority of the grain producers (50.0 percent) concentrate their production in an area located within 1 to 2 km from the village. Based on the researcher's own observation and knowledge of the areas and the inhabitants, the areas located within 2 km or more of the villages are mostly given to more extensive farming, forests, and pastures.

The Third Hypothesis

> Hypothesis 3: As the distance from the local markets increases, a smaller percentage of farm acreage is used for vegetables and fruits and a greater percentage is used for grain cultivation.

In recent years, the study area has experienced an accelerated growth of its villages owing to an increase in their population. Some of these villages have become large towns, like Al-Alayah in the Bal-Qarn district and Garn Ben Sahir in the Bashut area. These small urban areas have become the administrative and commercial centers for the region. As a result, the demand for vegetables, fruits, and dairy products has increased. Farmers who own agricultural land within an average of 5 km from these centers have found it to their benefit to concentrate on vegetable, fruit, and dairy production, while the majority of these farms, more than 10 km away from these centers, continue to grow wheat and sorghum.

The analysis of the third hypothesis was based on the responses of the farmers interviewed and related specifically to the areas growing vegetables, fruits, food grains, alfalfa, and multiple crops; and the distance of the farm from the local markets. The statistical method used to test this hypothesis is the chi-square test. The result of the analysis indicates that the majority of the farmers interviewed (62.7 percent) are still grain producers. Most of them (56.1 percent) own farms located within a distance of more than 10 km from the local markets. The farmers who specialize in vegetables, fruits, and other cash crops production formed 26.3 percent of the farmers interviewed. The majority of them (73.1 percent) own farms located within 2 to 7 km from the local markets. The hypothesis is supported at a .0000 significance level (Table 28).

Socioeconomic Factors

The patterns of agricultural land use of Saraht Bal-Qarn and Shomran in particular and of the Assarah region in general depend not only on the physical and locational factors but on the socioeconomic factors also. These socioeconomic factors include (1) income characteristics, (2) migration of farmers, (3) transportation characteristics, (4) agricultural technology and mechanization, (5) farm input-output ratio, (6) fragmentation of agricultural lands, (7) government assistance, (8) farm labor characteristics, and (9) social characteristics of the owners. This section focuses on the importance of these socioeconomic factors with relation to the agricultural land use patterns of the study area.

Income Characteristics

The first hypothesis--

> Hypothesis 1: Income from agriculture is lower than the income from jobs in other sectors of the economy.

As has been pointed out throughout this dissertation, agriculture was the main source of income for the majority of the people

Table 28.--Agricultural land use in relation to the distance from the local markets.

Land Use	Distance										Raw Total	
	< 2 km		2-4 km		5-7 km		8-10 km		> 10 km			
	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.
Food grains	22	13.7%	17	10.6%	18	11.2%	12	7.5%	91	56.1%	160	62.7%
Vegetables	7	10.4%	18	26.9%	31	46.3%	5	7.5%	6	9.0%	67	26.3%
Fruits	4	15.4%	2	7.7%	2	7.7%	6	23.1%	12	46.2%	26	10.2%
Multiple products	0	0.0%	1	50.0%	0	0.0%	0	0.0%	1	50.0%	2	0.8%
Column total	33	12.9%	38	14.9%	51	20.0%	23	9.0%	110	43.1%	255	100.0%

Raw chi-square = 75.04222 with 12 degrees of freedom

Significance level = .0000

in Saudi Arabia until very recently, but since the discovery of oil in the eastern part of the country the importance of agriculture to the Saudi economy has declined considerably. Assarah as an agricultural region was, until the 1970s, completely isolated from the rest of the country, and its inhabitants were for many centuries solely dependent on agriculture as the main source of their livelihood. The subsistence type of production was its major agricultural system. At present, agriculture in the Assarah region is declining, and incomes from it in comparison with other sources of income are low.

The findings of this research reveal that 49.8 percent of the farmers interviewed usually have no surplus of the farm products to sell at home or at the local markets. Their produce is all consumed by the producers themselves. Those farmers who have a surplus to sell form 50.2 percent of the total farmers interviewed. The majority of them (63.9 percent) have an income of no more than 15,000 Saudi riyals from the sale of their produce at home and in the local markets (Table 29).

Income from sources other than agriculture is usually much higher. An analysis of Table 29 reveals that only 12.5 percent of the farmers interviewed have no source of income other than from agriculture. The majority (87.5 percent) of the farmers usually have other sources of income in addition to their income from agriculture. These sources of additional income are (1) governmental subsidies for agriculture, (2) old-age benefits (social welfare), (3) remittances from the farmers' children, (4) employment, and (5) self-employment, business, and crafts. A substantial number of the farmers (41.5

Table 29.--A comparison of the incomes from agriculture and other sources.

Annual Income in Saudi Ryals	Income From Agriculture		Income From Other Sources	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
None	128	49.8%	32	12.5%
Less than 5,000 SR	24	9.3%	9	3.2%
5,001-10,000 SR	51	19.8%	63	24.5%
10,000-15,000 SR	20	7.8%	26	10.0%
15,000-20,000 SR	11	4.3%	21	8.2%
More than 20,000 SR	23	9.0%	106	41.5%
Total	257	100.0%	257	100.0%

One dollar = about 3.5 Saudi ryals (SR)

percent) make more than 200,000 Saudi riyals a year from sources other than agriculture, like jobs in the private sector or businesses. The farmers who have an additional income of 5,000 to 15,000 Saudi riyals receive their money from remittances by their children or old-age pension funds. The farmers who have less than 5,000 Saudi riyals of additional income form only 3.2 percent of the total. Their additional income comes usually from governmental subsidies for agriculture and some minor jobs (Table 29).

The farmers who had no farm produce to sell were asked to respond to a set of selected socioeconomic factors considered among the most important reasons why they do not have any surpluses to sell. These factors are: (1) subsistence production, (2) low market prices, (3) small farm size, (4) too old to farm, (5) abandonment of terraces, (6) low income from agriculture, (7) alternative jobs, and (8) a lack of modern agricultural technology (Table 30). The number of farmers who responded to the above questions were 128 (49.8 percent). Ninety-eight farmers of the ones interviewed (38.1 percent) were strongly of the opinion that agriculture involves hard work and that the returns in comparison with other sources are very low. At the same time, 99 farmers (38.5 percent) of those who had no farm produce to sell believed that the market prices for their agricultural produce offered no incentive to produce. Producing only for one's own consumption, age (too old to farm), having an alternative job, and lack of modern agricultural technology were regarded by the respondents as having had a serious effect on their being unable to produce sufficient produce to sell the surplus commercially. Abandonment of terraces and the size of farms

Table 30.--Selected socioeconomic factors responsible for the farmers' inability to sell their farm produce.

Socioeconomic Factors	Not Important		Slightly Important		Moderately Important		Very Important	
	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.
All produce consumed at home	2	0.8%	8	3.1%	63	24.5%	55	21.4%
Low market prices	6	2.4%	2	2.7%	21	8.2%	99	38.5%
Small farm size	44	17.1%	42	16.3%	24	9.3%	13	7.0%
Too old to farm	26	10.6%	16	6.2%	29	11.3%	57	22.2%
Abandonment of terraces	51	19.8%	56	21.8%	18	7.0%	3	1.2%
Low income from agriculture	3	1.8%	3	1.8%	24	9.3%	98	38.1%
Alternative jobs	39	15.2%	17	6.6%	1	7.4%	53	20.6%
Lack of modern agricultural technology	2	0.8%	16	6.2%	49	19.1%	61	23.7%

Valid cases = 128 (49.8 percent)

Invalid cases = 129 (50.2 percent)

had a slight effect on their ability to produce a surplus (Table 30). Based on the information derived from Tables 29 and 30, Hypothesis 1 was accepted.

Migration

The second hypothesis.--

Hypothesis 2: The migration of farmers is directly related to high wages paid for jobs in the urban centers.

The migration of the farmers to urban centers has resulted in a continuous decline in agricultural production due to shortages of labor. Many terraces now are abandoned, their walls have completely collapsed, and the soil which had formed for millions of years has been washed away by runoffs in a very short period of time. All of this is essentially due to the lack of maintenance.

This survey found that 75.5 percent of the farmers interviewed have members of their families residing customarily away from the village in the urban centers, though some have returned to their original home after a temporary stay away from home. To determine the causes of the rural migration to the major cities within Saudi Arabia, the farmers were asked to indicate to what degree each of the following reasons is not important, slightly important, moderately important, and very important: (1) better jobs and wages in the urban centers, (2) lack of economic opportunities in the village, (3) lack of education in the village, (4) lack of medical care in the village, (5) economic inadequacy of farming, (5) family feuds and disputes, and (6) attractions of the city (Table 31).

Table 31.--Factors affecting rural migration.

Factors	Not Important		Slightly Important		Moderately Important		Very Important	
	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.
Better jobs and wages in urban centers	7	2.7%	2	0.8%	10	3.9%	178	69.3%
Lack of economic opportunities in the village	3	1.2%	5	1.9%	63	24.5%	126	49.0%
Lack of education in the village	20	7.8%	48	18.7%	58	22.6%	71	27.6%
Lack of medical care in the village	85	33.0%	91	35.4%	19	7.4%	2	0.8%
Economic inadequacy of farming	7	2.7%	7	2.7%	69	26.8%	114	44.4%
Family feuds and disputes	126	63.0%	33	12.8%	1	0.4%	1	0.4%
Attractions of the city	140	54.5%	51	19.8%	5	1.9%	1	0.4%

The information contained in Table 31 reveals that the majority of the farmers (69.3 percent) perceive "better jobs and wages in the urban centers" as a very important reason for the rural migration. Further, they perceive the lack of economic opportunities in the village and economic inadequacy of farming as the two major causes of rural migration. The lack of medical care in the village, attractions of the city, and family feuds and disputes were perceived by the farmers as not important for their migration to the cities (Table 31).

It is evident that the major cause of the rural migration to the urban centers in the study area was and still is better jobs and wages in the urban centers. Further, this migration is spurred by a lack of economic opportunities in the village and adequate economic returns from farming. The findings support the hypothesis that the migration of farmers in the area is directly related to better jobs and wages in the urban centers.

Transportation Characteristics

The third hypothesis.--

Hypothesis 3: Poor transportation facilities discourage the production of cash crops.

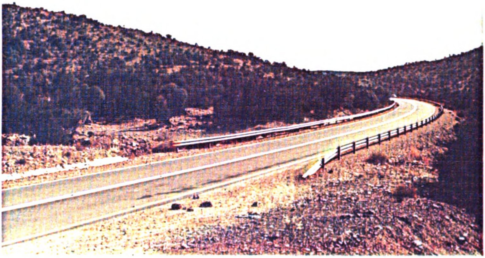
A transportation system plays a major role in influencing the farmers to grow what they grow on their farms. In fact, the majority of the farmers of the study area are highly conservative in their views and believe in growing mainly wheat and barley during the winter season and sorghum during the summer, and so on. There are some farmers who are willing to produce cash crops on their farms and maximize their profits by input-intensive farming, but unfortunately they are inhibited by the poor transportation facilities in the area.

The farmers told the interviewer that a majority of them do not grow cash crops because they do not own their own means of transportation, the cost of public transportation is high, the feeder roads are very poor, and their farms are isolated and inaccessible, and are located far away from the new paved highway that runs north-south through the region. Most farmers with these complaints constituted over 50 percent of the total number of farmers interviewed. What is more, 98.1 percent of the interviewees strongly agree that agricultural feeder roads are very poor. Because of the high cost of transporting agricultural produce from the farms to the market, the majority of the farmers (90.2 percent) agree that it is a major obstacle to their production of cash crops (Table 32, Plate 17).

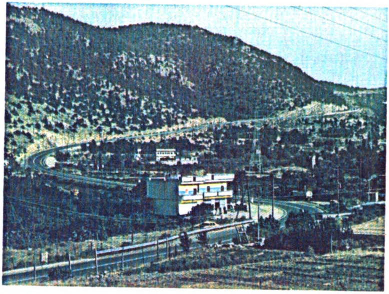
The relationship between the patterns of agricultural land use and the lack of good transportation facilities was determined. A majority of the farmers (70.6 percent) who are grain producers agree (strongly agree and agree) that the lack of good transportation facilities is the major factor inhibiting them from growing cash crops, and are sticking to the traditional crops. On the other hand, those who are vegetable (26.3 percent) and fruit (10.2 percent) producers disagree and believe that they have good transportation facilities to transport their produce to the local markets and perhaps it is the perception that makes them go on growing cash crops (Table 33).

Table 32.--Transportation characteristics.

Reasons Why Cash Crops Are/Are Not Grown	Strongly Agree		Agree		Disagree		Strongly Disagree	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
Grow cash crops because my farm is located near the paved roads	73	28.4%	40	15.6%	46	17.9%	98	38.1%
Grow cash crops because of good transportation facilities	28	10.9%	82	31.9%	93	36.2%	54	21.0%
Grow cash crops because of low transportation costs	3	1.2%	39	15.2%	167	65.0%	48	18.7%
Grow cash crops because of my not owning transportation facilities	5	1.9%	125	48.6%	120	46.7%	7	2.7%
Don't grow cash crops due to high transportation	97	37.8%	132	51.4%	15	5.8%	13	5.1%
Don't grow cash crops due to poor agricultural feeder roads	210	81.7%	42	16.3%	..	..	5	1.9%
Grow cash crops because of nearness of new highway to my farm; can sell near and around the road	38	14.8%	44	17.1%	46	17.9%	129	0.2%



(a) The new highway running through the Assarah region from Taif City in the north to Abha in the south



(b) The type and the nature of housing construction that seems to have been influenced by the new highway

Plate 17

Table 33.--Land use patterns in relation to the lack of transportation facilities.

Types of Land Use	Lack of Transportation Facilities								Raw Total	
	Strongly Disagree		Disagree		Agree		Strongly Agree			
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
Food grains	3	1.9%	44	27.5%	108	67.5%	5	3.1%	160	62.7%
Vegetables	3	4.5%	56	83.6%	8	0.0%	0	0.0%	67	26.3%
Fruits	0	0.0%	20	76.9%	6	23.1%	0	0.0%	26	10.2%
Multiple products	0	0.0%	0	0.0%	2	100.0%	0	0.0%	2	0.8%
Column total	6	2.4%	120	47.1%	124	48.6%	5	2.0%	255	100.0%

Chi-square = 77.77582 with 9 degrees of freedom

Significance level = .0000

However, since the majority of the farmers (70.6 percent) have strongly agreed with the statement that the farmers do not grow cash crops because they do not have good transportation facilities, the hypothesis is accepted at the computed significance level (Table 33).

The Pearson correlation analysis for the selected transportation factors.--The Pearson correlation coefficients are presented in Table 34 in easily interpretable form. The Pearson correlation coefficient form ranges from +1.0 to -1.0 where the limit +1.0 indicates a perfect positive relationship, and -1.0, a perfect negative relationship. If the value of r is zero, no relationship is indicated. The better the fit, the larger the positive magnitude of r in the range.

The second rows in the correlation-coefficient table show the levels of significance. The level of significance in this study was computed to be .05; that is, any relationship lower than .05 was statistically significant.

The Pearson correlation coefficient was used to analyze seven variables in relation to each other. In other words, each one of these variables was correlated with each of the remaining six variables. The variables included in the correlation analysis are shown in Table 34. The most significant correlations (r) found from the responses of the 257 farmers interviewed are:

1. A positive correlation between a cash-crop farm located near the paved roads and the availability of good transportation facilities (r = .651), implying that if cash crops are grown more

Table 34.--Correlation matrix for selected transportation determinants. (N = 257)

Variables	1	2	3	4	5	6	7
(1) I grow cash crops because my farm is located near a paved road	1.00						
(2) I grow cash crops because I have good transportation facilities	.651 (.001)	1.00					
(3) I grow cash crops because transportation cost is low	.312 (.001)	.379 (.001)	1.00				
(4) I do not grow cash crops because I do not own good transportation facilities	-.659 (.001)	-.666 (.001)	-.326 (.001)	1.00			
(5) I do not grow cash crops because transportation costs are too high	-.370 (.001)	-.264 (.001)	-.362 (.001)	.295 (.001)	1.00		
(6) I do not grow cash crops because agricultural feeder roads are very poor	-.182 (.001)	-.097 (.061)	-.171 (.003)	.153 (.001)	.202 (.001)	1.00	
(7) I grow cash crops because the new highway runs by my farm and I sell the produce to the people on my farm or by the roadside	.605 (.001)	.374 (.001)	.262 (.001)	-.452 (.001)	.365 (.001)	-.187 (.001)	1.00

Significance r = ±.103

intensively on a farm located near the paved roads, the possibility of the farmers' owning good transportation facilities increases.

2. A positive correlation between cash crops grown on a farm located near the paved roads and a low transportation cost (r = .312), implying that as distance between the paved road and a cash-crop farm decreases, the cost of transporting the farm produce to the market decreases, too.

3. A negative correlation between a farm located near the paved road and the lack of good transportation facilities (r = -.659), indicating that as the distance between the farm and the paved road increases, the cultivation of cash crops decreases owing to poor transportation facilities.

4. A negative correlation between the transportation cost and the cultivation of cash crops (r = -.370), showing that as the transportation cost goes up, the interest in cultivating cash crops declines.

5. A positive correlation between the cultivation of cash crops and the location of the farm from the new highway (r = .605), indicating that the closer the farm to the new highway, the greater the interest in the cultivation of cash crops.

6. A positive correlation between the cultivation of cash crops and the transportation cost (r = .379), implying that as transportation facilities become more readily available to the farmer, the transportation of the produce to the market becomes easier;

7. A negative correlation between the cultivation of cash crops and the lack of good transportation facilities (r = -.666),

indicating that as good transportation facilities become more scarce the cultivation of cash crops drops;

8. A positive correlation between the availability of good transportation facilities and the location of a farm from the new highway (r = .374), implying that as a farm gets closer to the new highway, the cultivation of the cash crops increases owing to this availability of good transportation facilities.

9. A negative correlation between the transportation cost and the cultivation of cash crops (r = -.362), indicating that as the cost of transportation decreases, the cultivation of cash crops increases.

10. A negative correlation between the proximity of a farm to the new highway and the cultivation of cash crops (r = .452), indicating that as the distance between the farm and the new highway increases, the cultivation of cash crops decreases.

11. A positive correlation between the proximity of a farm to the new highway and the transportation cost (r = .365), implying that as the distance between a farm and the new highway increases, the cost of transporting the farm produce increases.

Agricultural Technology

The fourth hypothesis.--

> Hypothesis 4: Farmers engaged in traditional farming are unwilling to use modern agricultural technology.

One of the best solutions to the problem of labor shortages in Saudi Arabia is the introduction of agricultural technology to increase output per unit of labor. The technical implements vary from simple hand-powered devices to very sophisticated machinery. Although tractors have generally proven to be well adapted to large-scale commercial farming in many areas of Saudi Arabia, their role in the development of small-scale agriculture--a characteristic of the Assarah region--has been less effective for a variety of reasons: First, the region is rugged, and flat plains are nonexistent; second, the farms are small owing to fragmentation; and third, the majority of the farmers do not know how to use modern agricultural machinery.

This study reveals that the majority of the farmers (94.2 percent) are willing to use modern mechanized farming methods on their terraces, and those who are not interested in this technology form only 5.8 percent of the total. The majority (57.6 percent) of the farmers use agricultural machinery such as tractors and other equipment, but about 7 percent of them who want to use agricultural technology do not know how to use it. One-fourth (25.7 percent) of them, however, would like to use it but cannot afford it. Yet a very small minority (3.1 percent) of the farmers who want to use mechanical farming methods complain of the shortage of trained operators in the village. This interviewer did not find a single farmer among the 257 interviewed who did not want to use the modern agricultural implements because his farm was too small. Finally, 3.5 percent of the population have more than one reason for not using the modern equipment. Those farmers who do not want to use modern technology because they prefer traditional methods of farming form only 3.1 percent of the total (Table 35).

To show the effect of modern agricultural mechanization on the patterns of agricultural land use of the study area, a cross-tabulation between the two variables was used to see whether there is

Table 35.--Farmers' perceptions about the use of modern agricultural technology.

Farmers' Responses	Absolute Frequency	Relative Frequency
Want to use modern agricultural equipment but do not know how to	48	7.0%
Want to but cannot afford it	66	25.7%
Want to but no trained operators available in the village	8	3.1%
Don't want to; prefer traditional methods of farming	8	3.1%
Terraces too small for mechanization	0	0.0%
Do use mechanized farming	148	57.6%
Want to, but more than one reason for not using it	9	3.5%
Total	257	100.0%

a relationship between them or not. Findings tabulated in Table 36 indicate that 43.1 percent of the farmers interviewed who are grain producers are currently using modern agricultural equipment, like tractors. Further, 35.6 percent of the grain-producing farmers are willing to use agricultural technology but they cannot afford it. The farmers who are vegetable producers constitute 26.3 percent of the total, and a majority of them (83.6 percent) use modern agricultural technology at present. The fruit-specializing farmers form 10.2 percent of the 257 farmers during the field survey, and the majority of them, 80.8 percent, use modern agricultural equipment today. Those preferring traditional methods form 5 percent of the total and grow only food grains.

It is evident that the majority of the farmers (94.2 percent) are willing to use modern agricultural technology, of which 62.7 percent of those interviewed produce grains, 26.3 percent vegetables, and 10.2 percent fruits. The majority of grain, vegetable, and fruit producers (more than 90 percent) do use modern agricultural equipment. These findings reveal that the fourth hypothesis is unsustainable (Tables 35, 36).

Farm Input-Output Relation

The fifth hypothesis.--

Hypothesis 5: The cost of farm input exceeds the revenues from the farm output.

It is true that the majority of the farmers from the representative area in particular and the Assarah region in general depend directly on agriculture for their livelihood. For many

Table 36.--Agricultural land use patterns in relation to the use of agricultural technology.

Agricultural Land Use	Use of Modern Agricultural Technology, Equipment, Machinery, and Implements												Raw Total	
	Want to Use But Don't Have the Skill to Use		Want to Use But Cannot Afford Them		Want to Use But No Trained Personnel Here		Don't Want to; Prefer Traditional Methods		Do Use Mechanized Farming		Don't Want to Use for More Than One Reason			
	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.	Absolute Freq.	Relative Freq.
Grains	13	8.1%	57	35.6%	5	3.1%	8	5.0%	69	43.1%	8	5.0%	160	62.7%
Vegetables	3	4.5%	7	10.4%	1	1.5%	0	0.0%	56	83.6%	0	0.0%	67	26.3%
Fruits	1	3.8%	2	7.7%	1	3.8%	0	0.0%	21	80.0%	1	3.8%	26	10.2%
Multiple products	1	50.0%	0	0.0%	0	0.0%	0	0.0%	1	50.0%	0	0.0%	2	0.8%
Column total	18	7.1%	66	25.9%	7	2.7%	8	3.1%	147	57.6%	9	3.5%	255	100.0%

Chi-square = 47.28304 with 15 degrees of freedom

Significance level = .0000

farmers, at present, the farm is more a symbolic than a real source of income. They need other sources of income to live. Of the 257 farmers surveyed in 1982, 142 (55.2 percent) have indicated that their farm input of labor, fertilizer, irrigation, and personal time was well compensated for by the output. On the other hand, 115 farmers (44.8 percent) said that their farm input is not compensated for by the output. The 55.2 percent of the farmers who claimed that their farm input was well compensated for by their output were asked to give an approximate annual net return from their farms. It was found that only 24.9 percent of them earned a net return of less than 5,000 Saudi riyals annually, 16 percent 5,001-10,000 Saudi riyals, 3.1 percent 10,001-15,000 Saudi riyals, 1.2 percent 15,001-20,000 Saudi riyals, and 8.2 percent more than 20,000 Saudi riyals a year from their farms (Table 37).

Table 37.--Approximate annual returns from farming.

Approximate Net Returns in Saudi Riyals	Absolute Frequency	Relative Frequency
Less than 5,000 Saudi riyals	69	24.9
5,001 to 10,000 Saudi riyals	41	16.0
10,000 to 15,000 Saudi riyals	8	3.1
15,000 to 20,000 Saudi riyals	3	1.2
More than 20,000 Saudi riyals	21	8.2

One dollar = 3.5 Saudi riyals

The relationship between the income characteristics of a farmer and his farm input-output relationship is examined in this section. It has been found that 81.5 percent of the farmers who grow enough farm produce to sell have their farm input equal or exceed output. On the other hand, 73.8 percent of the farmers who do not grow enough farm produce to sell do not have their farm input equal to the farm output. Those farmers who do not grow enough farm produce to sell but have their farm input equal to their output form 62.3 percent of all interviewed. Finally, the farmers who usually grow enough farm produce to sell but for one reason or another their input is not compensated for by their farm output are only 18.5 percent of the total (Table 38).

Since the majority of the interviewed farmers (55.2 percent) have asserted that their input of labor, fertilizer, irrigation, and personal time is compensated for by the output, the hypothesis that the cost of farm input exceeds the revenues from the output of the farm can be sustained.

Imported Food

The sixth hypothesis.--

> Hypothesis 6: It is cheaper for the farmers to buy imported food than to produce it on the terraces.

Assarah as an agricultural region was able to produce all the needed food grains, milk, meat, oil, vegetables, fruits, flowers, coffee, wood, leather, etc., for its needs and sometimes was able to

Table 38.--Relationship between income and the farm input-output.

Growth and Income	Input = Output		Input ≠ Output		Raw Total	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
Grows enough surplus to sell	110	81.5%	25	18.5%	135	52.5%
Do not grow enough surplus to sell	32	26.2%	90	73.8%	122	47.5%
Column total	142	55.3%	115	44.7%	257	100.0%

Chi-square = 79.12908 with 1 degree of freedom

Significance level = .0000

sell its surplus to the neighboring regions. In recent years, the demand for cosmetic and luxury commodities has far exceeded the supplies locally available because (1) many farmers have abandoned their terraces and have migrated to the urban centers; (2) the population has increased, creating a greater demand for agricultural produce; (3) the income of the majority of the farmers from nonagricultural sources has increased to create a demand for more agricultural commodities; and (4) the shortages of organic fertilizers have contributed to low fertility, leading to a decline in agricultural productivity.

Most farmers have in recent years come to depend on imported food. Imported food grains, vegetables, and fruits are within their means. Asked about them, an overwhelming majority of the farmers interviewed (94.9 percent) said it was cheaper for them to buy imported food than the locally produced food. A majority of these farmers (76.7 percent) indicated that imported food is cheaper than even the government-subsidized locally produced food because the government subsidizes even those people who import food grains from abroad to sell them to the public at low prices. Sixteen percent of the farmers argued that because of the shortages of farm labor, the prices of the locally produced agricultural commodities have risen by only 1.9 percent, and they attribute the decline in the locally produced food to a very high transportation cost. This argument does not make sense as the high transportation cost should have affected imported food more severely and made it more expensive in the local markets (Table 39).

Table 39.--Farmers' perceptions about imported food.

Farmers' Responses	Absolute Frequency	Relative Frequency
(A) Farmers' Perceptions About Imported Food		
Imported food is cheaper than the locally produced food	244	94.9
Imported food is not cheaper	13	5.1
(B) Farmers' Reasons Why the Imported Food Is Cheaper Than the Locally Produced Food		
Government subsidies for the imported food	197	76.7
Shortages of farm labor	28	10.9
High wages for hired labor	13	5.1
High transportation costs	5	1.9
Other	2	0.8

It is evident from the survey that imported food is cheaper than the locally produced food because of the high costs of labor, fertilizers, and irrigation. The evidence substantiates the hypothesis that imported food is cheaper than the locally produced items.

Fragmentation of Agricultural Land

The seventh hypothesis.--

> Hypothesis 7: Farmers perceive that low agricultural productivity is directly related to the fragmentation and smallness of holdings as well as to poor agricultural extension services and shortages of labor.

The final spatial shape of any agricultural holding is directly related to its physical, sociocultural, and operational factors. This group of three factors is believed to lie behind the problem of fragmentation and smallness of agricultural holdings.

The effect of the physical factors is directly related to the angle of the slope. Assarah is a rugged region, and its terrain is decimated by a series of ravines that break up the continuity of the land formation. This physiographic characteristic, of course, works against farming a vast expanse of level land which might have been cultivated as one large tract. In fact, the steepness of slopes is perceived as a major problem affecting the availability of flat arable land. To meet the challenges of the physiography of this terrain, man-made terraces were constructed to conserve the soil and water and to provide level surfaces for agriculture. These terraces cannot, by their nature, merge into one agricultural tract of land. The geographical distribution of the natural resources of soils, trees, water, etc., has contributed to fragmentation because each inheritor after the death of the father wants a part of each type of terrace, which cannot be found in one simple plot (Mughram, 1973, pp. 295-96).

The sociocultural factors for the fragmentation and smallness of holdings stem from the customs, values, and the system of ownership. The ownership of agricultural land in particular and nonagricultural land in general in Saudi Arabia is predominantly private. There are three ways of acquiring land as personal property in Assarah: (1) through inheritance, (2) through purchase or gift, and (3) through a property exchange.

> The Islamic Laws of inheritance set very elaborate conditions by which the relatives of the deceased person get specific shares in the legacy. These shares vary according to the priorities and postulates contained in the laws. It is becoming customary for many writers to attribute the extreme fragmentation and small size of farms to the Islamic Law of inheritance. This is a gross oversimplification for although Islamic Law may have an effect on the problem, certainly it is not by itself a primary cause. The primary and universal causes of the problem lie in the low land-man ratio and in the lack of alternative sources of livelihood, besides the other physical and operational factors. (Mughram, 1973, pp. 296-97)

The operational factors play a major role in the fragmentation of agricultural land. There are three types of these operational factors: (1) the access routes that connect the terraces with each other, (2) the divides or boundaries that the individual constructs to separate his farm or terrace from his neighbor's, and (3) the dividing lines that the owner himself creates in order to break his terrace into smaller parcels for different uses. The effect of all these factors is that the physical, sociocultural, and locational factors cause a waste of land and time, create mechanization problems, and render the productive farms uneconomic.

The 1982 survey revealed that 99.2 percent of the farmers believe that the agricultural productivity of their terraces has declined with time. The interviewees were asked to respond to some selected factors by indicating how important each of these factors was in contributing to the decline of agricultural productivity on their nonagricultural [illegible]

private. There are [illegible]

in Assarah: (1) [illegible]

and (3) through [illegible]

> The Islamic [illegible] which the [illegible] the tenancy [illegible] postulates [illegible] many writers [illegible] of farms [illegible] simplification [illegible] problem, [illegible] primary and [illegible] man ratio and [illegible] besides the other [illegible] 1972, pp. 290-[illegible]

The operational factors [illegible] of agricultural land. There are three types of [illegible] factors: (1) the access roads that connect the parcels with each other, (2) the division of inheritance that the individual [illegible] separate his farm or terrace from its neighbors, and (3) the dividing lines that the owner himself creates in order to break his terrace into smaller parcels for different uses. The effect of all these factors is that the physical, sociocultural, and locational factors cause a waste of land and time, create mechanization problems, and render the productive farms uneconomic.

The 1982 survey revealed that 94.2 percent of the farmers believe that the agricultural productivity of their terraces has declined with time. The interviewees were asked to respond to some selected factors by indicating how important each of these factors was in contributing to the decline of agricultural productivity on their farms. The overwhelming majority of the interviewees (92.6 percent) attributed the problem of low agricultural productivity to the shortages of labor and regarded this factor as very important. Those who attributed the problem to fragmentation of agricultural land and to poor agricultural extension services formed, respectively, 64.6 and 65.4 percent of the total. The lack of modern agricultural technology, scarcity of water supplies, and shortages of organic fertilizers were considered moderately important in contributing to the low agricultural productivity. High prices of energy were perceived as not an important factor (Table 40).

The effect of fragmentation, poor agricultural extension services, and shortages of farm labor on agricultural land indicates that the majority of the farmers interviewed have perceived these factors as very importantly contributing to the diminishing agricultural productivity, and thus their perception supports the fourth hypothesis.

Governmental Assistance

The Ministry of Agriculture and Water Resources is the main body responsible for agricultural development in the country. To encourage agricultural enterprises, the government of Saudi Arabia offers subsidies--the subsidies on land and labor for wheat, sorghum, rice, sheep, and camels. Further, the government subsidizes the purchase of farm machinery, fertilizers, animal feed concentrates, poultry and dairy farms, and transportation of 200 or more dairy cattle. Besides, the Saudi Arabian Agricultural Bank extends interest-free credit to farmers.

Table 40.--Farmers' perceptions of the selected factors as contributing to low agrioultural productivity.

Selected Factors	Not Important		Slightly Important		Moderately Important		Very Important	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
Fragmentation of agricultural land	9	3.5%	24	9.3%	58	22.6%	166	64.6%
Poor agricultural extension service	5	1.8%	18	7.0%	67	26.1%	168	65.4%
Lack of modern agricultural technology	8	3.1%	47	18.3%	145	56.4%	57	22.2%
Shortages of farm labor	1	0.4%	3	1.2%	15	5.8%	238	92.6%
Shortages of organic fertilizers	36	14.0%	90	35.0%	96	37.4%	35	13.5%
Scarcity of water supply for agriculture	10	3.9%	55	21.4%	90	35.0%	102	39.7%
High energy prices	191	74.3%	53	20.6%	3	1.2%	10	3.9%

N = 257

The 1982 survey revealed that 92.2 percent of the interviewed farmers have received some form of financial assistance from the agricultural bank, which has its main office in Al-Alayah. In the main, the assistance has consisted of agricultural equipment and machinery to 85.6 percent of them, interest-free loans to 10.8 percent, subsidies for farm operations to 3.1 percent, and cash subsidies to 3.1 percent. The researcher's investigation revealed that these subsidies are not used for the purpose for which they are meant by the majority of the farmers. Most of them collect the subsidies in the form of a tractor, an interest-free loan, etc., and use the cash for other businesses or nonagricultural purposes.

Farm Labor Characteristics

In the study area, the terraces are farmed by the farmer and his family members. The survey revealed that the average family size consists of at least six people. It has been found that 2 percent of the farmers have a family of the size of three persons or fewer, 12.1 percent of four to six persons, but the majority of them (86 percent) have a family of six persons or more (Table 41).

Table 41.--The frequency distribution regarding family size.

Family Size	Absolute Frequency	Relative Frequency
Less than 3	5	2.0
4 to 6	31	12.1
More than 6	221	86.0
Total	257	100.0

The [illegible] survey [illegible] farmers have received [illegible] agricultural bank, [illegible] mainly the assistance [illegible] machinery to [illegible] percent subsidies [illegible] subsidies to [illegible] that these subsidies [illegible] meant by the majority of [illegible] subsidies in the form of [illegible] use the cash for other [illegible]

Farm Labor Characteristics

In the study area, the farmer can obtain his labor from his family members. The survey revealed that the average family consists of at least six people. It has been found that 2 percent of the farmers have a family of the size of three persons or fewer, 12.1 percent of four to six persons but the majority of them (86 percent) have a family of six persons or more (Table 41).

Table 41.--The frequency distribution regarding family size.

Family Size	Absolute Frequency	Relative Frequency
Less than 3	5	1.9
4 to 6	31	12.1
More than 6	221	86.0
Total	257	100.0

A study of the labor force indicates that 40.5 percent of the farmers interviewed have fewer than three workers, 49.4 percent between four and six workers, and only 10.1 percent have more than six workers. These workers include males, females, children, and hired hands. Almost 90 percent (89.5 percent) of those interviewed said that all they have had are the family members and hired hands, and 10.5 percent have had some hired help besides the family members (Table 42).

Table 42.--The frequency distribution regarding the farm labor force.

Farm Labor Force	Absolute Frequency	Relative Frequency
Less than 3	104	40.5
4 to 6	177	49.4
More than 6	26	10.1
Total	257	100.0

Hired laborers are very few in the area. Only 7 percent of the farmers indicated that they have one hired hand, 3.1 percent no more than two, 1.2 percent three, 0.4 percent four, and 0.8 percent five hired laborers (Table 43).

Those farmers who use hired labor were asked to indicate when they usually hire help. About 11 percent (11.3 percent) of them said that they hired help all year round. Those farmers who hired labor during the sowing and harvesting seasons formed 0.4 percent of the farmers. The average wage a hired worker earns is about 50 Saudi riyals a day. It should be maintained that the majority of these hired workers are non-Saudi aliens.

Table 43.--The frequency distribution of hired farm labor.

Number of Hired Laborers	Absolute Frequency	Relative Frequency
1	18	7.0
2	8	3.1
3	3	1.2
4	1	0.4
5	2	0.8

Social Characteristics of the Owners

In analyzing the social characteristics of the farmer, selected criteria were developed to fully illustrate and comprehend the nature of the farmer's social characteristics. These criteria included the farmer's age, his educational level, his position within the family, and the duration of his residency in the village.

With regard to the farmer's role within his family, this study found that 93 percent of the farmers interviewed were the heads of their families, and only 7 percent were only members. It must be mentioned here that the farmers interviewed were all male, and no female could be interviewed owing to cultural reasons. The frequency distribution of farmers' residency in the villages revealed that 3.1 percent of them had been residents in their villages for no more than 5 years, 3.9 for 5 to 10 years, 3.1 percent for 11 to 15 years, and the majority (89.9 percent) had been riyals a day. It ...

hired workers are ...

Table 43.--The frequency ...

Number of Hired Laborers
1
2
3
4
5

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revealed that 3.1 percent of them had been residents in their
villages for no more than 5 years, 2.1 for 5 to 10 years, 5.4
percent for 11 to 15 years, and the majority (89.0 percent) had been

residing in their villages for more than 15 years. In other words, the majority of the farmers might have resided in their villages for even longer than 50 years (Table 44).

Table 44.--The frequency distribution of the farmers' duration of residency in the villages.

Duration	Absolute Frequency	Relative Frequency
Less than 5 years	8	3.1%
5 to 10 years	10	3.9%
11 to 15 years	8	3.1%
Over 15 years	231	89.9%
Total	257	100.0%

With regard to the level of education of the farmers, it was found that (1) 41.6 percent of the interviewees could neither read nor write, (2) 10.1 percent could only read, (3) 30.7 percent could both read and write, (4) 1.9 percent had completed primary school, (5) 10.5 percent high school, and (6) 5.1 percent had had some college education. The last group consists largely of teachers who work part-time on farms (Table 45).

With regard to the average age of the farmers, this survey found that 2.3 percent of the farmers interviewed were less than 20 years old, 24.5 percent were between 21 and 40, 48.2 percent were between 41 and 60, and 24.9 percent were more than 60 years old (Table 46).

The relationship between age and the educational level of the farmer was statistically computed. The correlation between these two

Table 45.--The frequency distribution regarding the educational level of the farmers.

Educational Level	Absolute Frequency	Relative Frequency
Neither read nor write	107	41.6%
Read only	26	10.1%
Read and write	79	30.7%
Completed primary school	5	1.9%
Completed high school	27	10.5%
Completed some college	13	5.1%
Total	257	100.0%

Table 46.--The frequency distribution of the farmers by age.

Farmers' Age	Absolute Frequency	Relative Frequency
Less than 20 years of age	6	2.3%
Between 21 and 40 years of age	63	24.5%
Between 41 and 60 years of age	124	48.2%
More than 60 years of age	64	24.9%
Total	257	100.0%

factors was found to be significant at .00001 (Table 47). The younger the farmers, the more educated they happened to be than the old farmers. For example, all those who had had some college education were between the ages of 21 and 40. Also, the farmers who had completed high school were between the ages of 15 and 40. Those

Table 47.--The relationship between the age and the educational level of the farmer.

Educational Level	Less Than 20 Years Old		21 to 40 Years Old		41 to 60 Years Old		More Than 60 Years Old		Raw Total	
	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency	Absolute Frequency	Relative Frequency
Neither read nor write	0	0.0%	10	9.3%	52	48.6%	45	42.1%	107	41.6%
Read only	0	0.0%	2	7.7%	14	53.8%	10	38.5%	26	10.1%
Read and write	0	0.0%	17	21.5%	54	68.4%	8	10.1%	79	30.7%
Completed primary school	1	20.0%	2	40.0%	2	40.0%	0	0.0%	5	1.9%
Completed high school	5	18.5%	19	70.4%	2	7.4%	1	3.7%	27	10.6%
Completed some college education	0	0.0%	13	100.0%	0	0.0%	0	0.0%	13	5.1%
Column total	6	2.3%	63	24.5%	124	48.2%	64	24.9%	257	100.0%

Chi-square = 173.61174 with 18 degrees of freedom

Significance level = .0000

farmers (46 percent) who could neither read nor write were between the ages of 41 and over (Table 47).

The farmers were asked to indicate whether they would encourage their children to become farmers or not. An overwhelming majority of them (91.4 percent) said "yes." Those who do not want their children to become farmers formed 8.6 percent of the total interviewees. The latter are young farmers who have alternative jobs and consider agriculture a secondary occupation.

It is important also to indicate that an attempt was made to determine if there was any significant relationship between the land use patterns and the farmers' age and educational level. The land use variables chosen for the analyses were food grains, vegetables, fruits, alfalfa, and multiple crops. The chi-square analyses of land use patterns with regard to the farmer's age and his educational level were shown to have no significant relation. For example, the educational level vis-à-vis land use patterns was shown to be a chi-square = 10.33491 and the significance level of .7982. At the same time, age with relation to land use patterns had a chi-square = 14.37955, at the significance level of .2771.

Farmers' Reaction to the Major Difficulties Facing Agricultural Development in the Study Area

The farmers' responses to an open-ended question were classified as follows: (1) shortages of water supply for agriculture, especially during the summer season; (2) poor agricultural extension services; (3) lack of trained and skilled professionals; (4) crop and animal disease; (5) poor transportation facilities; (6) a lack of wide paved agricultural feeder roads; (7) soil erosion by runoffs and the lack of capital to rebuild the abandoned terraces; (8) low prices for agricultural produce due to the absence of a good marketing system; (9) fragmentation and smallness of agricultural holdings; (10) a lack of irrigational dams and water conservation; (11) a lack of land use planning; (12) delays in agricultural assistance from the local department of agriculture; and (13) shortages of farm labor.

The farmers were also asked to suggest solutions to the difficulties enumerated above, and their responses were summarized as follows: The Ministry of Agriculture and Water Resources should concentrate its efforts on (1) constructing irrigational dams, providing the farmers with good-quality seeds, establishing departments of agriculture in each district, constructing agricultural roads and feeders, and providing effective agricultural extension services; (2) initiating agricultural land reforms, (3) providing cash subsidies to build abandoned terraces, (4) encouraging cash crops, (5) providing nonformal education to the farmers, (6) establishing a good transportation system; (7) encouraging farmer cooperatives; and (8) establishing a good marketing system, especially during the harvesting season.

Factor Analysis of the Physical, Locational, and Socioeconomic Factors Influencing Agricultural Land Use in Assarah

> Factor analysis is a general scientific method for analysing data. There is no restriction on the content of the data; they may be observational data on earthquakes, on movements of gas molecules, on group behavior, on attitudinal data derived from questionnaires or opinion polls; or they may be theoretical data on the probability of a Markov chain matrix, or on the hypothetical values of a transaction matrix. Indeed, any matrix can be factor analyzed. (Rummel, 1979, p. 13).

Factor analysis involves a three-step operation on the major variables available, namely (1) the preparation of a correlation matrix, (2) an extraction of the initial factors, and (3) a rotation of the terminal factors. Further, there are four rotational methods available to arrive at factoring solutions, three of which are orthogonal and one oblique. The three orthogonal solutions are varimax, quartimax, and equimax used with uncorrelated variables. In the oblique rotation, the user can control the degree of correlation among correlated variables (Norman et al., 1975, p. 469).

> What factor analysis does is this: it takes thousands and potentially millions of measurements and qualitative observations and resolves them into distinct patterns of occurrence. It makes explicit and more precise the building of fact-linkages going on continuously in the human mind. (Rummel, 1967, p. 445)

Among the many uses of factor analysis are included the classification or reduction of the data, the exploration of the content area, the structuring of a domain, a formulation of theories, the mapping of an unknown area, a control of variables, and the drawing of inferences (Rummel, 1967, p. 448).

> The single most distinctive characteristic of factor analysis is its data-reduction capability. Given an array of correlation coefficients for a set of variables, factor-analytic techniques enable us to see whether some underlying pattern of relationships exists such that the data may be "rearranged" or "reduced" to a smaller set of factors or components that may be taken as source variables accounting for the observed interrelations in the data. (Nurman et al., 1975, p. 469)

In other words, factor analysis is used to reduce a mass of information to a manageable level, without much loss of it, even to determine whether a set of variables can be reduced to a smaller number or not. Further, it is used to search for clusters of variables that are all correlated with each other (Rummel, 1967, p. 448).

The factor-analysis technique has been used in this study to explore the data to discover new concepts and obtain a possible data reduction, based on the identification of the underlying variables influencing the agricultural land use in the Assarah region. The variables that have a loading of ±0.30 or over were recognized as the resultant factors. The results of the factor analysis are summarized in Tables 48, 49, and 50, instead of a single table, to indicate that different segments and sizes of the population took part in the three surveys. When applied to 42 environmental factors based on the responses of the 257 farmers interviewed during the field survey, the 42 unrelated variables were reduced to 16 factors.

The first factor, reduced from eight variables, was described as transportation characteristics, with variable loadings ranging from -0.81 to 0.30 (Table 48). These variables have a strong bearing on what the farmers grow on their terraces. For example, the farmeres who have their farms located near the paved roads usually concentrate on producing cash crops such as vegetables and fruits because of the readily available transportation at competitive costs to transport their produce to the local markets. On the other hand, farmers located far away from the transportation facilities tend to produce food only for their own consumption because the feeder roads are almost nonexistent and the cost of transportation of their produce is prohibitive (Table 48).

The second factor, described as the physical hazards, was reduced from eight variables, with the loadings ranging from 0.42 to 0.66 (Table 48). These variables--excessive soil erosion, steep

Table 48.--Factor analysis of the general environmental variables influencing agricultural land use in the Assarah region.

Factor/Dimensions	Variables With More Than ± 0.30	Variable Loadings
The First Factor: Transportation	-Farm location from the paved road	-0.81
	-Availability of good transportation facilities	-0.71
	-Low cost of transportation	-0.50
	-High cost of transportation	0.72
	-Poor agricultural feeder roads	0.47
	-A poor tilth soil	0.45
	-A poor drainage soil	0.39
	-High energy prices	0.30
The Second Factor: Physical hazards	-Soil erosion	0.45
	-Steep slopes	0.66
	-Rolling land	0.66
	-Distance from the market	0.64
	-Farm size	0.42
The Third Factor: Fertilizers	-Shortages of organic fertilizers	0.78
	-Shortages of chemical fertilizers	0.71
The Fourth Factor: Social characteristics of the farmer	-Educational level of the farmer	0.73
	-Age of the farmer	0.80
The Fifth Factor: Farm accessibility	-Accessible farm locations	0.56
	-Inaccessible farm locations	0.53
	-Irregular rainfall	0.39
The Sixth Factor: Soil Characteristics	-Shallow soil	0.72
	-Poor soil	0.68
The Seventh Factor Geomorphology	-The slope	0.60
	-The soil	0.54
	-Distance	0.45

Table 48.--Continued.

Factor/Dimensions	Variables With More Than ± 0.30	Variable Loadings
The Eighth Factor: Water supply	-Adequate water supply	0.51
	-Shortages of water supply	0.58
	-Scarcity of water supply	0.48
The Ninth Factor: Climatic hazards	-Winter frosts and cold	0.65
	-Hail and thunderstorms	0.55
	-Crop disease	0.76
The Tenth Factor: Family Characteristics	-Family size	0.68
	-People working on the farm	0.62
The Eleventh Factor: Climate characteristics	-The climate	0.47
	-Short farming seasons	0.40
The Twelfth Factor: Fragmentation	-Geographical distribution of the farmers' terraces	0.51
	-Fragmentation of agricultural holdings	0.55
The Thirteenth Factor: Distance from the village	-Distance from the village	0.63
The Fourteenth Factor: Agricultural mechanization	-Use of modern agricultural technology	0.60
	-Use of traditional methods	0.59
The Fifteenth Factor: Farm labor	-Shortages of labor force	0.53
The Sixteenth Factor: Agricultural technology	-Lack of agricultural technology	0.48

slopes, the rolling land, distance from the local and regional markets, and the small size of farms--have always constituted a negative factor and a physical hazard to the agricultural production.

The third factor was labeled as the fertilizer component, reduced from two items--shortages of organic fertilizers and inadequate supplies of chemical fertilizers--with high loadings ranging from 0.71 to 0.78. Most of the 257 farmers interviewed complained of the shortages of both the organic and chemical fertilizers, and those who could get hold of some from the local agricultural agencies burned the soil by an overuse of them and ruined their crops.

The fourth factor, identified as the social characteristics of farmers, was reduced from two variables--the age and the level of education of the farmer--with the loadings between 0.73 and 0.80. Old and illiterate farmers tend to concentrate on food-grain production; the young educated farmers generally grow cash crops. Besides, the former want their sons and grandsons to go into farming, while the latter discourage their progeny from opting for farming.

The fifth factor was termed farm accessibility and was reduced from three moderately related variables--accessible farm locations, inaccessible farm locations, and the irregularity of rains--with their loadings ranging between 0.39 and 0.56. Accessible farms make it possible for the farmers to use modern agricultural technology more easily to solve the problem of the shortages of farm labor, whereas the inaccessibility of the farms and the irregularity of rains have a negative effect on both the agricultural land and technology use.

slopes, the rolling [illegible] and the small size of [illegible] and a physical barrier [illegible]

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The fifth factor was termed farm accessibility and was reduced from three moderately related variables—accessible farm locations, inaccessible farm locations, and the irregularity of rains—with their loadings ranging between 0.59 and 0.64. Accessible farms make it possible for the farmers to use modern agricultural technology more easily to solve the problem of the shortages of farm labor; whereas the inaccessibility of the farms and the irregularity of rains have a negative effect on both the agricultural land and technology use.

The sixth factor was described as soil characteristics and was reduced from two variables--shallow and poor soils--with a correlation loading of more than ± 0.40--indeed, between 0.68 and 0.72. In short, the terraces with poor and shallow soils, located at the margins of the productive farms, have a low productivity of barley and forest trees, their staple production. On the other hand, the terraces with deep and fertile soil profiles are largely devoted to vegetable, fruit, wheat, alfalfa, and sorghum growth.

The seventh factor was termed the geomorphology or landform and was reduced from the slope, soil, and distance variables, which were moderately correlated with one another, with loadings between 0.45 and 0.60. Implicit in this factor are the phenomena that the angle of the slope affects inversely the intensity of the land use; the depth of the soil is directly related to the angle of the slope; and finally, the intensity of the agricultural land use changes in an inverse proportion with the distance from the village as well as from the foot of the mountains upward toward their summits. What the farmers ultimately grow on their terraces is greatly influenced by these variables.

The eighth factor was reduced from two variables--an adequate water supply and the shortages of water supply--with the correlation loadings between 0.48 and 0.51. It must be added, with regard to these variables, that the production of wheat and barley in the winter season is due largely to the winter precipitation. During the summer season, vegetables and sorghum are produced only in the areas where artificial irrigation is available. In some places in the area, as much as half of the cultivable area is left fallow in the summer season because of the shortage of water.

The ninth factor, identified as the climatic hazards, was reduced from winter frosts and cold, hail and thunderstorms, and crop disease, with correlation loadings between 0.55 and 0.76. These variables are highly problematic to agriculture in general and to the Assarah region in particular.

The tenth factor reduced the family-size and the people-working-on-the-farm variables into a family characteristics factor, with the variable loadings between 0.62 and 0.68. Usually, the larger the family, the greater the number of people participating in the farmer's occupation. The opposite is equally true. And the influence of these variables is obvious. It is particularly so in the Assarah region, where most of the farm labor is provided by the members of the farmer's family in the form of sowing, harvesting, and management of the family holding. Their reward is the food and cash they produce.

The eleventh factor was named the climate characteristics and was reduced from only two variables--the climate and short farming seasons--that had a loading range between 0.40 and 0.47. The farmers grow wheat and barley in the winter, which provides the initial moderately cold climate and the warmth of the early summer, while the summer suits the production of vegetables and sorghum, within the high summer temperatures.

The twelfth factor, described as fragmentation, was reduced from the physical distribution of the farmer's terraces and the fragmentation of his holdings, bearing correlation loadings between

0.51 and 0.55. The geographical distribution of a farmer's terraces and the fragmentation of his agricultural holdings influence significantly the patterns of agricultural land use in that the farmers tend to intensify their efforts on the terraces that are located close to one another, and the ones that are fragmented and are scattered far and wide cannot be easily managed. Output on these terraces is low in comparison with the yield from the unfragmented farms in close proximity to each other.

The thirteenth factor was called the distance from the village and had only one variable with a loading of 0.63. This factor bears an inverse relationship with the intensity of agricultural land use. In other words, as the distance of the farm from the village increases, the farming on it becomes less intensive and more extensive. The larger the distant farm, the smaller the input.

The fourteenth factor reduced the variables, uses of modern agricultural machinery and traditional methods of farming, into the agricultural-mechanization factor, with the variable loadings ranging from -0.60 to -.59. In the context of labor shortages, modern agricultural technology is far preferable to the traditional methods of farming, but it requires trained personnel to operate the agricultural machines. One would expect low productivity associated with the traditional methods of farming, but this researcher's investigation shows that the agricultural production on these terraces in the past was higher when no agricultural machinery was used than now, when it is considerably in use. It seems that the present low agricultural productivity is not related, one way or another, to the use of modern agricultural technology or the abandonment of the traditional methods. But the factors listed in Tables 48, 49, and 50 are in combination responsible for the reduced agricultural land use and productivity.

The fifteenth factor was identified as farm labor and was reduced from only one variable, that is, the shortages of farm labor, with a loading of 0.53. Shortages of farm labor often result in the abandonment of many terraces every year, and the agricultural activity on these terraces comes to a complete halt, as most of the younger generation has migrated to the urban centers in search of better income alternatives. Some farmers are forced to abandon their terraces, as their children are either at school, or teaching, or engaged in other occupations, and the farmer and his wife, by themselves, cannot manage their holdings without some help from their children.

The sixteenth factor was identified as agricultural technology, reduced from only one variable--the lack of agricultural technology--with a loading of 0.48, perceived moderately negatively by the 257 farmers interviewed. Tractors, harvesting machines, water pumps, and other agricultural tools are not readily available to many farmers. In fact, the nature of the region, the lack of capital, a poor know-how of the agricultural machinery, and their poor maintenance are believed to be the real reasons why agricultural technology is not in use there.

The varimax rotated factor analysis was used to reduce the second category of eight attitudinal variables concerning the income of the farmers, based on the responses of 122 (47.5 percent) of the farmers interviewed. Two factors, following the same procedure as employed in factor analysis, were developed (see Table 49).

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farmers interviewed. Two factors, following the same procedure as

employed in factor analysis, were developed (see Table 49).

Table 49.--Factor analysis of the income variables.

Factors/Dimensions	Variables With More Than ±0.30	Variable Loading
The First Factor: Sources of income besides agriculture	-Has another job	0.89
	-Old age	0.43
	-Small size of the farm	0.32
	-Need for modern agricultural technology	0.39
The Second Factor: Income from agriculture	-Low income from agriculture	0.58
	-Abandoned terraces	0.51

The first factor in this category was labeled as the source of income besides agriculture and was reduced from the variables--sources of income other than from agriculture, alternative employment, old-age benefits, and agricultural subsidies--with their loadings between 0.32 and 0.89. While the additional income has contributed positively to the enhancement of the standard of living of the majority of the farmers, it has resulted in the farmers' abandoning their terraces, which, in turn, has lowered productivity.

The second factor was identified as the income from agriculture and was reduced from two moderately related variables--low incomes from agriculture and the abandoned terraces--within the loading range of 0.51 to 0.58. In recent years, many farmers have been complaining of low incomes from agriculture in comparison with incomes from other employment. Low incomes from agriculture have forced many a farmer to abandon his terraces altogether, while others have been forced to abandon some of the economically nonviable ones (see Table 49).

The varimax rotated factor analysis was applied to the third category of variables, concerning the migration of the farmers to the urban centers, to reduce seven variables derived from the responses of 194 (75.5 percent) of the farmers interviewed during the field survey. The technique produced three factors (Table 50).

Table 50.--Factor analysis of the migration variables.

Factors/Dimensions	Variables With More Than ± 0.30	Variable Loading
The First Factor: Health care	-Lack of medical care	0.84
The Second Factor: Economic inadequacy of farming	-Economic inadequacy of farming	0.51
	-Lack of economic opportunities in the village	0.44
	-Lack of education in the village	0.47
	-Better jobs and wages in the cities	0.35
The Third Factor: Family attraction	-Attractions of the cities	0.63
	-Family disputes and feuds	0.30

The first factor was identified as health care, reduced from only one variable--the lack of health care--with a high loading of 0.84. The lack of medical care in the villages has forced some farmers to migrate to the cities in search of better health care, resulting in the abandonment of terraces for months and sometimes even for years. Once in the cities, quite a few find it difficult to consider returning home.

The second factor, the economic inadequacy of farming, was reduced from four moderately related variables--the economic inadequacy of farming, the lack of economic and educational opportunities in the villages--with a loading range from 0.35 to 0.51. These variables have resulted in a large exodus of the farmers to the urban centers, where jobs, education, and other amenities of life are more easily available, and have brought about the abandonment of many terraces. The farmers who do not return find that the terrace walls have collapsed, the soil is washed away, and what is left of their terraces is no more than some stray trees and shrubs scattered here and there.

The third factor is called the famly attractions, reduced from two variables--the attractions of the cities and the family disputes and feuds--with the loading range between 0.30 and 0.63. Some of the migrants get so enamored with the city life that they persuade members of their families and relatives to join them in the cities, which have a promise of a better life. It must be pointed out that quite a few young farmers have left their villages for the urban centers, sick of family disputes and feuds, with the result that all this has led to the deterioration of agriculture in the Assarah region, with little hope of its reclamation because of the high cost involved.

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this has led to the deterioration of agriculture in the ... region

with little hope of its reclamation because of the high cost involved.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This study was based on a detailed analysis of agricultural land use with regard to the physical, locational, and socioeconomic factors in the Assarah region of Saudi Arabia; of the economic development with special emphasis on agriculture in Saudi Arabia in general and in the Assarah region in particular; and of past and present land use trends. The research identified the major obstacles facing modernization of the agricultural sector of the Assarah region. Furthermore, this researcher reached the following conclusions, based on the tabulation, analysis, and interpretation of the primary data, which were gained from a field survey and from secondary published and unpublished data.

1. The spatial distribution of the patterns of agricultural land use is directly influenced by such environmental factors as the angle of the slope inclination, soil and climate characteristics, distance from the village and market, the availability of water either through natural or artificial means, transportation characteristics, marketing, agricultural extension, subsidies, population density and preferences, and fragmentation of agricultural land.

2. Agriculture in the Assarah region is diminishing and is no longer considered the mainstay of the majority of the farmers. This decline is attributed to a variety of environmental factors, such as low agricultural productivity, shortages of water supplies, rural-urban migration, lack of good transportation facilities, poor agricultural extension, soil erosion, crop and plant diseases, unprotected agricultural commodity prices, and the lack of an agricultural marketing system.

3. Saudi Arabia, as a whole, suffers from a chronic shortage of water for drinking, irrigation, and domestic use. Since the Assarah region receives the greatest rainfall in Saudi Arabia, for centuries agriculture in the region was not only the main source of livelihood for the majority of inhabitants, but also the region was treated as the granary of Saudi Arabia. Recently, particularly after the 1950s, the use of land for agriculture has been continuously declining. More and more terraced farms are being abandoned each year for a variety of physical and cultural reasons.

4. Precipitation is the major source of irrigation, as well as of the underground supply of water in Assarah. But the rains are limited and mostly irregular. For this reason, agriculture in the region is precarious and production highly unpredictable. If the farmer can find an alternative source of income, he tends to neglect his farm and ultimately abandons it, with no one to restore it to production.

2. Agriculture in [illegible] longer considered the [illegible] decline is attributed to [illegible] low agricultural productivity [illegible] migration, lack of [illegible] mechanization, soil erosion [illegible] tural commodity process and [illegible] system.

3. Saudi Arabia [illegible] of water for drinking, irrigation [illegible] region receives the greatest rainfall [illegible] agriculture in the region was not only the [illegible] for the majority of inhabitants, but also the region was [illegible] granary of Saudi Arabia. Recently, particularly since the [illegible] use of land for agriculture has been continuously declining. More and more terraced farms are being abandoned each year for a variety of physical and cultural reasons.

4. Precipitation is the major source of irrigation, as well as of the underground supply of water in [illegible]. But the rains are limited and mostly irregular. For this reason, agriculture in the region is precarious and production highly unpredictable. If the farmer can find an alternative source of income, he tends to neglect his farm and ultimately abandons it, with no one to restore it to production.

5. Poor management of the farm--a direct result of the perception of its being unproductive--increases soil erosion by runoffs, winds, and animal and human agencies. This phenomenon, in turn, results in the abandonment of the marginal land, leading to moisture and vegetation depletion in general and to ecological deterioration of the irrigable prime land in particular.

6. The steep slopes and the ruggedness of the terrain have limited not only the development of level terraces where agriculture can be practiced on a large scale, but also the settlements due to spatial discontinuities.

7. Frosts, extreme cold, hailstorms, droughts, and plant disease are perceived to cause crop damage, leading to shortages of food grains.

8. The shortage of agricultural labor, partly due to the migration of the young people of the area to the cities in search of lucrative jobs, has had an inhibitive effect on the agriculture of the area.

9. The fragmentation of the agricultural land into small holdings is caused by a combination of factors, such as the topography, the ownership system, and the inhabitants' customs and traditions.

10. Poor transportation facilities and the absence of a network of roads and feeder arteries have reduced the farmers' desire to produce more because they find it difficult to transport their farm products to markets in the urban centers. The available roads are

5. Poor management of [illegible] perception of its [illegible] runoffs, winds, and [illegible] turn, results in the [illegible] moisture and vegetative [illegible] deterioration of the [illegible]

6. The steep slopes [illegible] limited not only the development [illegible] can be practiced on a large scale [illegible] spatial discontinuities.

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9. The fragmentation of the agricultural land into small holdings is caused by a combination of factors, such as the topography, the ownership system, and the inhabitants' customs and traditions.

10. Poor transportation facilities and the absence of a network of roads and feeder arteries have reduced the farmers' desire to produce more because they find it difficult to transport their farm products to markets in the urban centers. The available roads are

either unpaved, or the majority of farms cannot be reached by any roads.

11. Although agricultural extension services do operate in the area to provide new ideas, techniques, and technical know-how and encourage their implementation, the majority of the farmers have insufficient knowledge and experience to make full and effective use of the facilities provided.

12. The topography of the area makes the use of heavy agricultural machinery on the terraces in Assarah nearly impossible.

13. The economic stringency under which farming is carried out in the Assarah region has forced an almost continuous migration of able-bodied men to urban centers for better opportunities, leading to the abandonment of the ancestral terraced farmland.

14. The agricultural land in Assarah is being continuously encroached upon by houses built by farmers whose incomes come largely from nonagricultural means. Even the prime agricultural land is not being spared. This "encroachment," or what is described in the discipline's jargon as "land use conflict," is due to the lack of planning and control.

15. On some farms the use of capital, labor, fertilizers, and farm management has intensified, with the result that on these farms the yield per hectare has increased considerably.

16. Over the last two decades, there has been a shift to such cash crops as vegetables, fruits, and dairy products, in place of food grains, causing a rise in food grain prices.

17. Despite this shift to cash crops, older farmers continue to grow food grains such as wheat and sorghum, which still dominate the Assarah agricultural landscape.

18. Assarah is on the way to becoming primarily a supplier of vegetables, fruits, and dairy products and a summer resort for the urban populations because of its salubrious climate.

19. Evidence suggests that government subsidies for the improvement of livestock and agricultural production are diverted to nonagricultural or business purposes, resulting in the decline of agriculture and the ultimate abandonment of terraces. Some farmers actively seek help from the extension service to improve their farming, but the complete use of assistance is marred by their inability to use it to its maximum benefit.

Recommendations

The following recommendations are based on the findings and conclusions reached by this investigator and on the assumption that the agricultural development of Saudi Arabia is not only vital for the national economy but also for the overall health of well-integrated industrialization underway in the country:

1. Soil erosion should be stemmed by better watershed management.

2. A program to rebuild the abandoned terraces should be undertaken to conserve the soil and water for agricultural purposes.

3. Steps should be taken to make agriculture in the Assarah region an economically viable activity and competitive with other pursuits elsewhere.

4. There is a need for an efficient transportation system complete with feeder roads so that the agricultural products may be easily transported to markets in different areas of the country.

5. Immediate steps must be taken to preserve the prime agricultural land.

6. Government subsidies should be better managed and linked to farmers' genuine effort to improve agricultural profit.

7. Emphasis on cash crops should increase because they, as a whole, are economically very rewarding.

8. Light, small-scale agricultural machinery, perhaps especially designed for the terrain and suitable for the nature of the agriculture in the Assarah region, should be readily available to the farmers.

9. A well-integrated program of rural development, not only agricultural development in isolation, should be undertaken in light of the peculiar problems faced by the region in terms of the factors identified in this study. The region's need for health, education, and general economic well-being should receive equal weight and emphasis in planning for the future.

Recommendations for Further Research

This study identified the physical, locational, and socioeconomic factors that have profoundly affected the agriculture and farming in the Assarah region of Saudi Arabia, but many of the areas touched on in the study need further investigation. Among the most fruitful are the system of transportation in Assarah and its effect on the economy and the agriculture of the area, the effects of the die-hard adherence to the traditional methods of farming in the agricultural districts, the most cultivable crops in terms of the natural and man-made physical environmental factors, the role of government agencies in improving and promoting agriculture in the region, and the ways and means of stemming the deterioration of agriculture in the area.

Further, a study of the prime irrigable land, perhaps the most agriculturally productive and rewarding, can be undertaken. An investigation of the alternative sources of water supply, such as precipitation, underground reservoirs of water, and irrigation dams, and how these supplies can be augmented, should provide very useful results for planners. With the rise of and improvement in agriculture in the region, the problems of plant disease and control of pests and insects will become an important aspect of study in the area. Another rewarding area of research could be the extension services--the need for special training for extension personnel.

The construction of a highway through the region has enhanced the importance of the area as a summer resort and a recreational facility. A full-fledged study of the importance and development of the region as a summer recreational resort can be undertaken, with far-reaching effects on the overall economy and development of the Assarah highland.

The local population is, by and large, apathetic about participation in the decision-making process with regard to the development of the area. A study of how the local population's participation can be enhanced might produce results that will have a profound effect on the future of the region.

APPENDICES

APPENDIX A

THE QUESTIONNAIRE

APPENDIX A

THE QUESTIONNAIRE

Date ____________________

Name of the district __________________________

Name of the village ___________________________

Code number of the farmer _____________________

Comments ____

____

____

Physical Factors

Which of the following physical features are important in describing your irrigable terraces?

1. Slope: (1) Gentle (2) Moderate (3) Steep ___
2. Soil: (1) Deep Soil (2) Shallow Soil ___
3. Size: (1) Large (2) Medium (3) Small ___
4. Location: (1) Near the village (2) Far from village ___
5. Water Supply: (1) Sufficient (2) Insufficient ___
6. Accessibility: (1) Accessible (2) Inaccessible ___

Which of the following physical features are important in describing your dry terraces?

7. Slope: (1) Gentle (2) Moderate (3) Steep ___
8. Soil: (1) Deep Soil (2) Shallow Soil ___
9. Size: (1) Large (2) Medium (3) Small ___
10. Location: (1) Near village (2) Far from village ___
11. Water Supply: (1) Sufficient (2) Insufficient ___
12. Accessibility: (1) Accessible (2) Inaccessible ___

Which of the following physical features are important in describing your forest terraces?

13. Slope: (1) Gentle (2) Moderate (3) Steep ___
14. Soil: (1) Deep Soil (2) Shallow Soil ___
15. Size: (1) Large (2) Medium (3) Small ___
16. Location: (1) Near village (2) Far from village ___
17. Water Supply: (1) Sufficient (2) Insufficient ___
18. Accessibility: (1) Accessible (2) Inaccessible ___

19. How many times do you grow crops in your irrigable terraces annually? 1, 2, 3, 4 ___

20. How many times do you grow crops in your dry terraces? 1, 2, 3, 4 ___

21. If you grow crops in your forest terraces, how many times do you grow? 1, 2, 3, 4 ___

22. Which of the following crops do you usually grow on your irrigable terraces? ___

    (1) Vegetables (2) Fruits (3) Grains (4) Alfalfa
    (5) Multiple

23. Which of the following crops do you usually grow on your dry terraces? ___

    (1) Vegetables (2) Fruits (3) Grains (4) Alfalfa
    (5) Multiple

24. Which of the following crops do you usually grow on your forest terraces? ___

    (1) Vegetables (2) Fruits (3) Grains (4) Alfalfa
    (5) Multiple

Rate the importance of the following characteristics in terms of their importance in influencing you to grow what you grow on your terraces.

	1. Very Important	2. Important	3. Slightly Important	4. Not Important	
25. Soil	___	___	___	___	___
26. Climate	___	___	___	___	___
27. Slope	___	___	___	___	___
28. Distance	___	___	___	___	___
29. Water supply	___	___	___	___	___
30. Accessibility	___	___	___	___	___

Below are listed all the possible physical hazards to agriculture. Please rate below how much of a problem each one of them is to what you grow on your farm:

	1. No Problem	2. Slight Problem	3. Moderate Problem	4. Severe Problem	
31. Soil erosion	____	____	____	____	____
32. Shallow soil	____	____	____	____	____
33. Poor and stony soil	____	____	____	____	____
34. A poor tilth	____	____	____	____	____
35. A poor drainage	____	____	____	____	____
36. Steep slope	____	____	____	____	____
37. Inaccessible location	____	____	____	____	____
38. Rolling land	____	____	____	____	____
39. Short farming season	____	____	____	____	____
40. Winter frost and cold	____	____	____	____	____
41. Water shortage	____	____	____	____	____
42. Irregular rainfall	____	____	____	____	____
43. Shortage of organic fertilizers	____	____	____	____	____
44. Crop and plant diseases	____	____	____	____	____
45. Hail and thunderstorms	____	____	____	____	____

Locational Factors

Geographical distribution

Please indicate by putting an (X) in the appropriate blank space against each of the following statements concerning the physical distribution, the degree of agreement or disagreement with them.

	1. Strongly Agree	2. Agree	3. Disagree	4. Strongly Disagree	
46. The area around the village is dominated by fruit trees such as grape, fig, peach trees and others.	____	____	____	____	____
47. The second zone is an irrigable land which is devoted to intensive vegetable agriculture.	____	____	____	____	____
48. The third zone is an irrigable land which is dominated by intensive grain production.	____	____	____	____	____
49. The fourth zone is an area which is devoted to less-intensive grain production (dry farming).	____	____	____	____	____
50. The fifth zone is dominated by private forests trees.	____	____	____	____	____
51. The last zone is devoted to animals grazing and livestock production.	____	____	____	____	____

Distance to the market and the village

52. How far is your farm from the local market? ___

    1) less than 2 kilometers ____
    2) from 2 to 4 kilometers ____
    3) from 5 to 7 kilometers ____
    4) from 8 to 10 kilometers ____
    5) more than 10 kilometers ____

53. How far is your farm from your village? ___

    1) less than 1 kilometer ____
    2) from 1 to 2 kilometers ____
    3) from 3 to 4 kilometers ____
    4) from 5 to 6 kilometers ____
    5) more than 6 kilometers ____

What percentage of your farm acreage have you allocated for each of the following crops?

	(1) 20%	(2) 40%	(3) 60%	(4) 80%	(5) 100%	
54. vegetables	____	____	____	____	____	___
55. fruits	____	____	____	____	____	___
56. alfalfa	____	____	____	____	____	___
57. grains	____	____	____	____	____	___
58. pastures & forests	____	____	____	____	____	___

Farm characteristics

59. What is the average size of your farm? ___

    1) less than 3000 square meters ____
    2) 3001 to 6000 square meters ____
    3) 6001 to 9000 square meters ____
    4) 9000 square meters and more ____

60. How many terraces do you own? ___

    1) less than 10 terraces ____
    2) 11 to 20 terraces ____
    3) 21 to 30 terraces ____
    4) 30 terraces and more ____

61. Are all of your terraces located in one area? ___

1) all of them ____
2) some of them ____
3) only a few of them ____
4) none of them ____

Change and development of land-use

62. What part of the cultivable area on your terraces have you had under cultivation thirty years ago? ___

1) all of it
2) 2/4 of it
3) 1/2 of it
4) 1/4 of it
5) none of it

63. What part of the cultivable area on your terraces have you had under cultivation twenty years ago? ___

1) all of it
2) 3/4 of it
3) 1/2 of it
4) 1/4 of it
5) none of it

64. What part of the cultivable area on your terraces have you had under cultivation ten years ago? ___

1) all of it
2) 3/4 of it
3) 1/2 of it
4) 1/4 of it
5) none of it

65. What part of the cultivable area on your terraces do you grow now? ___

1) all of it
2) 3/4 of it
3) 1/2 of it
4) 1/4 of it
5) none of it

66. What was the main crop you grew on your farms thirty years ago? ___

1) food grains
2) vegetables
3) fruits
4) alfalfa
5) multiple

67. What was the main crop you grew on your terraces twenty years ago? ___

1) food grains
2) vegetables
3) fruits
4) alfalfa
5) multiple

68. What was the main crop you grew on your terraces or farms ten years ago? ___

1) food grains
2) vegetables
3) fruits
4) alfalfa
5) multiple

69. Which of the following crops did you grow the most during the last thirty years? ___

1) food grains
2) vegetables
3) fruits
4) alfalfa
5) food grains and vegetables

70. Which of the following crops do you grow the most now? ___

1) food grains
2) vegetables
3) fruit
4) alfalfa
5) food grains and vegetables

Socioeconomic Factors

Income characteristics

71. Do you grow enough farm produce to sell? ___

    1) yes ____
    2) no ____

72. If your answer to the above question is "yes," what is your approximate annual income in Saudi ryals? ___

    1) less than 5000 ryals ____
    2) 5001 to 10,000 ryals ____
    3) 10,001 to 15,000 ryals ____
    4) 15,001 to 20,000 ryals ____
    5) 20,000 to 25,000 ryals ____
    6) 25,000 and more ____

If your answer to question 71 is "no," what is/are the reasons? Please indicate whether each reason is very important, moderately important, slightly important, or not important to you.

	1. Not important	2. Slightly important	3. Moderately important	4. Very important	
73. I produce food only for the consumption of my family.	____	____	____	____	___
74. Market prices for agricultural produce are not encouraging.	____	____	____	____	___
75. The size of my farm is too small to produce enough for the market.	____	____	____	____	___
76. I am too old to farm without help.	____	____	____	____	___
77. Most of my terraces are abandoned and I can't bring them back under the plow.	____	____	____	____	___

	1. Not important	2. Slightly important	3. Moderately important	4. Very important	
78. Agriculture is a hard occupation and its income in comparison to incomes from other jobs is low.	____	____	____	____	___
79. I have another job, and agriculture to me is only a secondary occupation.	____	____	____	____	___
80. Profitable agriculture nowadays depends on modern technology, which I can't.	____	____	____	____	___

Emigration

81. Have you or any member of your family been residing customarily away from the village in urban centers? ___

    1) yes ____
    2) no ____

If your answer to the above question is "yes," what is/are the reasons for the change of residence? Please indicate whether each one of the following reasons is not important, slightly important, moderately important, or very important.

	1. Not important	2. Slightly important	3. Moderately important	4. Very important	
82. better jobs and wages in urban centers	____	____	____	____	___
83. lack of economic opportunities in the village	____	____	____	____	___

		1. Not important	2. Slightly important	3. Moderately important	4. Very important	
84.	lack of education in the village	____	____	____	____	____
85.	lack of medical care in the village	____	____	____	____	____
86.	economic inadequacy of farming	____	____	____	____	____
87.	family feuds and disputes	____	____	____	____	____
88.	attractions in the city	____	____	____	____	____

89. Do you have another source of income besides agriculture? ____

1) Yes ____
2) No ____

90. If your answer to the above question is "Yes," would you please indicate the sources of this additional income? ____

1) governmental subsidies for agriculture ____
2) old-age benefits (social welfare) ____
3) remittances from my children ____
4) employment ____
5) others ____

91. Since you have other sources of income besides agriculture, please indicate your approximate annual income from that source(s). ____

1) less than 5000 Saudi ryals ____
2) 5000 to 10,000 Saudi ryals ____
3) 10,001 to 15,000 Saudi ryals ____
4) 15,001 to 20,000 Saudi ryals ____
5) 20,000 and more ____

Transportation characteristics

Listed below are seven statements concerning farms. Please indicate the degree of your agreement or disagreement with each statement.

	1. Strongly agree	2. Agree	3. Disagree	4. Strongly disagree	
92. I grow cash crops on most of my farm because my farm is located near the paved road.	___	___	___	___	___
93. I grow cash crops on most of my farm because I have good transportation facilities to transport my farm produce to the market.	___	___	___	___	___
94. I grow cash crops on most of my farm because the transportation cost is low.	___	___	___	___	___
95. I do not grow cash crops on my farm because I do not own transportation facilities.	___	___	___	___	___
96. Transportation cost is very high, which discourages me to grow cash crops.	___	___	___	___	___
97. Agricultural and feeder roads are very poor, which discourage the cultivation of cash crops on my farm.	___	___	___	___	___
98. I grow cash crops on my farm because it does not cost my anything to transport them to the local or regional markets; the new highway runs near my farm, and I sell the produce to the people on the road.	___	___	___	___	___

Modern agricultural technology

99. Would you like to use modern mechanized farming methods on your terraces or farms? ___

    1) Yes ____
    2) No ____

100. Please indicate which of the following statements represents your situation concerning the use of agricultural machinery: ___

    1) I want to use modern agricultural machinery, but I do not know how to ____
    2) I want to, but I cannot afford it ____
    3) I want to, but there are no trained operators available here ____
    4) I do not want to, as I prefer traditional methods of farming ____
    5) I do not want to, as my farms (terraces) are too small for mechanization ____
    6) I do use mechanized farming ____
    7) Most of the above reasons ____

Farm input-output relationship

101. Are your inputs of farm labor, fertilizers, irrigation and your personal time compensated for by the output of your farm? ___

    1) Yes ____
    2) No ____

102. If your answer to the above question is "Yes," please indicate your approximate net returns per year. ___

    1) less than 5000 Saudi ryals ____
    2) between 5001 and 10,000 Saudi ryals ____
    3) between 10,001 and 15,000 Saudi ryals ____
    4) between 15,001 and 20,000 Saudi ryals ____
    5) above 20,000 Saudi ryals ____

Imported food

103. Is it cheaper for you to buy food for your consumption from the market than to produce it on your terraces or farms? ___

1) Yes ____
2) No ____

104. If your answer is "yes," please indicate the reason why it is cheaper to buy food from the markets. ___

1) because of government subsidies for imported food ____
2) because of the shortages of farm labor ____
3) because farm labor is very expensive ____
4) because the transportation cost is very high ____
5) because imported grains are better than locally produced grains ____
6) most of the above reasons ____

Fragmentation

105. Do you think that agricultural productivity of your terraces has fallen during your lifetime? ___

1) Yes ____
2) No ____

If your answer to the above question is "Yes," please indicate how important is each of the following factors in contributing to the decline of agricultural productivity on your farm.

	1. Not important	2. Slightly important	3. Moderately important	4. Very important	
106. Fragmentation of agricultural land	____	____	____	____	___
107. Poor agricultural extension services	____	____	____	____	___
108. Lack of modern agricultural technology	____	____	____	____	___

	1. Not important	2. Slightly important	3. Moderately important	4. Very important	
109. Shortages of farm labor	____	____	____	____	___
110. Shortages of organic fertilizers	____	____	____	____	___
111. Scarcity of water supply for agriculture	____	____	____	____	___
112. High energy prices	____	____	____	____	___

Governmental assistance

113. Do you receive any assistance from the department of agriculture in your district to help increase your production? ___

    1) Yes ____
    2) No ____

114. If "Yes," what kind of assistance do you receive? ___

    1) agricultural equipment and machinery ____
    2) interest-free loan ____
    3) subsidized farm inputs ____
    4) cash subsidies ____
    5) other assistance ____

Farm animals

115. Do you raise animals on your farm? ___

    1) Yes ____
    2) No ____

116. If "Yes," what animals do you raise? ___

    1) sheep ____
    2) goats ____
    3) cattle ____
    4) other animals ____

117. Why do you raise livestock on your farm? ___

1) for domestic use ____
2) for commercial use ____
3) for farm management ____
4) all purposes ____

118. Where do you graze your animals? ___

1) on my farm ____
2) outside the farm ____
3) others ____

119. Do you have sufficient veterinary care for your livestock? ___

1) Yes ____
2) No ____

Farm labor characteristics

120. How many members are there in your family? ___

1) less than 3 ___
2) 4-6 ___
3) more than 6 ___

121. How many people work on your farm? ___

1) less than 3 ___
2) 4-6 ___
3) more than 6 ___

122. Are they all members of your family? ___

1) Yes ___
2) No ___

123. If your answer to the above question is "No," how many hired are normally used to work your farm(s)? ___

1, 2, 3, 4, 5

124. When do you usually hire farm labor? ___

1) during the harvesting season ___
2) during the sowing season ___
3) during sowing and harvesting ___
4) all year around ___
5) only when it is needed ___

125. What is the average wage you usually pay to a hired worker on your farm per day in Saudi ryals? ___

1) less than 40 ryals ____
2) from 40 to 60 ryals ____
3) from 61 to 80 ryals ____
4) more than 80 ryals

Social characteristics of the owner

126. Are you the head of the family? ___

1) Yes ___
2) No ___

127. How long have you been living in this village? ___

1) less than 5 years ___
2) 5 to 10 years ___
3) 11 to 15 years ___
4) over 15 years ___

128. What is your educational level? ___

1) I can neither read nor write ___
2) I can only read ___
3) I can read and write ___
4) I have completed primary school ___
5) I have completed high school ___
6) I have completed some college ___

129. How old are you? ___

1) less than 20 years old ____
2) between 21 and 40 years old ____
3) between 41 and 60 years old ____
4) more than 60 years old ____

130. Do you encourage your children to become farmers? ___

1) Yes ____
2) No ____

131. In your opinion, what are the major difficulties facing agricultural development in your area in particular and in the Assarah region in general?

1) ______________________________

2) ______________________________

3) ______________________________

4) ______________________________

5) ______________________________

6) ______________________________

132. In your opinion, how can the major agricultural difficulties in particular and in Assarah in general be overcome?

1) ______________________________

2) ______________________________

3) ______________________________

4) ______________________________

5) ______________________________

6) ______________________________

133. Do you have any comments to offer on your answers?

1) ______________________________

2) ______________________________

3) ______________________________

4) ______________________________

5) ______________________________

6) ______________________________

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