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AN EVALUATION OF THE CURRENT NATIONAL
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AN INFORMATION SYSTEM APPROACH

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AN EVALUATION OF THE CURRENT NATIONAL AGRICULTURAL
DATA BASE IN SAUDI ARABIA: AN INFORMATION
SYSTEM APPROACH

By

Khalid A. Al-hamoudi

A DISSERTATION

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ABSTRACT

AN EVALUATION OF THE CURRENT NATIONAL AGRICULTURAL DATA BASE IN SAUDI ARABIA: AN INFORMATION SYSTEM APPROACH

By

Khalid A. Al-hamoudi

The principal objectives of this study were to describe the agricultural sector of Saudi Arabia, present an agricultural information systems paradigm, evaluate the agricultural information system of Saudi Arabia and discuss the analytical framework as a subsystem of the agricultural information system. The information system paradigm is composed of three subsystems--data, inquiry, and decision making. The Saudi Arabian agricultural information system is yet in its infancy and is plagued by several problems, including lack of experience, ambiguous objectives of data suppliers, and inadequate institutional arrangements. It can best be described as a data base or repository of all agricultural data.

The data system suffers from several problems at the conceptual and operational stages. Changing socio-economic conditions and agenda of policy makers have left certain data concepts obsolete. Some concepts are not properly defined. As a result, the concepts measured don't adequately reflect the reality it purports to measure. Lack of communication between data suppliers on the one hand and between data



users and suppliers on the other hand led to a duplication of efforts and a waste of resources. Agricultural and resource economists have analytical tools like linear programming, forecasting models, and benefit-cost analysis that assist them in transforming data into information. Such tools can be used to develop the inquiry subsystem, which was found to be the least developed.

Decision makers in Saudi Arabia include both the private and public sectors. The agricultural information system, however, is designed to serve the public sector better than the private sector. In some cases, documents of information are not communicated to the decision makers.

The study recommends that a planning and coordinating committee be established with the main objectives of ensuring the policy relevance, quality, and integrity of all the data and information produced by all data suppliers; developing plans to meet current and future data needs in the face of a changing society, maintaining a proper balance between protecting individual rights to privacy and confidentiality and meeting information needs of decision makers through legislation; and of coordinating all data supplies on the one hand and data suppliers and users on the other. The study also recommends the establishment of a close link between all Agricultural Colleges and the Department of Economic Studies and Statistics (ESS), and a redefinition of ESS objectives.



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

In the name of Allah the most merciful and the most beneficent

DEDICATED

TO

My father Abdulrahman Fahd Al-hamoudi

and my mother Sarah Abdulaziz Al-Yusuf

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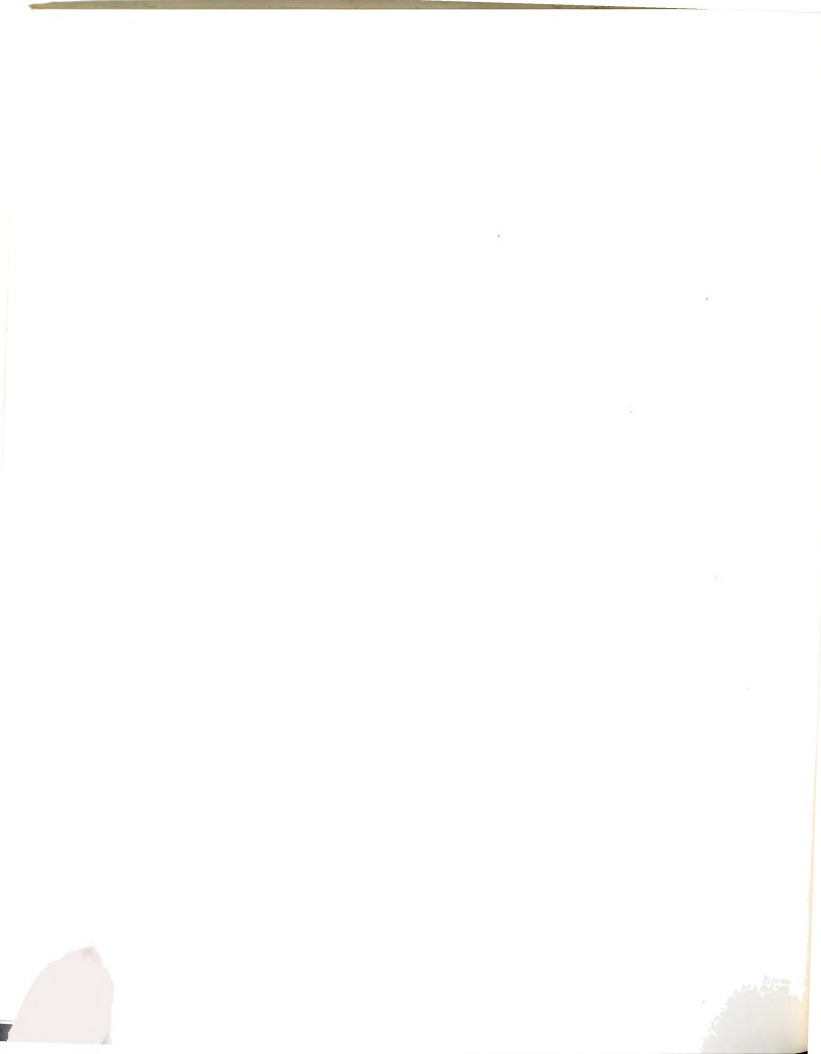
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CHAPTER I

INTRODUCTION

The dependence of a country on one source of income for its livelihood, especially on an exhaustible source, is an extremely risky phenomenon. Oil production and oil-related industries are currently the major contributors to the growth of the Gross Domestic Product (GDP) in Saudi Arabia. Given the exhaustible nature of petroleum, a gloomy future is predicted for the Saudi economy in the post-oil era. Therefore, the Saudi government wants to diversify its sources of income and to reduce its dependence on the production of crude oil. This diversification represents one of the underlying principles of the long-term development goals for Saudi Arabia.

Fortunately, other natural resources are plentiful. Agricultural lands, grazing lands, fisheries, and mineral resources exist in abundance. The agricultural sector was the mainstay of the economy before the discovery of oil, and it still is the largest employment sector in the country. Approximately 40 percent of the total land in Saudi Arabia is classified as grazing land for livestock. The coastline is about 1,760 kilometers along the Red Sea, and about 560 kilometers along the Arabian Gulf, providing access to a valuable fisheries resource.



This abundant resource has yet to be exploited. While the total annual tonnage of fish caught in 1977 in both the Red Sea and the Gulf was approximately 19,000, the potential fish yield of Saudi Arabia is estimated to be between 300,000 and 500,000 tons annually (Saudi Arabia, 1979). Saudi Arabia also has large deposits of various mineral resources which remain essentially unexploited.

So a brighter picture and a pleasant future are definitely possible if they are planned for in advance. Devising a sound plan for the development and management of natural resources is a real challenge for Saudi policymakers.

Incorrect decisions are always costly, especially when they involve natural resources, since irreversible processes and side effects may occur. Decisions, however, are only as good as the information upon which they are based. Therefore, accurate and reliable information should be available to reduce the risk and uncertainty for decision makers. The shortage of both quality and quantity of data concerning natural resources in Saudi Arabia forms a major decision-making and management problem.

Decisions are also affected by the type of model used to represent the real system. The greater the discrepancy between the output of the model and the real world system, the less useful the model for describing the behavior of the real system (Moskowitz and Wright, 1979).

These factors which influence the decision-making process in natural resources, are used as the basis for drawing up the objectives of this study.



Problem Statement

Agriculture is the most significant of Saudi Arabia's promising renewable natural resources. The prominent role played by agriculture in Saudi Arabia's past may well be repeated in the future, as agriculture rapidly expands to meet the increasing domestic demand for agricultural products.

Before the discovery of oil in 1938, the Saudi landscape was predominantly rural, containing vast stretches of pastureland spotted with grazing livestock and small family farms. The country's economy was dependent upon agriculture and related activities. The agricultural sector, including livestock management, was the major source of both income and employment for the majority of the population. Farm life before the oil era was simple, and agriculture was at a very primitive stage, similar to other traditional agricultural societies. Agricultural productivity was low, and each farm was a self-sustaining unit, producing the various agricultural products necessary to support the family. The entire country was also self-sufficient in food production.

After the discovery of oil, the relative importance of agriculture began to gradually decline. This decline can be measured by its current low contribution to the Gross Domestic Product--approximately 1 percent. Yet agriculture remains the largest employment sector, providing employment for more than 25 percent of the total labor force.

The slow rate of growth in agricultural production has occurred simultaneously with a fast rate of growth in demand for



agricultural products. High population growth rates (estimated at 3 percent per year), increased per capita income, an accelerated rate of urbanization, and the employment of foreign labor in large numbers have all significantly increased the country's demand for food. As a result of this low-productivity, high-demand situation, Saudi Arabia imports approximately half of its yearly food requirements.

Between 1979 and 1981, agricultural imports doubled from 10.5 to 21 billion Saudi Riyals¹ (SR), making Saudi Arabia OPEC's² leading importer of agricultural commodities. Since the late 1970's, Saudi Arabia has been one of the world's three leading importers of poultry, barley, soft drinks, and fruit juices (Parker, 1982).

These imports have been made possible by the country's huge revenues from oil production. Since oil is a depletable resource, the "boom" years will eventually end. Saudi Arabia will then be faced with a substantially increased population and, unless early measures are taken, an agricultural sector which has not kept pace with the needs of the country. In a world with at least one billion people presently regarded as undernourished and a rapidly increasing world population, it may not be wise for Saudi Arabia to depend permanently upon other countries for half of its food needs.

For this reason, Saudi Arabia is committed to developing its agriculture to the point of self-sufficiency. In the third of Saudi's five-year plans, 1980-85, SR 72 billion has been devoted to

¹\$1.00 = 3.5 Saudi Riyals in January 1984.

²Organization of Petroleum Exporting Countries.



the development of agriculture and water resources for irrigation and drinking. The Saudi government has invested in building the basic infrastructure for agriculture, financing studies on soil characteristics and underground water resources, and on extension services for farmers. The government also offers interest-free loans and subsidies through the Agricultural Bank and the Saudi Industrial Development Fund (Saudi Arabia, 1981). Agricultural interest-free loans are projected to be SR 5 billion and subsidies of SR 2.5 billion during the third plan.

These incentives have caused the private sector to make unprecedented investments in agricultural production. The Minister of Agriculture recently reported that one Saudi businessman alone has recently invested SR 600 million in agriculture (Al-Sheik, 1983). Investments such as these from the private sector have resulted in the tripling and quadrupling of production in recent years. Wheat production has increased more than 600 percent between 1975 and 1983, from 93,000 to 600,000 tons. Broiler chicken production increased from 14 million in 1975 to 119 million birds in 1983, and egg production increased from 204 to 1,748 million eggs over the same period, meeting 43 percent, and 98 percent, of the country's broiler and egg consumption, respectively. On 28 operating milk farms, 82,259 tons of milk were produced in 1983, more than 800 percent increase over 1970 production of 9,233 tons. In addition, traditional farmers produced an estimated 227,837 tons of milk in 1983 for home consumption. Thus, the total milk produced in the country was 320,096 tons, accounting



for 85 percent of total liquid milk consumption in 1983 (Saudi Arabia, 1981; Saudi Arabia, N.D.a)

These increases in agricultural production, commercialization, and specialization are associated with an increase in the demand for agricultural information. Bonnen (1976) states that "Without an adequate information system, the potential gains in productivity from specialization and new technologies are lost in inadequate coordination and management of the developing industry or economy." Saudi Arabia's needs for information were more limited in scope and complexity when its agricultural sector was primarily traditional than is the case at present. Now that it has begun to industrialize and commercialize its markets and to fragment its production processes into highly specialized subsets requiring extensive coordination, the need for accurate and timely information has become imperative.

In specialized, concentrated industries, an investment in information has a sufficiently high return to justify the expense by private sector users. In very competitive, unconcentrated industries such as agriculture, where the information will be widely disseminated, however, a public investment is usually necessary to ensure these returns. With agriculture fragmented into so many relatively small operations, information collection and analysis cannot be left to the private sector, since the value of this information to any small subset of users may very well outweigh its cost. Publicly collected data for private agricultural management decision making have been a major factor in the increased productivity of U.S. agriculture over the past



century. For this reason, most governments collect far more detailed data on highly competitive industries such as agriculture than on highly concentrated industries such as steel (Bonnen, 1977). The association between economic statistics and economic development in United Nations countries is marked; statistical data are unavailable more frequently in developing than in developed countries (Olivera, 1976).

Quantity of data alone, however, is not a guarantee of good decision making. Bad quality data can affect decision making even more adversely than the absence of data. As American humorist Will Rogers said, "The trouble isn't what people don't know; it is what they do know that isn't so" (in Boulding, 1966). The diplomat Talleyrand said, "Man was given the power of speech in order that he might hide his thoughts" (in Gardner, 1975). Unfortunately, statistics which are intended to be revealing may actually hide the facts. This is why an appropriately-designed information system is an important part of a long-term investment in statistics. Intelligent selection from the infinite potential data around us will minimize the possibility of our information concealing, rather than revealing facts.

The lack of both quality and quantity of data creates a serious problem in Saudi Arabia's development effort. This has been recognized by both government officials and individual researchers. According to the third plan, "The data base for agriculture remains inadequate, and all estimates must be taken as indicative rather than firm." The improvement of the agricultural data base was explicitly stated in the third plan as a policy measure to achieve the national goals for agriculture.



Private researchers have repeatedly encountered the problem of inadequate data in their studies. Al-Bashir (1977), when building an econometric model of the Saudi Arabian economy from 1960 to 1970, was faced with shortages of both quantity and quality of data concerning the economy in general, and the agricultural sector in particular. He described the agricultural sector's estimate as the most unsatisfactory finding in his model.

In 1979 when presenting the per capita availability of food in Saudi Arabia for the period 1973 to 1975, Quotah questioned the reliability of the figures, indicating that they underestimate the availability of food per capita in Saudi Arabia. He attributed this to several possible sources of error, including faulty data on production in Saudi Arabia, inflated population figures, and incomplete records on imported foods.

The author of this dissertation chose the information system as a focus because of his own frustration in attempting to obtain data for a previous topic. An earlier proposal was prepared for a farm management study to investigate resource allocation under different technologies and alternative government policies for Saudi Arabia. It was assumed that data could be collected by conducting one survey of farmers, and supplementing the survey with secondary data. However, the shortages of data meant that the author would have had to use the cost-route method, meeting with a large sample of farmers twice a week for a year. The high cost of data collection by this method in terms of both time and resources resulted in the



author abandoning the project and concentrating on the problem of a workable information system for Saudi Arabia.

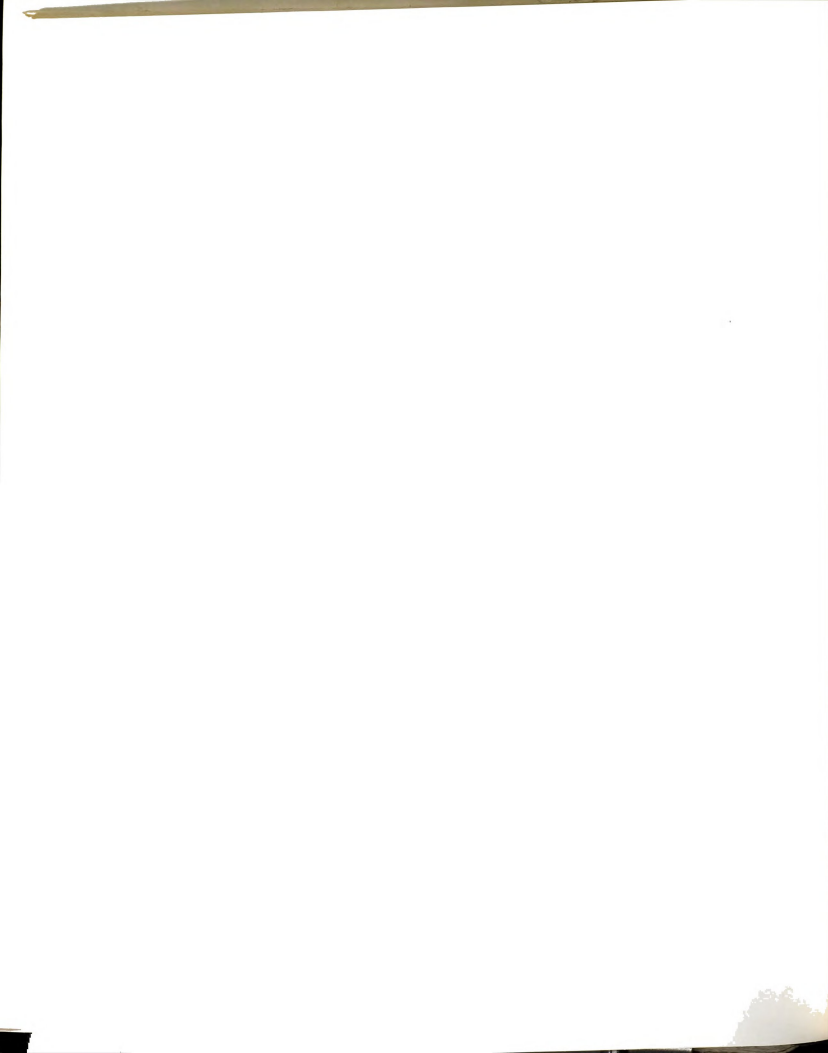
Societal problems, especially those in agricultural and rural societies, have been identified as fundamentally problems of information processing. Therefore, information processing problems, which usually involve the design of the information system, must be solved in order to address societal problems (Dunn, 1974; Bonnen, 1975).

Objectives of the Study

As the previous section has stressed, agricultural information plays a vital role in the development of the agricultural sector. Relevant, reliable, and timely information is a prerequisite for sound decision making. The shortage of this kind of information, resulting from the absence of a complete and comprehensive agricultural information system, forms a major obstacle to the development of the agricultural sector. This study has one major goal: to develop and implement a method for designing and evaluating information systems for the agricultural sector in Saudi Arabia.

Several objectives related to this major goal are:

1. to describe the agricultural sector in Saudi Arabia, its potential and its limitations
2. to present an agricultural information system paradigm as an idealized model to be used as a frame of reference in evaluating or designing any agricultural information system



3. to use this paradigm in evaluating the existing data base in Saudi Arabia
4. to discuss the analytical framework as a subsystem of the agricultural information system, and
5. to delineate some of the agricultural data needed for certain specific problems and decisions in Saudi Arabia

Outline of the Study

An introductory discussion of the problem and the study objectives have been presented in this chapter. Chapter II will provide additional background information on Saudi Arabia. Emphasis in this chapter will be on agricultural and natural resources.

Chapter III develops the conceptual framework underlying this study. Included are the development of an agricultural information system paradigm and a brief discussion of the economics of information.

Chapter IV is devoted to discussing and evaluating the existing agricultural data base in Saudi Arabia. The agricultural information system developed in Chapter III will be used as a frame of reference in the evaluation process.

The inquiry system as a major component of the information system will be presented in Chapter V. A presentation of some of the standard agricultural economics analytical tools and techniques will facilitate the discussion.

Finally, a summary and conclusion of this study will be given in Chapter VI.



CHAPTER II

HUMAN, AGRICULTURAL, AND NATURAL RESOURCES IN SAUDI ARABIA

Introduction

The main objective of this chapter is to describe the human, agricultural, and natural resources of Saudi Arabia. Saudi Arabia is a relatively sparsely populated country with most of its people living in rural areas. The fast rate of development has left the country with an acute shortage of skilled manpower and an increasing rate of rural to urban migration. Tremendous progress is being made in the direction of improving the skills of the local population--through training, education, and health care. Strict adherence to the Islamic faith and values is the cornerstone of all developments in Saudi Arabia.

The resources that are available for the development of the agricultural sector will be described in some detail. The potentials of all the sectors of agriculture will also be described. Finally a description of the oil and natural gas and mineral deposits both for the present and future will be presented.

Location and Climate

The Kingdom of Saudi Arabia is approximately the size of the United States east of the Mississippi River. It is located on the



Arabian Peninsula between the Red Sea and the Arabian Gulf. Saudi Arabia occupies about four-fifths of the peninsula, with a total area of about 2,150,000 square kilometers. It shares its borders with eight neighbors--Jordan and Iraq to the north; Kuwait to the northeast at the Arabian Gulf; Qatar, the United Arab Emirates, and Oman on the east and southeast; and Yemen and the Republic of South Yemen on the south. Saudi Arabia's western border is the Red Sea.

Nearly all of this land is desert. Sand forms the great deserts of the Nafud, the Dahna, and the Rub al Khali (Empty Quarter). Although the percentage of suitable agricultural land is small, the large size of the country coupled with a low population density means that there is enough land to support the country's food requirement. At present less than 30 percent of what is classified as suitable agricultural land is under cultivation. As may be expected in a desert area, Saudi Arabia's climate is one of abrupt contrasts. The smouldering heat of Arabian days is softened by the long, heavy cool of Arabian nights. Although the daytime temperatures in some regions can peak at 120°F in summer, nighttime temperatures for the same region and season can drop to 70°F.

Saudi Arabia's average temperature is 95°F in summer and 77°F in winter, yet temperature varies widely from region to region. In coastal regions along the Red Sea and the Arabian Gulf, the desert temperature is moderated by the proximity of large bodies of water. Here temperatures seldom go above 97°F, but the relative humidity is usually more than 85 percent and frequently 100 percent for extended



periods, producing a hot mist during the day and a warm fog at night. Because the prevailing winds are from the north, these coastal areas are more bearable in the summer and even pleasant in the winter. The average summer temperature throughout the central part of the country is 110°F. The heat becomes intense shortly after sunrise and lasts until sunset, when the cool nights begin. Although the winter temperature seldom drops below 32°F in this region, lack of humidity and high wind-chill factors make a bitterly cold climate. Spring and autumn temperatures average 86°F (Nyrop et al., 1977).

The temperature contrasts of Saudi Arabia in 1980 included a high of 120°F in July near Dhahran (in the eastern part of the country) and a low of 22°F in January at Ha'll (in the northern region). In Khamis Mushait in the southwest during the same year, the temperature ranged from 94°F in July to 27°F in December.

Annual rainfall averages less than 100 mm, but this also varies from region to region. The northwest averages from 30 mm to 50 mm, and the northeast 40 mm to 90 mm, while the Riyadh region has an annual average of 85 mm to 110 mm. Rainfall in the Hijaz Mountains and Asir regions in the west and southwest exceeds 300 mm in the mountains and averages 250 mm along the Red Sea coast south of Jeddah (El Khatib, 1974).

Human Resources

Saudi Arabia's human resources are an indispensable factor in converting its other resources to the nation's use and benefit. In order to discover and exploit Saudi Arabia's extensive natural



resources, mobilize its capital, develop the necessary technology, and produce goods and services, adequate human resources must be developed. This means not only adequate in terms of numbers, but especially in terms of health and skills.

According to the 1974 national population census, the total population of Saudi Arabia was 7,012,642, with an average family size of six. Nearly 27 percent of the population are considered nomads. Approximately 38 percent live in cities of more than 30,000 inhabitants. An annual population growth rate of 3 percent is projected for the second and third national plan periods of 1975-1985, despite a high mortality rate.

Saudi Arabia may be considered under populated, both in relation to the country size and to the required labor for the implementation of the national development plans. Population density per square kilometer in 1975 was 3.26, which may be considered low if compared to mainland China, which has 874 people per square kilometer, or may be considered high if compared to Australia, with only 1.8 people per square kilometer.

The national development plans indicate a deficit of skilled labor ranging between 600 thousand to one million, which is presently being met by foreign labor. A top priority, therefore, is converting the nation's existing unskilled population to skilled labor by decreasing the high illiteracy rate. Saudi Arabia's national plans have strongly stressed national investment in human resources, including heavy investments in education and health services.

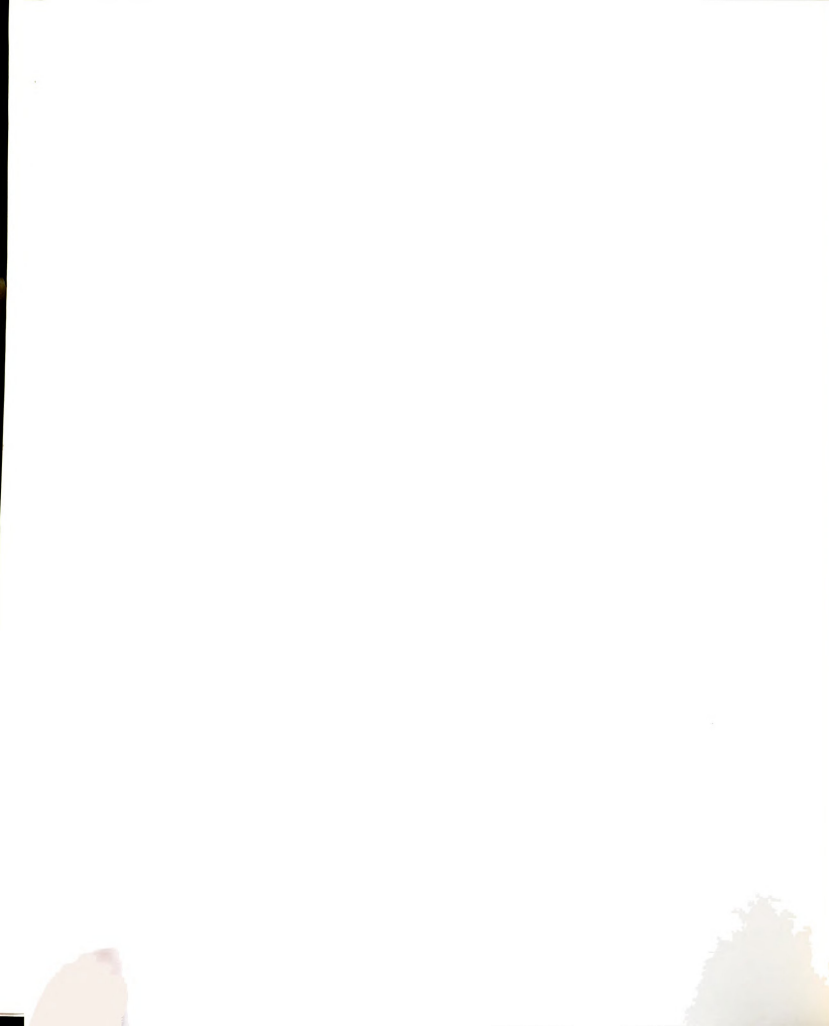


The three major types of education in Saudi Arabia are general education, higher education, and special training programs. General education is the responsibility of two agencies--the Ministry of Education, which administers elementary and secondary schools for boys, and the Presidency for Girls' Education, which manages elementary and secondary schools for girls.

Higher education is the responsibility of the Ministry of Higher Education and the General Secretariat for Girls' Colleges, but is also shared by seven universities. Vocational training falls under the Directorate General of Vocational Training within the Ministry of Labor and Social Affairs. Government training is achieved through the Institute of Public Administration and various Ministries and agencies which provide their own staff training.

During the ten-year period covered by the first and second national plans, 1970 to 1980, total government expenditures for education increased from SR 655 million for the year 1970-71 to SR 17,396 million in 1980. The increase was 2,615.9 percent which means an annual compound increment of 38.6 percent. The number of schools and colleges increased at an annual rate of 14.5 percent, from 3 thousand in 1970 to 11 thousand in 1980. During this period the average annual rate of growth for the number of teachers (male and female) was 14 percent, from 23 thousand in 1970 to 78 thousand in 1980.¹

¹Most of the figures on Education and Health were obtained from Saudi Arabia, Ministry of Planning, Accomplishments of the First and Second Development Plans, 1970-1980 (in Arabic) (No Dates B)



The total number of students educated also showed tremendous growth. In the general and higher education, the number of male and female students increased at an average annual growth rate of 10.5 percent from 545 thousand in 1970 to 1.5 million in 1980. At the elementary level, the rate was 8.1 percent when it increased from 400 thousand students to 862 thousand for the same period, and 16 percent at the secondary level, where the numbers jumped from 77 thousand to 338 thousand students.

Higher education has shown an even greater annual growth rate--24 percent--when it increased from 7 thousand to 48 thousand students during this period. The student/teacher ratio at the general level improved, from one teacher for every 23.5 students to one teacher for every 18.5 students.

National contributions to education have also included student salaries for lower income elementary and secondary students. Higher education students receive tuition, housing, and salaries for other expenses. Both education and health care in Saudi Arabia are free.

A second important factor in the development of Saudi Arabia's human resources is the improvement of health care facilities and services. During the years 1970 to 1980, the total budget for the Ministry of Health, including the Red Crescent Society, increased from S.R. 182.6 million to S.R. 4,236,34 million, showing a total increase of 2,320 percent or an annual compound growth rate of 36.9 percent.

During the same period the total number of beds in the Ministry of Health administered hospitals increased from 7,165 to 11,968, or



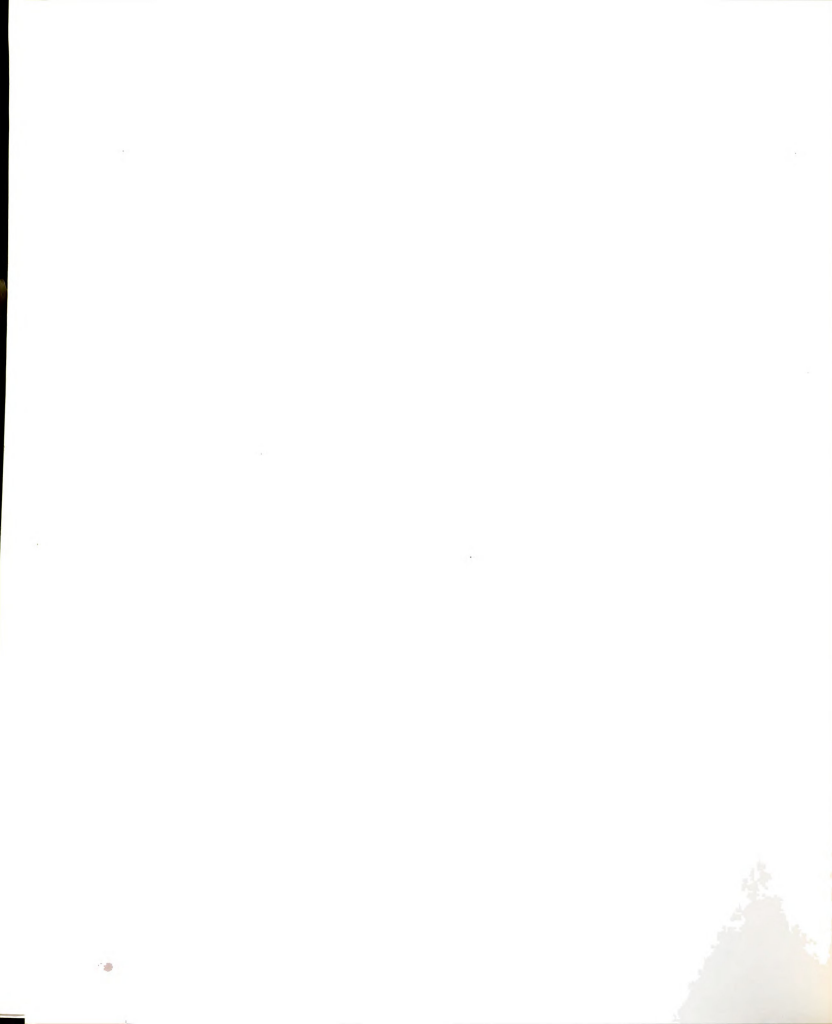
by 4.6 percent annually. The number of doctors in the Ministry of Health hospitals increased by 18.6 percent a year, beginning with 800 doctors in 1970 and reaching 3,800 by 1980. Similar growth patterns have occurred in the numbers of hospitals and doctors under the authority of other government agencies, the military, universities, and private hospitals.

There is little doubt that the above figures show a significantly high rate of growth in the provision of services designed to improve the human resources. What these figures don't show, however, is the ratio of the services provided to the population. This ratio could show a better picture of the extent to which these services could benefit a given target population and comparisons could be made from period to period. For example, the number of students in elementary school to the total number of children of elementary school-going-age in 1970 could be compared to that of 1980. At the present time, lack of data makes such comparisons impossible.

Islamic Law and Agriculture in Saudi Arabia

The overall development of Saudi Arabia is strictly guided by the principles of the Islamic faith. This is emphasized in the third national development plan where it states that

The distinguishing mark of the Saudi approach to development is that its material and social objectives are derived from the ethical principles of Islam and the cultural values of Saudi society. These principles and values are reflected in: the dedication of the government to upholding Islam and to maintaining its associated cultural values; . . . to maintain the religious values of Islam, by applying, propagating and fostering God's Sharia; . . . (p. 3).



A basic understanding of these principles, therefore, is critical to an understanding of the Saudi Arabian agricultural policies.

Sharia or Islamic law is the basis of the legal system in Saudi Arabia. The main sources of sharia are the Quran and the Sunnah. The Quran contains the exact words of God, while the Sunnah encompasses the Prophet, Mohammad's (peace be upon him) deeds, sayings, and approvals. Other sources of the sharia include, the Ijma, which is the consensus of jurists and competent thinkers of an age; the Qiyas, which refers to the systematic inference from texts for new issues which are not covered by the text; and the Istihson, which defines the law in accordance with what is good or expedient. Traditional practice and customs which do not conflict with the sharia may be considered as part of the law. These other sources are placed on a different footing due to the role played by the human mind and the imprint of the changing times (Siddiqui, 1982).

Government policies must be within the framework of Islamic principles. There are two Islamic principles which directly affect agriculture--property rights and zakat. According to the Quran, man is the kalifa, that is, the trustee of God on earth. The sixth chapter and twelfth verse of the Quran states, "Say: unto whom belongeth whatsoever is in the heavens and the earth? Say: unto Allah." Everything in the heavens and on earth is owned by God and man is simply a custodian as indicated in the second chapter and thirteenth verse of the Quran. "The Lord said unto the angels, I am about to place a viceroy in the earth." By virtue of being a trustee



of God on earth, man has no absolute control or claim over the earth, therefore in Islam there is nothing like absolute property rights. Man is obligated to use and rule the earth in accordance with the principles and laws of God.

The right to ownership is sacred in Islam. There is no limit on how much a person can own provided that such ownership is obtained without infringing upon the laws of Islam. Zakat, taxes² on property owned must be paid. Islam encourages the development of land and it gives the right to Muslims to develop and own barren land. An Islamic government is empowered to distribute and reallocate barren land. If a person fails to develop land assigned to him or her within a period of three years, claim to that land by that person is forfeited. This three years period was determined by the Prophet Mohammad (peace be upon him). Land is allocated to an individual to be developed by him or her for the benefit of the whole society and is not meant to be owned by an individual in perpetuity. By 1980, about 988,500 donums³ had been distributed to about 14,554 recipients under the scheme for distributing barren land and in accordance with Islamic principles in Saudi Arabia.

Zakat is a compulsory duty to be paid by Muslims according to their wealth. It represents one of the five basic pillars of Islam.

²Tax as used in this study differs from the meaning it carries in the Western world, where it is levied for the main purpose of meeting the cost of government. In Muslim societies, it is a measure designed to transfer part of the wealth from the haves to the have-nots.

³A donum is equal to one-tenth of a hectare or 1000 square meters.

It is the duty of the Islamic government to enforce the payment of zakat by the Muslim society, even if it means waging a "holy war" against defaulters or opponents of zakat. To refuse to pay zakat is to deny the right of the entire society to enjoy part of the national wealth which in the final analysis is nobody's individual property but God. Zakat is not charity for the poor, but it is the right of the poor to a fair share of the riches of the wealthy.

Zakat can be paid for almost every kind of wealth and this includes cash and bullion, business inventory, minerals, animals, and agricultural products. Property which lacks productive capacity or forms part of the basic necessities of life is exempt from taxation. This includes such things as homes, transport animals, food used for family consumption, and similar items (Shik, 1977). Central to the discussion of zakat is the concept of nisap. Zakat becomes obligatory only when one possesses a nisap. Strictly speaking, a nisap is the minimum taxable volume of a property in the possession of an individual for a continuous period of one year. For example, the nisap of sheep, camels, and cattle is 40, 5, and 30, respectively, and that of wheat is 1,600 Iraqi pounds.

The rate of zakat differs by type and amount of property; and the amount of capital and labor that has gone into its creation. The rate of zakat on cereal crops is between one-tenth and one-twentieth of the total produce, if total production is a nisap or more, the actual rate depending on the method of irrigation employed. If the cereal is grown under rainfed conditions, the zakat is one-tenth



of the total output. If the cereal is grown under an irrigated method that involves pumping water, the zakat is only one-twentieth of the total output. The laws governing the use of water are described in Caponera (1978).

The Agricultural Sector

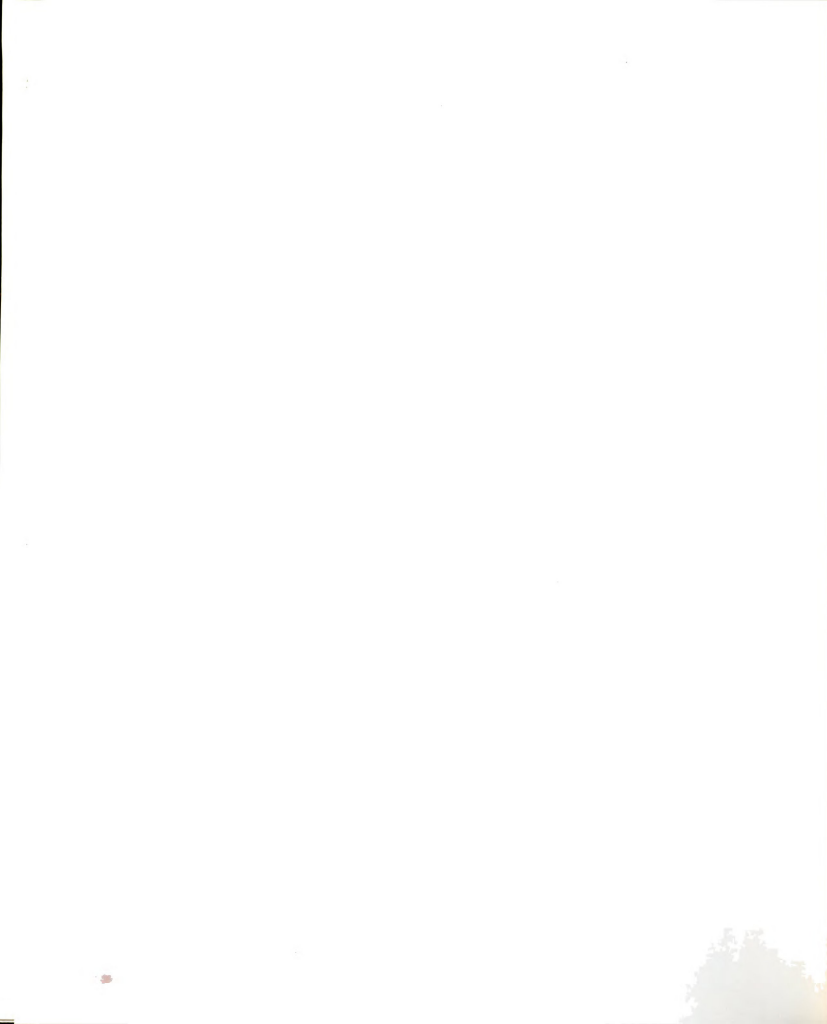
The Saudi Arabian agricultural sector includes settled agriculture as well as range, forestry, fishery, and water resources. The present Ministry of Agriculture and Water (MOAW) evolved from the General Directorate for Agriculture in 1953. The General Directorate of Agriculture was established in 1948 under the Ministry of Finance and National Economy.

The MOAW is currently entrusted with the responsibility of planning and implementing all agricultural development programs. It also has power to enforce regulations that apply to the use and conservation of the scarce water resources for agricultural development. Other government agencies also have direct or indirect responsibilities in the development of the agricultural sector.

Agricultural Policy

The main objectives for the development of agriculture in Saudi Arabia as stated in the third national plan are to:

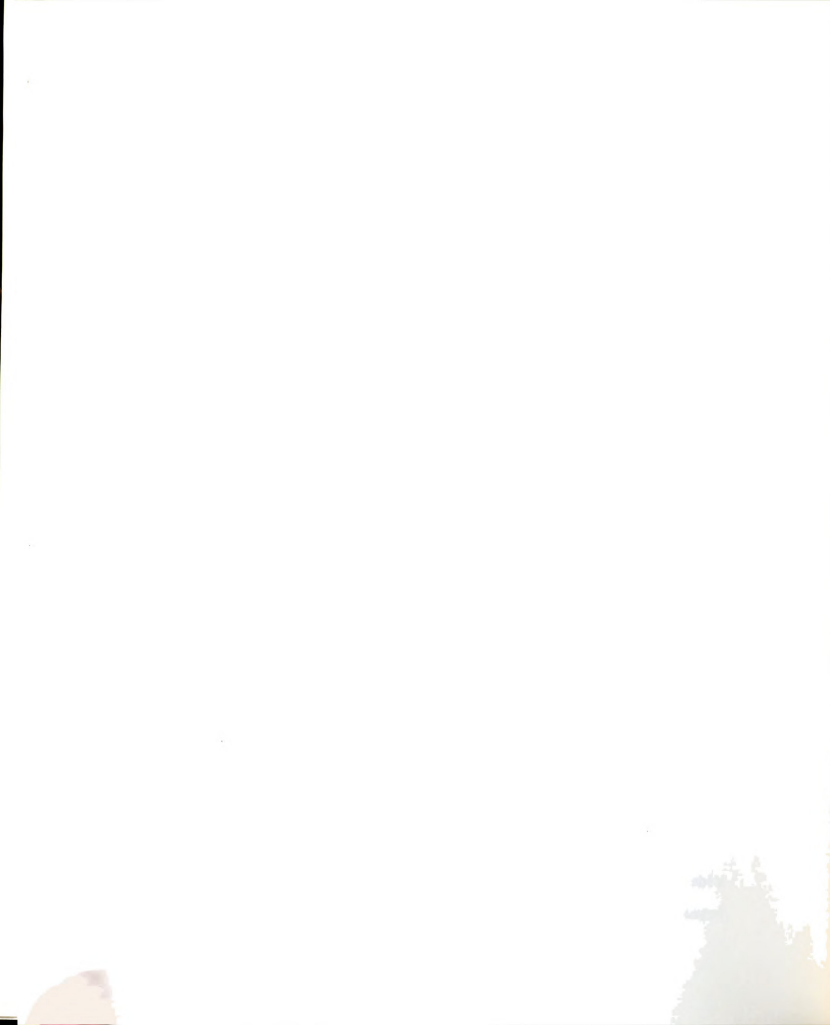
- Establish and maintain a prudent level of self-sufficiency in food production, recognizing both producer and consumer demands
- Provide the opportunities for attaining reasonable agricultural incomes and raise the welfare of rural people



- so as to achieve a balance between the economic and social rewards attainable in rural and urban areas
- Optimize the use of agricultural water resources, land resources, and marine resources
- Improve the skill level in the agricultural sector
- Protect the agricultural (including marine) environment

The policies necessary to achieve the above objectives are detailed in the third development plan. Since the early 70's Saudi Arabia has adopted what Inayatullah (1974) called a low intervention or productivity mode of rural development. This model primarily seeks to raise farm productivity without bringing about drastic changes in social structure and land tenure systems of the rural population. The strategy seeks to assist those who have the necessary capital, resources, skills, and motivation to increase productivity through an increasing exposure to improved technology, availability of highly subsidized resources, an interest-free credit, and a setting of floor prices on certain commodities.

Incentives for agricultural production in the third development plan showed that fertilizer, animal feed, engines and pumps will be subsidized at 50 percent of cost; poultry; and dairy equipment will be subsidized at 30 percent of cost; land, and air transport of cows and some potato seed will be provided free. Various subsidies were placed on rice, corn, millet/barley, and dates and a floor price was established for wheat. In addition, spraying equipment, pesticides, and veterinary care are also free. Extension services and research on problems of crop and livestock production, fish and locust



control research, sand stabilization, and land classification are being intensified.

Agricultural Land

Of the 2,150 million donums in Saudi Arabia, only about 15 to 20 million donums or approximately 1 percent is said to be suitable for agriculture, and only 6.1 million donums were under actual cultivation in 1979-80. This means that only 0.28 percent of the total area of the country and 30 percent of the suitable agricultural land was under cultivation in 1979-80. About 51 percent or 3.1 million donums of this cultivated land was rain fed and the rest was mechanically irrigated.

Farm size per holding is typically small, but it varies from region to region. The 1973 agricultural census showed that the total holding area of 12,134,623 donums was owned by 180,670 different owners. This appears to indicate a national average farm size of 67.2 donums. Further analysis, however, shows that there are wide differences in farm size from region to region, as shown in Table 2.1. For example, Asir, which is located in the southern part of the country, shows a total area of 534,801 donums that are held by 36,564 holders. This gives an average holding size of 14.6 donums. This can be compared to Quassin in the central region where the average holding is 563.6 donums per holder.

Manpower in Agriculture

Between 1974 and 1980, the total number of agricultural workers in Saudi Arabia dropped by about 96,000 people, or from 40 percent of

TABLE 2.1.--Land Holding by Region in Saudi Arabia

Amarat	Total Area (donums)	No. of Farms	Average Land Holding (donums)	Average no. of Land Pieces	No. of Rainfed Farms	% of Rainfed Farms
Eastern	150,242	11,010	13.6	2	32	0.3
Riyadh	2,091,324	10,752	194.5	1	4,941	46.0
Quassim	3,365,831	5,972	563.6	1	224	3.8
Khasira	7,108	33	215.0	1	1	3.0
Afif	5,371	78	68.9	1	0	0.0
Hail	281,154	6,261	44.9	1	1,322	21.0
Tabouk	24,452	834	29.0	1	4	0.5
Quarayyat	7,302	191	38.0	1	1	0.5
Joat	34,643	1,543	22.5	2	2	0.1
Ranya	29,218	950	30.7	1	1	0.1
Najran	84,217	2,490	33.8	3	376	15.0
Beisha	139,500	7,351	19.0	4	2,954	40.0
Jazan	2,792,700	36,253	77.0	2	12,466	34.0
Medina	175,212	7,404	23.7	1	355	5.0
Mecca	2,149,018	34,601	62.0	2	19,103	55.0
Al Baha	262,530	18,383	14.3	4	12,506	68.0
Asir	534,801	36,564	14.6	5	35,027	96.0
KINGDOM	12,134,623	180,670	67.0	3	89,316	49.0

Source: Constructed from Saudi Arabia, Ministry of Agriculture and Water, Agricultural Census Report 1973-74 (in Arabic), Department of Economic Studies and Statistics, 1974.

the civil labor force to 30 percent. The 650,671 agricultural workers in 1974, including 216,012 or 33 percent female workers, were occupied in agricultural production, agricultural planning and management, irrigation, and agricultural construction. Of these, 68 percent were permanent workers, 29 percent worked seasonally, and 3 percent were involved in agriculture for only three to six months of the year.

Although the number of agriculture workers has decreased in recent years, agriculture is still the largest employment sector in the country. This trend should not be considered a major constraint on agricultural development, since agricultural mechanization with skilled and well-trained manpower could easily substitute for the declining numbers of workers. The U.S.A. and England have less than 10 percent of the labor force in agriculture, yet they are among the leading exporters of agricultural products. The quality of labor and level of technology are more important than the quantity of labor.

Water Resources for Agriculture

Of the four potentially limiting components of agriculture--land, labor, capital, and water--the most severely limiting factor in Saudi Arabia is water. Water is the most scarce and crucial factor in the development of the agricultural sector in the Kingdom.

Water for agriculture comes mainly from two sources: rainfall and groundwater. About 75 percent of the cultivated lands were rain-fed in 1974, and the rest were irrigated. Rainfall only averages 90 mm per annum, ranging from 25 mm in Jeddah to 360 mm in Khamis

Mushait in 1974. Rainfall is also unpredictable and can vary substantially from year to year.

In the central and eastern parts of the country, where precipitation is light, groundwater forms an important source of agricultural water. Many aquifers with large amounts of stored water have been located, the most important of which are shown in Table 2.2.

TABLE 2.2.--Main Aquifers in Saudi Arabia

Aquifer	Average Thickness (Meters)	Size
Saq	300-600	1500 km x 250 km
Qajid	950	300 km x 250 km
Tabuk	150-170	900 km x 150 km
Minjur	300	800 km x 600 km
Al-Bayyad	600	600 km
Al-Wasi	500	1450 km x 800 km ^a
Umm Er Radhuma	240	1000 km
Dammam	35	
Noejene	300	

^aExtends into Kuwait, Iraq, and Bahrain.

SOURCE: Derived from Saudi Arabia (MOAW), A Guide to Agricultural Investment in Saudi Arabia, Department of Agricultural Development, 1979.

Agricultural Capital

Capital is not a constraining factor in the development of agriculture in Saudi Arabia. This is due to the liberal availability of credit and a high degree of subsidy. Most of the agricultural credit

and subsidy is provided through the Saudi Arabian Agricultural Bank. This bank was created in 1964, and it offers short, medium, and long-term interest-free⁴ loans. The bank was established in Riyadh with four branches in four different cities. It had an original capital of 10 million Saudi Riyals. By 1982 the bank was extending its loans through 66 branches and offices located throughout the country. At the end of the 1982 fiscal year, the bank disbursed a total of 37,446 loans amounting to approximately 3 billion Saudi Riyals and a total of 1 billion Saudi Riyals in subsidies.

Forestry

Saudi Arabia has approximately 1,600,000 donums of native forests, most of which lie in the Sarwat Mountains. Native species of juniper (Juniperus procere) and wild olive (Olea chrysophylla) cover parts of the higher slopes of Asir. These forests are extremely important in the maintenance of a stable eco-system in their respective areas and in the prevention of a further desertification of the Kingdom. But, for a long time, they were subjected to uncontrolled and continuous cutting operations by the rural population to the extent that the country's forest reserves were seriously decreased. As a result, the Council of Ministers approved a set of regulations in 1978 which were designed to protect the forestry and wildlife resources. Today a Department of Forest and Range under the Ministry of Agriculture and Water is responsible for these resources (Saudi Arabia, 1980; Al-Saleh, 1976).

⁴The influence of the Islamic religion is the driving force behind this system of banking--usury is prohibited in Islam.

Range Resources

More than 95 percent of Saudi Arabia or 2,100 million donums can be considered as range areas. However, about 60 percent of that total area is of poor quality. Only 5 percent or 105 million donums are classified as excellent range areas, 10 percent or 210 million donums are classified as good and the remaining 25 percent or 525 donums are of medium quality (FAO, 1980).

Al-Saleh (1976) classified range lands in two main categories: arid range lands and pasture lands. On range lands, the natural plant community is composed mainly of vegetation suitable for grazing and there is sufficient plant life to justify use at least during those periods when adequate moisture is available. On pasture lands, vegetation is produced for year-round grazing. This type of land is limited to only 17 million donums and is located in the rain-fed areas of the southwest.

Soil, topography, and climate determine the vegetative species available in the various geographical areas of the country, and each region supports a uniform plant community which displays significant differences from those of other areas (Al-Saleh, 1976). Alired (1968) identified over 600 plants by their scientific, Arabic, and English names where possible, and showed their geographical distribution in the country.

The grazing capacity of Saudi Arabia is largely unknown. Grazing capacity is a concept used in evaluating range resources. It refers to the maximum number of animals which can graze each year in a given area of range, for a specific number of days without inducing

a downward trend in forage production, forage quality, and soil quality (Stoddart et al., 1975).

In order to estimate grazing capacities, a complex number of factors must be considered, including soils, topography, trees, and palatable shrubs, condition (resulting from erosion or growth of undesirable plants) and rainfall. Unfortunately, an accurate rating of this kind is not available for the country's ranges, and there are no complete and comprehensive national surveys of desert vegetation, its nutritive value, quality and above all its production per donum. The limited knowledge that is available shows that the national range land's grazing capacity is very low, indicated by the sizable number of donums devoted to an animal unit. This ranged from 84 donums in the best area to 600 donums in the poorest range quality area in 1967/68 (Al-Saleh, 1976). In 1971 Kingery estimated that the country had a potential range carrying capacity of only 10.4 million sheep units (5 sheep or goat units has the grazing capacity of one camel or cow). He also estimated the total number of domestic animals at more than nine million sheep units.

In 1971 pastoralism supported more than 60 percent of Saudi Arabia's internally produced animal products, including 85 percent of the nation's camels, 69 percent of its sheep, and 46 percent of its goat stock (Al-Saleh, 1976). Unfortunately, pastoralism is now in a state of decline because most of the grazing lands are considered public property. Unlike ancient land use, in which grazing lands were controlled through traditional tribal arrangements, public lands today are available to all without restriction. This may have

contributed to degradation of the range, as the stockman no longer feels he stands to gain by careful use of the range (Kingery, 1971).

Fishery Resources

Despite its potential fish yield of 300,000 to 500,000 tons per year, Saudi Arabia's fishery resource has been neglected for many years. Annual production of fish in 1982 was only 37,000 tons. This is less than 10 percent of the estimated annual potential yield. The annual fish consumption, which represents only 13 percent of the annual protein consumption in Saudi Arabia is estimated at 2.3 kilograms per capita. This is low when compared to international standards. The average consumption in Western Europe, for example, is between 12 and 15 kilograms per capita (Saudi Arabia, 1978). Lack of adequate transportation and poor marketing facilities is mainly responsible for the low production of fish on the coastline and the low consumption of fish inland.

Efforts are now being made to increase fish production and consumption throughout the country. In 1979, the government established a National Fish Company for exploiting marine fish wealth in Saudi Arabian territorial and other regional waters. The Arabian Fisheries Company, which is older than the National Fish Company, concentrates its activities on the high seas beyond territorial waters. The last few years has seen a cooperative effort between the Ministry of Agriculture and Water Resources and two British Institutions--the White Fish Authority and the University College of North Wales, in a fisheries research and development program for the Kingdom.

Considerable information is being compiled on the various fish species of commercial interest, their size, range distribution and habitat. Since 1976, more than 180 different species in the Red Sea Coast markets and over 110 in the Gulf Coast markets have been identified by the White Fish Authority. The available fish range from the economically important snapper, jack and grouper, to the less valued unicornfish, mojaira, and shark (Wray, ed., 1979).

A wealth of information on fishing communities is also being provided by the White Fish Authority. They conducted a survey of fishing communities along the Red Sea coastline in 1977 and their results are documented in Peacock (1978). Three community types were identified--the town or city, the fishing village, and the fishing camp.

Towns or cities were large seaboard communities where fishing was a permanent, well-established feature, although not necessarily a major industry. Infrastructure in the form of markets, ice plants, and repair facilities was generally in place. Fishing villages were smaller, but essentially permanent communities where fishing dominated the economy in the past. The fleet was usually large, and fishermen were settled with their families, but the infrastructure was limited to at most a water supply and electricity. Fishing camps were very small communities totally dependent upon fishing. They are often temporary and are at most working camps consisting of a few huts for fishermen. There is virtually no infrastructure, the only established feature usually being a coastguard station. Even basic supplies such as food, water, ice, and fuel are supplied from trucks.

Out of seventy-two communities surveyed along the Red Sea coastline, 13 percent, 19 percent, and 68 percent were towns, villages, and camps, respectively. A fleet of 1,225 boats, in the 6 to 8 meters range, worked the Red Sea coast from these communities with 2,400 full time fishermen and a total annual catch of 10,200 tons.

In the Gulf where the three main fishing ports--Jubail, Dammam, and Qatif--are located, the fleet was about 200, ranging in size from 8 to 20 meters and supporting about 2,000 full-time fishermen. The main fishing methods were gill nets, hand lines, and pot fishing, while trawlers were used to catch shrimp (Saudi Arabia, 1979).

Prospects for Food Self-Sufficiency

In summary, Saudi Arabia has the potential of achieving self-sufficiency in most of the domestically produced products. However, the rate at which self-sufficiency can be achieved is limited by the small size of holdings, a scarcity of water, and a shortage of skilled manpower. About 65,957 farms or 37 percent of the total holdings in the country account for less than 8 percent of the total land holding with an average of about 14 donums per holding. This average holding is often divided into four to five parcels of land. Although these holdings do not encounter water problems, the small size and fragmentary nature of these holdings make the introduction of improved technology, especially mechanization, difficult. Improvements of such small-size holdings will have to rely on biological-chemical technology which is labor-intensive. Labor in the rural areas of Saudi Arabia is currently in short supply. To allow for the



introduction of limited mechanization most of the small fragmented fields will have to be consolidated through cooperative and community efforts.

The extent to which size and fragmentation of land affects the level of investment in agriculture can be partially shown by the loan disbursement patterns of the Agricultural Bank. Although the 1974 census showed that there were 5,972 holdings in Quassim or 3.3 percent of the total national holding with an average farm size of 564 donums per holding, the Agricultural Bank annual report indicated that the Buraidah Branch in Quassim made 5,348 loans totalling 555 million Saudi Riyals. This was about 19.1 percent of the total amount of money in loans by the Bank for the 1982 year. In contrast, the Jizan region had 36,253 holdings or more than 20 percent of the total holdings with an average size of 77 donums per holding in two parcels of land. The Jizan Bank Branch disbursed only 1,353 loans totalling less than S.R. 93 million. This was only 3.2 percent of the total amount of loans disbursed by the Agricultural Bank in 1982. It seems as if larger farm size holders are able to attract more loans.

Water availability limits the production capacity of Saudi Arabia. Irrigation of lands in Quassim depends heavily on ground water and this may explain the high investment in irrigation in this region. The continuation of agricultural production in this region depends on the continued availability of ground water, which, in turn, depends on the rate of extraction and replenishment. Unless ways are found to replenish the water extracted, agricultural production in this region will be jeopardized in the long run. Meanwhile,

it is necessary to introduce regulations and legislations that will control the use of ground water.

While it is possible to achieve self-sufficiency in some products like fish and potatoes, the prospects for being self-sufficient in rice in the near future are not bright. Unfortunately, rice forms a staple diet for most Saudi Arabians. In 1981 Saudi Arabia imported more than 414 thousand metric tons of rice, making it the sixth largest among the major importers (Duwais, 1983). The high demands that rice places on moisture makes it uneconomical for growing in a moisture-scarce country. If self-sufficiency cannot be attained through increasing domestic supply, it can possibly be attained through a manipulation of the demand side. The government could design long-term policies that will influence consumer taste and preference, and so shift demand toward products that could be produced domestically--fish and potatoes and away from products that must be imported--rice and meat. The government could, for example, encourage the consumption of fish and potatoes in their school lunch programs, to create a new generation of fish and potato consumers.

Oil and Natural Gas

It may be said that Saudi Arabia is a land whose treasures are hidden from view beneath the desert. The country's most valuable natural resource lay dormant under land where nomads pastured their sheep and camels until 1938, when the Arabian American Oil Company (ARAMCO) first tapped the largest crude oil reserve in the world. Even then, the magnitude of the resource's impact on the country was not

imagined. Since 1938, more than 50 billion barrels of oil have been produced in Saudi Arabia. The ARAMCO concession area alone contains 165 billion barrels of crude oil and 114 trillion cubic feet of natural gas (ARAMCO, 1983).

Oil production in the early days was less than 20,000 barrels a day until the close of World War II when production jumped to 50,000 barrels daily. By 1950 production had increased 1,000 percent to more than half a million barrels a day, and by 1956 it had hit the million mark. Ten years later this amount had more than doubled, and more than 90 percent was produced by ARAMCO, with the remainder produced by both the Getty Oil Company and the Arabian Oil Company, Ltd. In five years, oil production nearly doubled again, with 3,799,235 barrels a day produced in 1970. Five more years showed another doubling of production to 7,075,452 barrels a day in 1975. By 1980 daily production was nearly ten million barrels, and by then 97.3 percent was produced by ARAMCO. In 1982 daily production by ARAMCO averaged 6,327,220 barrels. In 1983 the average fell to 4,872,000 barrels per day.

Natural gas, which is produced with crude oil, was originally flared because of the lack of an adequate market. In 1954, ARAMCO began conserving natural gas by reinjecting it into the oil fields in order to maintain underground pressure (Nyrop et al., 1977). In 1962 liquified gas was produced commercially, and since that time more than one billion barrels have been produced (ARAMCO, 1983).

In order to determine how long Saudi Arabia will be producing oil in the future, a reserve-to-use ratio must be estimated. This

ratio depends upon assumptions made about the rate of growth of the oil resource (through new discoveries or development of new technologies which can bring more oil into reserve) and the rate of growth of the current extraction level. Based on the forecasting level of international demand, Saudi Arabia's financial needs, and the known reserve, which was assumed to grow by 20 percent annually, the Ministry of Petroleum and Mineral Resources has estimated the reserve/use ratio for crude oil to be 148 years.⁵ This ratio is very high compared to that postulated in the Third Five Year Plan, which estimated the Reserve/Production Ratio to be only 48 years.

The price which Saudi oil may be expected to bring, however, has little connection with the supply of crude oil. Oil prices are not determined by the supply and demand of oil; in fact, Adelman (1972) maintains that the higher crude oil prices have no connection with world supply or demand for crude oil. They reflect no scarcity of oil, present or foreseen. Adelman suggests that supply and demand will be as irrelevant to future oil prices as they have been to those in the past. Because there are relatively few oil suppliers in the market, they enjoy some level of monopoly, and oil is priced accordingly.

In 1933 the Standard Oil Company of California (later ARAMCO) agreed to pay the Saudi government a royalty of four shillings gold per ton of net crude oil produced. Prices increased gradually until 1974, when the price of oil tripled from the previous year. Oil

⁵"The Approximate Age of the Oil Reserves is a 148 years in the Kingdom," (Arabic), Al-yaum, Damman, September 22, 1983.



prices have continued to increase at a high rate since that time. Prices have increased from \$5.04 per barrel in 1973 to \$11.25 per barrel in 1974. In 1981 the price of crude oil reached a high of \$34.00 a barrel, but fell to \$29 per barrel in 1983.

Mineral Resources

Thirty years ago a tradition nearly as old as Islam ended in Saudi Arabia: the mining of Arabian gold. Since the second century of Islam, twelve centuries ago, there has been gold, silver, and other mineral workings scattered around the Arabian shield. In 1955 the Kingdom's last major mine, the Mohed ad Dahab gold mine, ceased commercial exploitation (Saudi Arabia, 1980). In 1983, after nearly thirty years, the Mohed ad Dahab gold mine was reopened by the King of Saudi Arabia (Taher, 1983). Extensive exploration and research have not only indicated that the Mohed ad Dahab mine will be once more economically profitable to operate, but have also revealed large commercial deposits of such mineral resources as copper, iron, silver, sulfur, phosphates, lead, and zinc in the country. By 1980 more than 700 mineral occurrences have been identified in the main metalliferous mineral belts. Tables 2.3 and 2.4 show some of these minerals. Work on these mineral belts, which individually may occupy several thousand square kilometers, is still in a relatively early stage. The General Directorate of Mineral Resources has signed contracts with some companies for mineral exploration in different areas of the Kingdom. "The Saudi-Sudanese Joint Red Sea Commission was established in 1975, following a bilateral agreement between the two

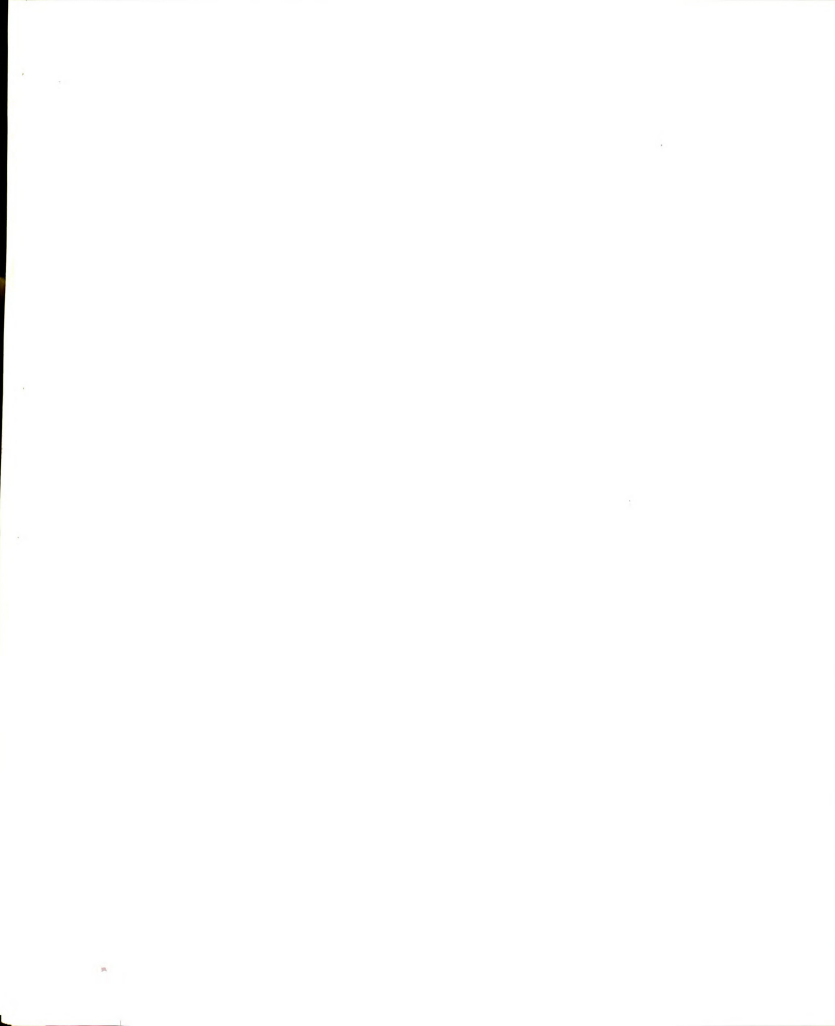


TABLE 2.3.--Known Industrial Mineral Deposits in Saudi Arabia

Name of locality	Material	Location	Remarks
Sirhan-Turayf Basin	Phosphate minerals	400--450 km from Red Sea	Extensive region with beds containing phosphate minerals being explored.
Thaniyat	Phosphate minerals	300--350 km from Red Sea	Under licence to Granges International Mining since 1976.
Yanbu-Umm Lajj Area	Gypsum		Huge gypsum deposits suitable for the manufacture of plaster.
Zurghat	Magnetite	300--400 km NE of Yanbu	4 million tonnes high grade deposit being evaluated.
Rokham	Magnetite	300 km ESE of Yanbu	Being evaluated.
Jizan	Rock salt		Huge salt dome, over 30 million tonnes at 96% NaCl.
Al Tardifiyah	Kaolin-clay minerals	Close to Buraida	Being explored.
Az Zuleiyim	Kaolin-clay minerals	Close to Buraida	Being explored.
Durma Marat	Clay shale	100--150 km W-NW of Riyadh	Being explored.
Jabal Burmah-Ad Dughim	Glass sand	50 km NW of Riyadh	Good quality occurrences being explored.
Khushaym Radi	Kaolin-clay minerals	100--150 km SE of Riyadh	Huge deposits which can be used for earthenware tiles.
Umm Al Ghirban	Pure limestone	100--150 km SE of Riyadh	Pure limestones could be used for chemical purposes.
Huraysan	Pure dolomite	100--150 km SE of Riyadh	Pure dolomite could be used for chemical purposes.
Khashim Umm Hywayd	Gypsum	100--150 km S of Dammam	Small deposit suitable for the manufacture of plaster.
Al Haydaruk	Kaolin-clay minerals	100--150 km NNW of Dammam	Being explored.
Al Lidam	Kaolin-clay minerals	50--100 km W-SW of Dammam	Being explored.

SOURCE: Saudi Arabia, A Guide to Industrial Investment (Riyadh: The Saudi Consulting House, 1981).

TABLE 2.4.--Known Metallic Mineral Deposits in Saudi Arabia

Name of locality	Type and minerals	Estimated tonnage (million metric)	Location	Remarks
(1) Major deposits				
Wadi Sawawin	Banded jaspelite iron deposit: Hematite and magnetite	400 - Fe 42%	40-60 km from Red Sea	Contains 0.6% P. A more comprehensive study is in progress.
Ghurayyah	Alkaline granite: Nb, Re, Y, Zircon, U, Th, Sn		40-60 km E of Red Sea	Large, low-grade tantalum and columbium deposit. Market studies and new extraction methods to be undertaken.
Nugrah	Massive sulfide deposit: Cu, Pb, Zn, Au, Ag	1.2 - Cu 1.1%, Pb 3.2%, Zn 8.1%, Au 6 g/t, Ag 230 g/t	400-500 km E-NE of Yanbu	Small, high grade deposit under licence to Granges International Mining since 1978.
Jabal Sayid	Massive sulfide deposit: Cu, Zn, Pb, Au	40 - Cu 1.7%	300-350 km N-NE of Jeddah	Underground exploration by the Ministry expected by 1981.
Mahd adh Dhahab	Ancient gold mine		300-350 km N-NE of Jeddah	Under exploration licence to Consolidated Gold Fields. Strong likelihood of first gold production starting in 1983.
Khnaiguiyah	Base metal deposit: Zn, Cu	15 - Zn 5%	700-750 km E-NE of Jeddah	Exploration in progress.
Jabal Idas	Magnetic andesite deposit: Fe	106 - Fe 22%	700-750 km E-NE of Jeddah	
Al Massane	High grade polymetallic deposit: Zn, Cu, Ag, Au	0.25 per m depth indicated - Cu 1.5%, Zn 4.5%	150-200 km E of Jizan	Under exploration licence to Arabian Shield Development Co. Underground exploration in progress.
Jabal Guyan	Ancient gold vein mine		150-200 km E of Jizan	Under exploration licence to Arabian Shield Development Co.
Jabal Harr	Nickeliferous iron sulfide deposit: Ni	2 - Ni 1.5%	150-200 km E of Jizan	Under exploration licence to Arabian Shield Development Co.
Wadi Wassat	Massive pyrite deposit: Fe, S	180 - Pyrite 80%	200-250 km E of Jizan	
(2) Minor deposits				
Al Amar	Low-grade zinc deposit: Zn, Au	2.5 - Zn 2.5%, Au 2.7 g/t	700-750 km E-NE of Jeddah	
Samrah	Ancient silver mine	0.33 - Ag 452 g/t, Pb 1.1%, Zn 4.9%	650-700 km E-NE of Jeddah	
Wadi Bidah District: Sha'ba at Tare Rabathan, Gehab	Several low grade copper-zinc deposits	6.5 - Cu 1.5%, Zn 0.7%	200-250 km E-SE of Jeddah	Investigations are continuing in the region.
Wadi Fatimah	Oolitic iron ore deposits: Fe	48 (to 200 m depth) - Fe 41-46%	50 km E of Jeddah	Contains 0.3 to 0.8% P.
As Safra	Small base metal deposit: Cu, Zn, Ag	2.7 at 2.1% Cu and 4.5 at 1.3% Cu	400-450 km E of Yanbu	Under licence to Granges International Mining since 1978.
Jabal As Shizm	Small base metal deposit: Cu, Zn	3 - Cu 2.8%	250 km N of Yanbu	Investigations are continuing in the region.

SOURCE: Saudi Arabia, A Guide to Industrial Investment (Riyadh, The Saudi Consulting House, 1981).

governments, to organize and supervise all research and development work required to exploit the metal-rich sediments of the Red Sea deposits" (Saudi Arabia, 1980).

Exploration indicates that there are 17 mineral deposit locations in the Red Sea between Saudi Arabia and Sudan. One of the most promising locations is estimated to have 2.2 million tons of zinc, 600 thousand tons of copper, 400-900 thousand tons of silver, and 80 thousand tons of gold. This mining operation, which is expected to be in production by the end of this decade, will be the first of its kind, since operations will occur more than 2,000 meters underwater (Al-Madina Daily, 1983).

Summary

This chapter was devoted to a presentation of background information on Saudi Arabia. The Kingdom of Saudi Arabia is relatively sparsely populated. Recent rapid developments in all sectors of the economy have resulted in an acute shortage of skilled manpower and a rapidly growing urban population. It has also attracted a large influx of foreign workers. Substantial progress has been made to increase the pool of local skilled manpower through heavy investments in education, training abroad, and modern health care.

Saudi Arabia strongly adheres to the Islamic faith and all development is undertaken in a manner that will preserve the Islamic faith and values. Rules and regulations governing the distribution of land and the payment of zakat are derived from the sharia. The government of Saudi Arabia is committed to attaining self-sufficiency in

food production and in maintaining a balance in social and economic rewards between the rural and urban population.

The country has a vast amount of land that is mostly desert; only about 1 percent is suitable for agriculture. Water resources are scarce and a large investment is being made in irrigation. The country is promoting agricultural development by way of substantial subsidies on agricultural inputs, maintaining floor prices for some products and giving interest-free loans.

CHAPTER III

CONCEPTUAL FRAMEWORK

Introduction

In this chapter one of the most frequently used paradigms of agricultural information systems will be described. This paradigm will be used in a later chapter to address the problems of Saudi Arabia's national agricultural information systems. The paradigm will be discussed in terms of its philosophical basis and its components. This will be followed by a review of its application in some studies to show its strength and weaknesses. A brief discussion of the economics of information will also be presented to highlight some theoretical concerns on the use of neoclassical economic theory in the analysis of the demand and supply of information. This chapter will conclude with an explanation of the potential of this paradigm in the development of a new information system for Saudi Arabia's national agricultural sector.

Information and Inquiry¹

Economists have several theories which provide a framework within which researchers work. In like manner, one would expect that

¹This section and the following one are derived from C. H. Riemenschneider and J. T. Bonnen, "National Agricultural Information Systems: Design and Assessment," *Information for Agriculture*, ed.: M. J. Blackie and J. B. Dent (London: Applied Science Publishers, 1979), pp. 145-172. Quotation marks indicate direct quotation from the above source.

a theory of information is available to guide researchers in their examination of information systems. There is, however, no single theory of information. Economists, sociologists, engineers, management specialists, and others all have different theories of information which focus on their unique disciplinary concerns and philosophical beliefs. It is thus necessary to develop a general framework for the understanding of information systems in agriculture.

Information systems in agriculture are designed to assist both private and public decision makers in solving problems that arise in the farm, the industry, or the national economy in general. This would suggest that any framework for understanding information system would focus, at least in part, on problem solving and decision making. Problem solving and decision making at both the private and public levels normally require knowledge from a variety of disciplines. This means that if any information theory is to be useful in understanding information systems, it must have a multidisciplinary perspective. Thus, in assessing any operating information system, concern is not with developing a separate information theory for a particular discipline, but rather with a way of viewing and understanding the process of inquiry and decision making (Riemenschneider and Bonnen, 1979).

In a broad and general sense, Riemenschneider and Bonnen view information as the product of some basic process of inquiry. This point is emphasized by Churchman (1971) who adds that to model a problem is to conduct an inquiry about the problem, which is, in turn,



an attempt to produce information on the very nature of the problem. Any knowledge about a specific problem is thus dependent on the system of inquiry used in obtaining that knowledge. In this sense, information must be considered as a function of epistemology (Mitroff and Sagasti, 1973).

Riemenschneider and Bonnen indicate that Churchman, Mitroff, and others, demonstrated the relationship between epistemology and information by pointing out the differences between the pure philosophical systems of inquiry of Leibnitz, Locke, Kant, and Hegel. Any model or conceptualization of an information system could be traced back to some philosophically based inquiry system, indeed, to a basic image of reality.

Mitroff and Turoff (1973) described the inquiry of Leibniz, Locke, Kant, and Hegel. In summary, they state that in the Leibnizian inquiry system truth is analytic, that is, the truth content of a system is associated entirely with its formal content. In other words, the truth of a model does not rest upon any external considerations. It is independent of the raw data of the external world. In the Lockian system, truth is experiential. This means that the truth content of a system is associated entirely with its empirical content. In Locke's view, the truth of a model does not rest upon prior assumptions of any theory.

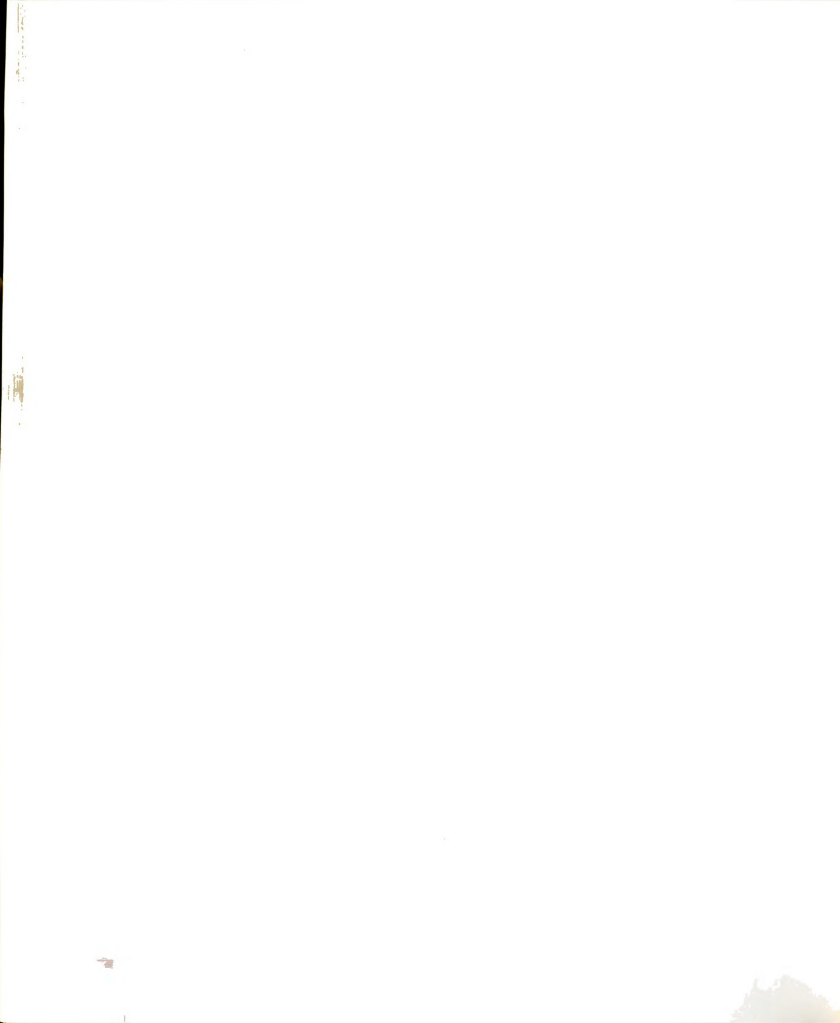
The Kantian inquiry system attempts to integrate that of Leibniz and Locke in that it is characterized by the fact that the truth content of a system is not located in either its theoretical

or empirical components, but in both. Neither the data input nor the theory has priority. The Hegelian system is a dialectical inquiry system. Its basic idea is that truth is conflictual in that the truth content of a system is the result of a highly complicated process that depends on the existence of a plan and a diametrically opposed counter plan.

These systems tend to emphasize one system of inquiry or one component of a tightly coupled system to the detriment of the other components. "However, to limit an information system to any single philosophical mode of inquiry will limit its ability to capture reality adequately. To assist in solving problems, an information system must represent the reality relevant to that problem. Thus, it is the nature of the problem that dictates the information system or mode of inquiry designed to solve that problem." For example, "well-structured problems in decision theory are of the type where a known deterministic or probabilistic relationship exists between the choice of an act by a decision maker and the occurrence of a specific outcome. Further, these acts must in some sense, optimize the value to, or utility of, the decision maker given a known set of states of nature" (Mitroff and Sagasti, 1973). "Thus, these types of problems are subject to more precise analytical methods of attack in that there are unambiguous rules for deciding on an optimal course of action, as well as known relationships between actions and outcomes." On the other hand, "ill-structured problems in decision theory are such that one's knowledge about a given problem is limited by the

fact that one or more sets of acts, outcomes, utilities of the decision-maker or states of nature are not known with confidence. With these types of problems, decision makers are frequently concerned with the achievement of multiple desired outcomes under the conditions of imperfect knowledge." Because of the uncertainty in ill-structured problems, the greatest difficulty often lies in defining the problem.

The pure philosophical systems of inquiry of Kant, Hegel, and others are useful in gaining insight into various aspects of problems, but they have their shortcomings in dealing with the totality of certain types of problems. The solution of ill-structured problems requires a more general philosophical system of inquiry. It requires a multidisciplinary approach that stresses the interaction between different modes of inquiry. This is similar to what can be thought of as a systems approach--and is characterized by Edgar Singer's inquiring system. According to Mitroff and Turoff (1973), the main feature of Singer's system of inquiring is that truth is pragmatic. The truth content of a system is relative to the overall goals and objectives of the inquiry. A model of a system in this sense is, teleological or explicitly, goal oriented in the sense that the truth of the model is measured with respect to its ability to articulate certain systems objectives, to create several alternate means for securing these objectives and finally at the end of the inquiry to specify new goals that remain to be accomplished by some future inquiry. In essence, this inquiry system constitutes a theory about the inquiry systems of Leibniz, Kant, Locke, and Hegel.



This systems approach to problem solving provides the foundation for the information systems paradigm described below. The concern of information systems are with solving practical problems and consequently with the decisions addressed to those problems.

It has often been said that there are no problems, only perceptions of problems. Since "problems" are by nature nothing more than obstacles to the achievement of arbitrarily set human goals and values, the first step in problem solving is to identify the decision makers and isolate their perceptions of the problem (obstacle) based on their goals and objectives. The decision maker is an integral part of the information system, not only because his or her insights influence the definition of the problem, but because that definition influences the method of attack or analysis of the problem, and the method of analysis or inquiry determines the kind of information obtained. This means that any attempt at designing an information system must begin with the decision makers' view of the problem and his agenda. Since the system is dictated by the needs of the user, an information system designed for farm policy decisions made by government policy makers would differ greatly from an information system designed for use by farmers in the day-to-day operation of the farm.

An Information Systems Paradigm

The information system paradigm described here is heavily dependent on Riemenschneider and Bonnen (1979). Essentially, Bonnen presented this paradigm in his presidential address to the American

Agricultural Economics Association on "Improving Information on Agricultural and Rural Life" in 1975. The following paradigm contributes to the clarification of the steps necessary in structuring data systems and inquiry, or analytical systems, and also clarifies the linkages between these systems. The primary value of Bonnen's paradigm is in its demonstration of the steps necessary to develop information from data.

The Nature of Data and Data Systems

Every data system involves an attempt to represent reality empirically. Reality can be one of two types: agreement reality--the things that one considers to be real because one has been told they are real, and experiential reality--the things that one knows as a result of one's direct experience (Babbie, 1979). This section is concerned with the second kind of reality--experiential reality. Since reality is nearly infinite in its variations and configurations and is not readily grasped by the human mind, it is necessary to break down experiential phenomena into a set of categories or classes that can be counted or measured. Counting and measuring is usually thought of in quantitative terms, but the arguments apply equally to numerical and nonnumerical data. Subjective impressions and simple relative comparisons, such as good and bad, can be treated in similar fashion. However, for pedagogic reasons, this section is discussed in terms of numerical data, bearing in mind that the ideas remain valid for both quantitative and qualitative data.

Data collection is normally perceived in terms of measuring or counting samples or taking a census of a specific population. But problems of sampling or measuring only arise after one determines what phenomena are to be counted or measured. The phenomena to be counted or measured depend on the decisions to be made. "To maintain logical coherence and to represent reality adequately, these quantified phenomena must be related to each other and to reality in a meaningful manner. Thus there must be a concept of reality to be measured and to be meaningful this concept must be capable of accurately systematizing and categorizing reality so it can be understood by those using the data. This categorization must also be such that the concepts are relevant to the decisions being made. Improvements in sampling procedures or other measurement techniques will be of little value without this solid conceptual base."

Although data presupposes a concept, concepts are abstract ideas and it is not possible to measure concepts as such. "Instead, it is necessary to operationalise or define these concepts so the definitions (categories of empirical variables) are as representative as possible of the chosen concept." There are thus three distinct steps which must be taken before one can produce data that purport to represent any reality. These are (1) conceptualization, (2) operationalization of the concept, and (3) measurement. These, essentially, are the components of a data system. The failure or deficiency of any one of these components affects the quality and characteristics of the data produced. "Any inadequacy at any stage can be offset only

to a very limited extent by improvements or manipulations at the other stages" (Bonnen, 1975). With this in mind, reliability of data takes on three possible meanings: reliability of measurement, reliability of operationalization, and conceptual reliability.²

The Nature of Information

The data system is only part of an information system. Data are language, mathematical, or other symbolic surrogates which are generally agreed upon to represent people, objects, events, and concepts (Burch, Jr., et al., 1979). To become information, data must be analyzed and interpreted and placed in a decision-making content. "Raw data or even semi-processed data are rarely used directly by decision-makers." Rather, there are intervening acts of interpretation ranging from statistical and economic analysis through less complex programs and political evaluations, which transform data into information by placing them in a specific problem context to give the data meaning and form for a particular decision or decision maker. In this sense, the demand for data is derived from the need to make decisions on problems. Information systems then can be viewed as a process which imposes form and gives meaning to data. Thus an information system is made up of three major components including: (1) a data system, (2) the analytical capability necessary to interpret data, and (3) the decision maker. The relationships between these components are illustrated in Figure 3.1.

²Bonnen (1977) attributes this to L. V. Manderscheid.

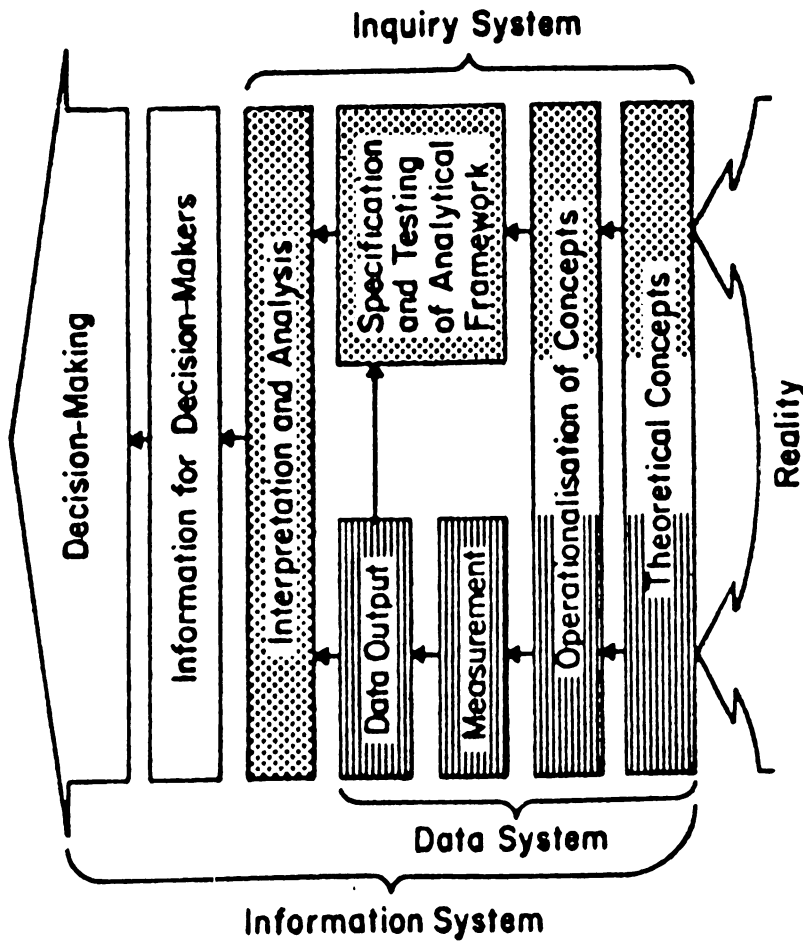


Figure 3.1.--An Information System

Source: J. T. Bonnen, "Assessment of the Current Agricultural Data Base: An Information System Approach," Survey of Agricultural Economic Literature, Vol. 2, Quantitative Methods in Agricultural Economics 1940s to 1970s, eds.: George Judge, et al. (Bloomington, Minn.: University of Minnesota Press, 1977), pp. 386-407.

The analysis of any given problematic situation in agriculture usually starts with a received body of theoretical concepts which purport to represent reality. The concepts are operationalized through the definition of variables that are often specified formally in a model. The model is then tested against the data and conclusions are drawn. Hence, data production must share the same conceptual ground with the analytical system of inquiry if an empirical test is to be valid or even possible.

In representing the data system, left side of Figure 3.1 and the inquiry system, right side of Figure 3.1, as components of the same information system, attention is drawn to the need for the same sets of theoretical concepts and the same set of definitions which make those concepts operational: without this common conceptual background, there can be no mesh between empirical analysis and theory between the inductive and deductive processes.

The paradigm discussed above is an abstraction of an ideal information system. Riemenschneider and Bonnen alluded to some problems that can be encountered when the paradigm is applied to an actual specific information system--the real world situation. They indicate that there are some problems in separating the various components of the system. When applied to a specific information system, there is a difficulty in attempting to determine the difference between data and information. Very few decision makers can use true raw data. "In most cases, data are presented in a selected format. The choice of a format implies some purpose and therefore a level of

interpretation of the data." This low level of interpretation points to the critical nature of the communication function in an operating information system. The usefulness of data is tied to their interpersonal transmissibility. All data undergo initial formatting so that they can be understood by analysts. This formatting is analogous to the encoding of messages, as used by communication theorists, before transmission. Related to the interpersonal transmissibility of data is the choosing of an appropriate level of aggregation and understanding the ability of users to access data. Thus whenever the data collection process is organizationally separate from the analysis and decision making a formatting and communication process becomes an integral part of the information systems.

Previous Applications and Evaluations of the Paradigm

The following four studies applied the paradigm as a method for evaluating different agricultural information systems. Charles Henry Riemenschneider's (1978) study, "An Information Systems Analysis of USDA Farm Income Data," had several objectives. The first objective was to describe the relationships between data design, data collection, analysis, interpretation, and decision making for the farm income information system. It was hoped that this would lead to a better understanding of information system design. The second objective was to further develop the economic and social theory with regard to information and information systems. Riemenschneider utilized Bonnen's paradigm in this study. The paradigm at this time had not been extensively applied to specific information systems;

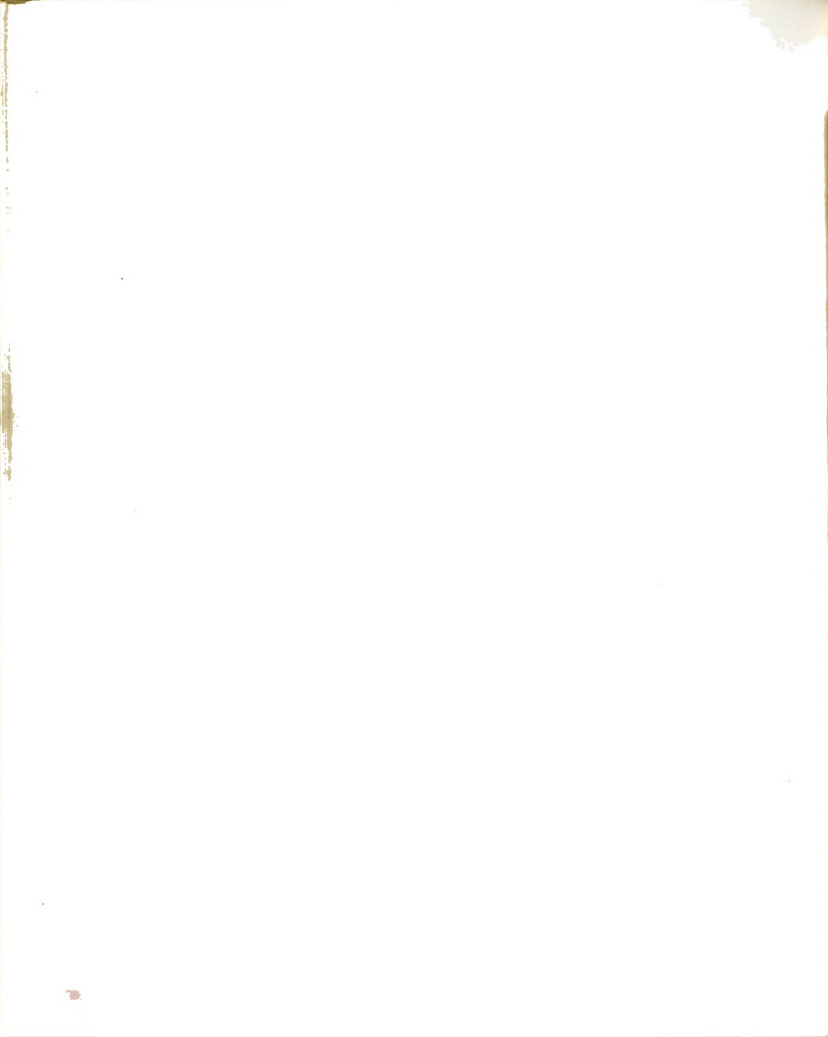
therefore, the study's third objective was to test the usefulness of the paradigm as a research methodology. The final objective was to suggest changes and improvements in the current farm income information system.

The farm income information system was found to have four major components: a primary data subsystem, a formatting and communication subsystem, an analysis subsystem, and a decision-making subsystem.

Data collection was based on a mail survey and personal interviews with farm income data users. These users pinpointed two major problem areas in the system: conceptual obsolescence and credibility. Changing issues in agricultural policy have not been reflected in the concepts of farm income, and data revision and methodology modification over time created credibility problems.

The study entitled, "The Michigan Processed Potato Industry: An Information System Case Study," by Ralph Dean Christy (1980) had two broad goals. The first was to describe one type of problem, obsolescence, as it related to the data systems and as it impacted the decision-making process of plant managers in the Michigan processed potato industry. The second major goal was to implement and develop a methodology for evaluating information systems operating in the Michigan processed potato industry. Several objectives were related to these two broad goals.

This study was also based on Bonnen's paradigm in conjunction with neoclassical economics, industrial organization theory, the



behavioral theory of firm decision making, and a limited construct of the cost and benefits of information over various market structures. One of the objectives of the study was to test the applicability of the information system paradigm and to revise or extend it where possible.

Personal interviews were conducted with each plant manager. The interviews were designed to obtain information on structural characteristics of the industry and to evaluate the usefulness of various types and sources of price information in the firm's marketing decisions.

Christy's study concluded with recommendations to public statistical agencies, implications for the usefulness and limitations of the information system paradigm as a framework integrated with other bodies of theory, and suggestions for the agricultural economist's research agenda.

Marvin Lee Klein's (1979) study, "An Information System Approach to the Study of Price Data: A Case Study of the Michigan Potato Industry," examined the changing nature of the Michigan potato industry and the relationship of these changes to needed changes in the data system. This study had the following objectives: (1) to identify and describe the structural make-up of potato production, marketing, and pricing at the producer/first handler level in Michigan, (2) to identify potato producer uses of price data and information, the sources of price data used by producers, and information used in determining a selling price, (3) to determine whether there is evidence of a relationship between the structure of potato production and



marketing and the producer's use of the sources of price data and information, (4) to identify conceptual, operational, and measurement problems confronting the information system for Michigan potato producers against producer decision needs, and finally, (5) to evaluate the information system approach as a tool in identifying, defining, and evaluating the problems of price data and information.

Data for analysis was collected by a mail survey to all commercial potato growers in Michigan. The questionnaire identified the producing firm, its marketing pattern, the producer's data source, and producer's evaluation of price data and information for decision making. This survey was supported by telephone interviews with a random sample of the nonrespondents to identify the effects of response bias on the mail survey results. Also, potato buyers and representatives of farmer organizations were interviewed to identify their price data and information uses.

Carl Borres Montano's (1982) study of Philippine Agrarian Reform Policy Decision-Making under Martial Law emphasized the relationship between effective management and the information system. Montano stressed that the capability of the public decision makers to deal with policy problems and issues surrounding agrarian reform in the Philippines depended on the effectiveness of the supporting information system in providing policy makers relevant, accurate, and timely information.

The objectives of this study as stated by Montano were:

(1) to provide a description of (a) the structure and dynamics of the



agrarian reform policy-making process in the Philippines, as well as of (b) the associated information system, showing the relationships among data, analysis, and decision making; (2) to identify problem areas in the agrarian reform information system requiring immediate and long-run improvements and to make suggestions on alternative ways of improving them; (3) to identify the relevant program performance variables; and (4) to suggest potential contributions of the General System Simulation Approach toward improving the analytical capability of the information system, and to outline the resource and organizational requirements for realizing these potentials.

Montano's analytical framework was built around four theoretical developments: (1) the theory of a feedback control system as developed by Manetsch and Park (1977); (2) the theory and economics of information systems as developed by Bonnen (1975, 1976, and 1977), Riemenschneider (1977); (3) the theory of rational decision-making processes in the field of agricultural policy as developed by Johnson (1975), Johnson and Rossmiller (1978); and (4) the concept of a general system simulation approach as developed by Manetsch et al. (1971), Johnson and Rossmiller (1978).

Data for this study were obtained through survey and non-participant observation. These primary data were supplemented by secondary data from different sources such as policy/implementation workshops and conferences.

The population of participants in the agrarian reform decision-making process was stratified into four groups according to roles in

the process, namely (1) policymakers, (2) implementors/administrators, (3) analysts/investigators/researchers and statisticians, and (4) affected parties and other interest groups.

The major relevant findings of Montano's study were that the management component of the Philippine agrarian reform program was composed of two subcomponents, namely, policy making and implementation. Likewise, the information component was composed of two subcomponents, namely, data and analytical. The operation land transfer information system was inadequate. Its major deficiency lay in its weakness in the operationalization of the concepts.

Each of the four preceding studies tested the usefulness of the information system paradigm in their analysis.

One major problem Reimenschneider saw in the use of the information system paradigm in designing a study was the identification of the population of users. He indicated that decision makers would have difficulty determining their potential needs, since they could not place a value on data until it was used. However, Reimenschneider found most decision makers capable of identifying gaps in the existing data and describing the types of data still needed. This would indicate that the information system paradigm is effective as a guide to research, since it offers possibilities to specify problems and data gaps in the system by examining the users and the uses of the information.

A weakness Reimenschneider found in the paradigm was the problem of defining a unit of measurement of information, which makes

it difficult to place a value on the information. This affects the usefulness of the paradigm in setting priorities among different types of data.

Klein concluded that the information system framework can be effectively used for defining problems confronting the potato price data and information system, and is particularly effective as an aid to the identification and definition of the specific nature of the problems and the data and information system. This usefulness is a result of viewing data and information problems in a conceptual, operational, or measurement context. However, the information system framework understates the value of publicly reported data if it neglects the nondecision-making uses of the price data. The study, for example, identified the importance of price forecasting to potato producers, ignoring outside information used by decision makers--that is, information produced by analysts outside the particular data and information system being analyzed--would understate the price data value.

Christy saw the greatest strength of the paradigm in its ability to aid the researcher in defining problems, lending clarity to complex settings. The framework was found to be applicable to most informational problem areas, both at a micro- and macroeconomic level, and was particularly suited to research involving ill-defined problems wherein the emphasis of the research is at least in part the articulation and definition of the problem.

Another strength of the paradigm exemplified by Christy's study is the ease with which it can be combined with various concepts

from other theories. The framework is an epistemological taxonomy, not a methodology, which allows it flexibility. For example, in his study, the information system paradigm was combined with concepts from neoclassical theory, institutional economics, and from industrial organization.

Unlike Reimenschneider, Christy maintains that because decision makers cannot place a value on information until they have used it, then evaluation of information types and sources is limited to their realm of experience with existing information types and sources.

Another limitation Christy saw in the framework is its inability to provide decision rules so that, for example, trade-offs can be made between competing data users. The framework does not help the researcher in prescribing which types of information should be publicly supported and which type should be supported by the private market. All this hinges on the problem of placing a value on different uses of data and on the distribution of benefits.

Unlike Reimenschneider and Klein who found it difficult to identify the universe of data users when applying the paradigm to their particular studies, Christy, with a relatively definitive user group did not have difficulty in identifying his study group.

Economics of Information

In order to design a successful agricultural information system, it is necessary to understand information economics, how information as a commodity differs from other commodities, and how this

difference influences its supply and demand are important concepts to consider in gaining an understanding of information systems.

Theoretical Concerns in the Economics of Information

It is only in recent years that a number of studies have begun to surface on the economics of information. In neo-classical economic theory, problems of information were simply assumed away by economists who asserted that, under "perfect competition," consumers are rational and possess perfect knowledge. This implies that information about goods and services is costless in a perfectly competitive market. With a few buyers and sellers, this assumption of "perfect knowledge" might be plausible, but a perfectly competitive market also assumes large numbers of buyers and sellers (Boulding, 1966). As Newman (1976) points out, the only economic analysis which really results from this approach is a comparison of resource allocation outcomes produced under perfect knowledge with those produced under any state of imperfect knowledge. These comparisons have much to be desired, since imperfect knowledge, the real world situation, is regarded as a distortion from the outset and it becomes difficult to avoid the conclusion that resource allocation is improved if the distortions are not present.

Many scholars have recognized the inadequacy of the economic theory in addressing information problems, and a significant amount of work has been done in this area during the last two decades. Lamberton (1976) stated that the assumption of "zero information cost" is unrealistic in a world where as much as one-quarter of the Gross

National Product (GNP) is accounted for by knowledge production and distribution. He suggests that economic models need further modification in order to tell us about the role of information in economic and social development.

Faced with the problem of information, some economists attempted to produce a dynamic version of perfect competition. The basic assumption here is that firms are not supposed to know what the market clearing prices are, but that they are supposed to react quickly to any deviations of expected demand from expected supply. In these models the perfectly elastic demand of pure competition is replaced by a negatively sloped demand curve of expected sales. Thus, the real world is portrayed as one of monopoly and competition blended in monopolistic competition. Economists before this time had assumed that reality could be divided into either perfect competition or pure monopoly. However, the procedure of putting together these two models is inadequate. A firm which lowers its price may not sell because consumers are not informed. The assumption that a price reduction can transmit itself effortlessly to consumers is a naive assumption (Lamberton, 1971).

Economists have also tried to incorporate the problems of incomplete information by distinguishing between risk (uncertainty that can be insured against) and uncertainty (for which there can be no safeguards). Lamberton (1971) maintains that this dichotomy fails to come to grips with the various decision rules--Maxmin, and other rules, that decision theorists produce--and that we cannot

believe in a scalar of information which commences with perfect knowledge and ends with pure uncertainty.

The most prominent attempt to overcome some of the explanatory problems arising from the neoclassical assumptions comes from the view that information can be treated like any other commodity and can be analyzed by way of the neoclassical principles of supply and demand (Arrow, 1962). Thus, information in this context is analyzed with the use of equilibrium theory where the primary task is to explain or determine the prices and quantities that will clear the market for information. Furthermore, if markets were perfect, then the quantities of information so produced could be regarded as optimal. This framework requires information to be unambiguously measured in quantitative terms. However, it is simply not clear what such a measure could be. Newman (1976) says that the central questions concerning information are not those about its sheer quantity, but its quality or truth value. However, finding a measure for this dimension is difficult. This stems from the peculiar properties of information which arise even more fundamentally in the discussion of the demand and supply of information.

Boulding (1966) contends that although knowledge (information) is something that can be bought or sold, it is difficult to put a price on it because of the difficulty of measuring the quantity of the commodity itself. The absence of any unit of information and the intrinsic heterogeneity of its substance makes it very difficult to think of a price of knowledge.

Another difficulty that Boulding sees is that only things which are clearly capable of being appropriated are subject to being exchanged and that if they cannot be private property, then they cannot be treated as a commodity. While knowledge has many of the aspects of property, its capacity for reproduction in many minds and its accessibility in the form of the published work make it a very peculiar form of property. Boulding cited Price (1965) who quoted J. W. Powell as saying that possession of property is exclusive; possession of knowledge is not exclusive, for the knowledge which one has may also be the possession of another. These difficulties may have led to a certain neglect of the commodity aspect of knowledge.

Arrow (1973) in his presidential address to the American Economic Association expressed his admiration for the accomplishments of the neo-classical economic theory, especially for its productive theoretical insights into the resource allocation process and its ability to give a sufficient answer and explanation to economic questions and problems. Arrow emphasized, however, its inadequacy to answer other kinds of economic questions, such as the existence of unemployment in a capitalist market, and the inequality in economic development among countries and among groups and regions within a country.

These two failures of the neoclassical explanatory mechanisms were linked to its foundations. The economic model, as Arrow perceives it, is founded on two concepts. One is that of the individual economic agent, whose goal is to optimize his utility function subject

to certain constraints. The other is a market which is assumed to equate the aggregate individual demand to the aggregate individual supply at the equilibrium point.

According to Arrow, the existence of unemployment is a direct contradiction to the notion of the smoothly clearing market. He also attributes the differential levels of economic development to a difficulty with the second fundamental concept, which is the condition of optimization.

As Arrow argues, although the model is comprehensible and the motives and constraints are real and important, its simplistic approach disregards other factors. He pointed out that one of the greatest inadequacies of the system was in terms of the apparent minimization of the information needed by the individual to carry out "efficient" transactions. All information about the rest of the system was assumed to be transmitted to the individual via prices.

Arrow hypothesizes that two firms having similar economic positions but with different access to productive information will have different levels of economic development. (The empirical results of Debutin et al., 1975, document such hypotheses.)

The assumption that the market system is informationally economical is not true. The individual agent, while knowing his utility function and production possibility set and also the commodities' prices that he buys and sells, does not know the utility function and production possibilities for all individual agents which are part of the economic system. Also, maximization should consider

future as well as present time. Although the neo-classical economic theory can handle decisions over time, the needed information, such as prices, does not exist. That is because of the absence of the future market, which implies that the optimizer faces a world of uncertainty. The inherent characteristic of information as a commodity, which does not satisfy all the neo-classical norms, prevents the existence of an economic information industry to produce information of predictive value.

Arrow concludes that if we are to take informational economy seriously, we have to add to our usual economic calculations an appropriate measure for the information costs.

Characteristics of Information

Information possesses several characteristics which are helpful in answering questions that are related to information systems design. The understanding of these characteristics is crucial to a discussion of the demand and supply of information which, in turn, can give insight into the value of information and the appropriate role that can be played by both private and public institutions in the use and provision of information.

Most of the characteristics of information have already been alluded to in the preceding section. This section, therefore, only serves to emphasize some points that were made earlier. Information possesses certain characteristics of a public good which leads to allocation inefficiencies when compared to private goods in a competitive economy. The characteristics of uncertainty, indivisibility

and nonappropriability that are peculiar to information all violate the classical properties of purely private goods. The existence of uncertainty is inherent in the definition of information (Riemen-schneider, 1978).

Because private goods are divisible and because there is rivalry for their consumption, they meet both the necessary and sufficient conditions for Pareto-efficiency.³ However, the characteristics of public goods--indivisibility in consumption and nonexclusiveness--inherent in information may lead to "market failure" or inefficient information allocation.

Since information is an indivisible good, the difficulty of achieving efficiency in its production and consumption results from the fact that the marginal cost of adding an additional consumer of information is zero, once the information has been produced. Any price greater than the lowest money value for information to any consumer would inefficiently exclude that consumer. If the price of information is set at the lowest money value assigned to it by a consumer, the total revenue to the producer will probably be insufficient to cover the cost of producing the information (Randall, 1981).

³"Pareto-efficiency is defined as a situation in which every-one is so well off that it is impossible to make anybody better off without simultaneously making at least one person worse off" (Randall, 1981, p. 113). There are three necessary conditions for Pareto-efficiency: (1) efficiency in consumption, (2) efficient product mix, and (3) efficient resource allocation. The sufficient condition for Pareto-efficiency is that all isoquants and indifference curves must be nonconcave (Randall, 1981, p. 118).



Theoretically, Pareto-efficiency can be achieved in producing and consuming information only if there is perfectly discriminatory pricing of information and a universally accepted unit for measuring information. Some mechanism must be found to charge each user of information the money value of the utility derived from the information. It is impossible for the supplier of information to objectively determine the money value of the marginal utility each individual derives from consuming the information. There is also an incentive to the consumer to understate the value of the information (Randall, 1981). Therefore, there is in reality no possibility of achieving Pareto-efficiency for producing and consuming information.

The only remaining options for the public sector in providing information are to provide it free of charge, or to charge a nominal price but sufficiently high to cover the cost.

The nonappropriability of information is related to the concept of property rights (Wunderlich, 1974). The producer or owner of the information does not realize the full benefits of the property alone. It is difficult for information produced to appropriate through market pricing the full social benefits arising directly from production or use of information (Christy, 1980). Since information cannot be appropriated, then it cannot be a commodity in the proper sense of the word.

Lack of appropriability of information has led to underinvestment in its production and has resulted in concerns as to the appropriate measures to take. Suggestions include that of Newman (1976)

who proposed that institutional reforms should be carried out to increase appropriability. But the usual ways of enhancing appropriability include copyright and patent laws, as well as user fees charged for the information. There are, however, some problems. For example, the cost of enforcement with regard to copyright and patent laws limit their use to only selected cases as pointed out by Riemen-schneider (1977). Similarly, the use of user fees requires that the fees be low enough to discourage resale by those who buy the information.

Information and Economic Structure

The demand for information by the public and private sector is greatly affected by the configuration of the major economic sectors in the society and the degree of concentration of these economic sectors. In some sectors, an industry or firm can appropriate all the gains from data collection and analysis that is financed by that association. There are other sectors where the benefits from private investments in data can never be captured by an individual firm or even by an entire industry. The difference is primarily found in the nature of the industrial sector itself.

Christy (1980) analyzed the costs and benefits that can be incurred by the private and public sectors under different market structures. He concluded that as market concentration increases, the cost of information acquisition increases for the public agency, while the cost for the private firm decreases. Also, as market concentration increases, private benefits from information investment



increase greatly, providing a major incentive for the private firm to invest in information and deny access to the public. As market concentration increases, the social benefits from public investment in information to facilitate market coordination decline rapidly, while the benefits from information for public policy and regulation increase. These are similar to the conclusions reached by Bonnen (1977).

Application of the Paradigm in this Study

The Saudi Arabian agricultural information system will be examined in the following chapters in relation to the information system paradigm. In doing so, the author will utilize knowledge of the Saudi Arabian agricultural data base, government publications, questionnaires, and manual references of the 1973 and 1982 censuses and annual surveys. This will be supplemented by information obtained from informal interviews with the head and other informed personnel of the Department of Economic Studies and Statistics and Agricultural Bank and on the author's experience as an enumerator in the 1972 census.

The Saudi Arabian system will be evaluated on the following criteria: How closely does it parallel the paradigm? Does it have the three distinct subsystems (data, analytical, and decision systems)? How accurate and relevant are the concepts upon which the system is based? How are these concepts operationalized and measured? How flexible and dynamic is the system? Does it allow for social, economic, and geographical differences?

Based on these findings, the paradigm will be used to suggest some remedial measures for improving the existing Saudi Arabian agricultural information system.

Summary

This chapter has discussed the information systems paradigm as presented by Bonnen (1975). Essentially, the paradigm consists of a data system, an inquiry system, and a decision maker. The analysis of a problem in agriculture usually starts from a body of theoretical concepts which represent reality. The concepts are then operationalized through the definition of variables that are often specified in a model. This model is then tested against data and conclusions are drawn. The paradigm is an abstraction of an ideal information system and may present some problems when applied to an actual information system. These problems are related to the distinctions between data, and information and to the interpersonal transmissibility of data.

Neoclassical economic theory has not been successful in analyzing the demand and supply of information. This is mainly due to the nature of information which possess certain characteristics that are unique to public goods. These characteristics include uncertainty, indivisibility, and nonappropriability.

The next chapter will attempt to evaluate the Saudi Arabian information system by using the idealized information paradigm.

CHAPTER IV

EVALUATION OF THE AGRICULTURAL DATA BASE
IN SAUDI ARABIA

Introduction

The statistical data base for an agricultural information system in Saudi Arabia evolved out of a response to national development needs. Its growth and effective contributions to development in the future can only be assured if there is a recognition of its value by political leaders, accompanied by scientific progress that facilitates the collection and analysis of the necessary data. It is only in recent years that farm data collection in Saudi Arabia has gained some national respect and recognition. This is not surprising, for even in developed countries, the development of an information system for the collection, processing, dissemination, and interpretation of agricultural statistics has been a slow process. This chapter will attempt to document the demand for and supply of data in Saudi Arabia.

The demand for data is derived from the prior demand for knowledge and information. The demand for knowledge, itself, stems from its consumption value as an end in itself and from its value as a tool in public and private planning--and in program development, implementation, and evaluation, all of which takes place under conditions of uncertainty. It is this uncertainty that is the driving force behind the total demand for data.



Because of the nature of information as a public good, the supply side of the data market in Saudi Arabia is dominated by the national government. The supply side is characterized by a centralized system composed of national ministries and departments, and a decentralized system in which individuals and agencies, typically funded by grants from the government, collect small amounts of data for very specific purposes.

After a presentation of the supply of and demand for data, the balance of the chapter will be devoted to an evaluation of the information system as obtained in Saudi Arabia. The paradigm presented in Chapter III will be used as a basis for evaluation.

The Supply of Data

The supply side of the data market in Saudi Arabia is much more concentrated than the demand side, and is largely coordinated at the ministerial level. A natural consequence of this kind of arrangement is that the data collected better serve the goals of the government and national policymakers than the goals of other areas of demand. Even the decentralized component of the supply of data is also influenced by government initiatives and goals. Individual researchers and agencies collect data on specific issues. But much of the funding for such projects comes from government organizations and the proposals are reviewed by government representatives. Undoubtedly, the judgments of these people about research project viability and priorities are influenced by the goals of the ministries and agencies in which the reviewers are employed.

There are several government ministries and agencies in Saudi Arabia which are responsible for the provision of agricultural data. These include the Ministry of Agriculture and Water, the Ministry of Finance and National Economy, the Ministry of Planning, and the Ministry of Municipal and Rural Affairs. No single ministry or agency within these ministries has the sole responsibilities of collecting and providing agricultural data. Rather, each ministry provides data on certain aspects of agriculture that is of interest to them. The Ministry of Agriculture and Water (MOAW) is perhaps the most important source of agricultural data in Saudi Arabia.

The Ministry of Finance was formally established in 1953 and in 1954 it was expanded to the Ministry of Finance and National Economy with greater power to audit and supervise the accounts of all other ministries. It has the overall responsibility for the preparation of the national budget. Within the Ministry of Finance and National Economy are the Saudi Arabian Agricultural Bank and the Central Department of Statistics. The data provided by the Agricultural Bank are mostly related to credit movements and are usually contained in the Bank's annual financial reports. The data contained in these reports show the number and size of loans, the type and category of loan by geographical region, loan collection and repayment, and agricultural subsidies provided through the Bank. The Bank sometimes publishes research papers on varied topics ranging from estimating farm production costs to estimating demand and supply equations.

The Central Department of Statistics publishes data on all sectors of the economy in its annual statistical yearbook, which was

first published in 1965. The yearbook has data on climate--rainfall, temperature, humidity, and winds; commodity prices; imports and exports; government budget; social data on education, labor forces, population; and others.

The Ministry of Planning was established in 1975 and was formerly known as the Central Planning Organization. Its main function is to plan economic development for the entire country. The Ministry provides data on national plans for agricultural development and on the resources needed to implement these plans. It has been responsible for the publication of the three five-year national plans covering the period 1970-1985. It has also published a statistical book on the accomplishments of the first and second national plans.

The Ministry of Municipal and Rural Affairs was created from the Ministry of Interior in 1975. It is basically responsible for regional planning and community development. The ministry provides data on the natural setting, economic structure, land use, housing, community buildings and networks, for some cities and towns.

The Ministry of Agriculture and Water (MOAW)

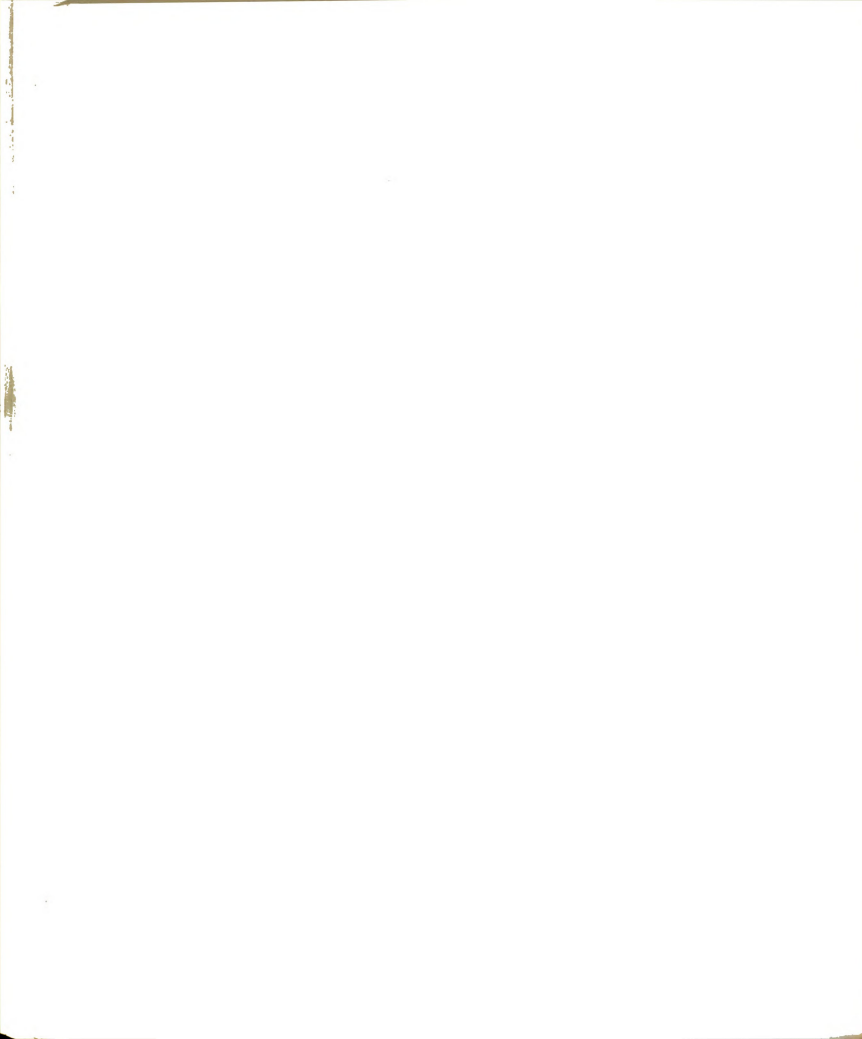
The MOAW carries the major responsibility for developing and implementing plans and programs for the development of the entire agricultural sector. In this capacity, it serves as the most important source of agricultural data and will, therefore, be given a disproportionately greater space in this discussion. The main department within MOAW responsible for the collection and analysis of



agricultural data is the Economic Studies and Statistics Department. This department started in 1960 as a statistics division under the Department of Agricultural Research and Development within the MOAW. In 1979 with the recognition of the importance of agricultural information, the Statistics Division became a separate department under the Director General of Organization, Planning, and Budget who is directly responsible to the Minister of Agriculture.

The Economic Studies and Statistics Department is charged with the responsibility of collecting and analyzing agricultural data and for conducting economic and marketing studies related to agriculture. At present the department has fifteen permanent employees, including agricultural engineers, agricultural specialists, statistical analysts, and administrators. To conduct agricultural censuses and surveys, the department relies on recruiting a number of enumerators for the field work and on consultants from the Food and Agriculture Organization and the joint Saudi-American Economic Committee for the more scientific aspects.

The data provided by the Economic Studies and Statistics Department can be classified into three main categories. First are the basic statistics which refer to data that are relatively stable and don't exhibit significant changes from year to year. Examples of these types of data are the number of farm holdings, land tenure, land use, land fragmentation, agricultural population, and machinery ownership. The second type of data is current statistics. This refers to data on agricultural activities performed more or less



continuously every year and which can vary significantly from year to year. Examples of these types of data include crop hectarages and production, livestock numbers, milk, and egg production and prices. Basic statistics are usually obtained through the decennial agricultural censuses. The lists of the most recent censuses are used as sampling frames to conduct sample surveys from which current statistics are obtained.

In addition to the decennial censuses and annual surveys, occasional surveys are conducted from time to time to meet special needs such as evaluating certain policies, programs, or methods, answering new questions or for studying certain special phenomena. This is the source of the third type of data, special needs statistics, and are usually obtained through one-time surveys.

The department cooperates and consults with other government agencies within and without the MOAW. For example, the permission of the Central Department of Statistics is required before the dissemination of agricultural data. However, the level of interdepartmental coordination and cooperation both between sources and users of the data is minimal and sometimes nonexistent. The lack of effective communication between data sources and data users or between the supply and demand sides of the data market, especially within the private sector, is a major obstacle in the utilization of the data base to meet the needed information.



The Demand for Data

The demand for data is derived from the demand for information. The demand for information on agriculture is simply part of a larger demand for information on all sectors of the economy, all areas, and all people, urban or rural. It is difficult to separate the users of information from the suppliers of information in Saudi Arabia. This is because most of the data collected is targeted toward meeting the specific needs of the agency collecting the data. Nevertheless, the data collected are usually available for use by both the private and public sectors, and by agencies, institutions, and individuals. Among the public sector users of agricultural data, the Ministries of Agriculture and Water, Municipal and Rural Affairs, Planning, Finance, and National Economy and Commerce are probably the greater beneficiaries. Farm input suppliers, farm output traders, importing and exporting firms of agricultural commodities, and commercial farmers also derive a lot of benefits from the data provided.

With the foregoing discussion on the demand and supply of agricultural data, the stage is now set for a closer examination of the Saudi Arabian agricultural information system. The following sections will describe the operating agricultural information system as is currently obtained in Saudi Arabia. This will be done in line with the idealized system described in Chapter III. Wherever necessary, suggestions for improving the operating system will be made.

The Agricultural Information System

In Saudi Arabia the agricultural information system is yet in its infancy. Although it is possible to identify the three subsystems --data, analytical, and decision makers--it is sometimes difficult, if not impossible, to separate the actors of these subsystems. Added to that, there is yet no single subsystem that has developed to the extent of earning both a national and an international reputation. The data subsystem is probably the most developed of the three subsystems. As a result, most of the discussions in this section will be devoted to an examination of this subsystem. First, an overview of the information system will be presented. This will be followed by a discussion of the problems involved in the conceptualization and operationalization of the concepts and on the problems encountered at the measurement stage. A brief statement will be made on the inquiry subsystem. The last subsection on the Agricultural information system will look at the decision-making subcomponent.

An Overview of the Information System

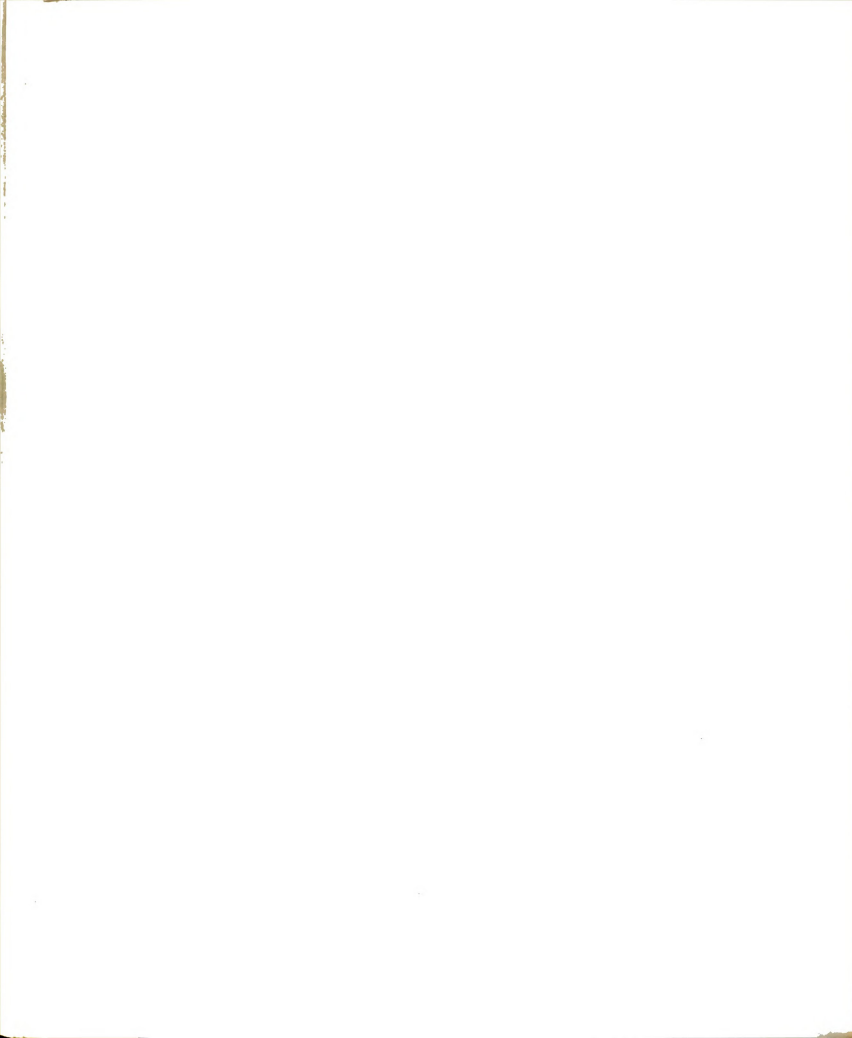
The Agricultural Information System in Saudi Arabia can best be described as a data base or a repository of all agricultural data that is scattered among the suppliers of the data. It consists basically of data elements that are organized into records and files and forms the foundation of the agricultural information system. Because data from all agricultural aspects are not readily available, and the available data are not sufficiently analyzed, the agricultural

information system falls short of meeting the needs of the decision makers and it is plagued by several problems which include a lack of experience, ambiguity of objectives of agencies collecting data, and an inadequate institutional arrangement.

The rapid growth in the agricultural sector in general, coupled with the increasing specialization and commercialization of some subsectors has placed a heavy demand for agricultural information on a system that is set on a primitive stage with very little and very short experience on data collection. The first national attempt to collect a comprehensive set of agricultural data, for example, started in 1960 and ended in 1966. This covered six different regions of the country. A two-stage census was conducted in 1971-72 and 1973-74. The first stage¹ collected current statistics and was based on sample surveys. In the second stage, basic data were collected, and it included all farmers. A second census was conducted in 1981-82. This was also conducted in two stages. The results of this census have not yet been published. It is not known how much has been learned from mistakes in these censuses, but it is clear that two censuses probably do not develop enough experience on which to establish confidence on the accuracy and reliability of the data collected. This is even more so in a rapidly changing society such as Saudi Arabia.

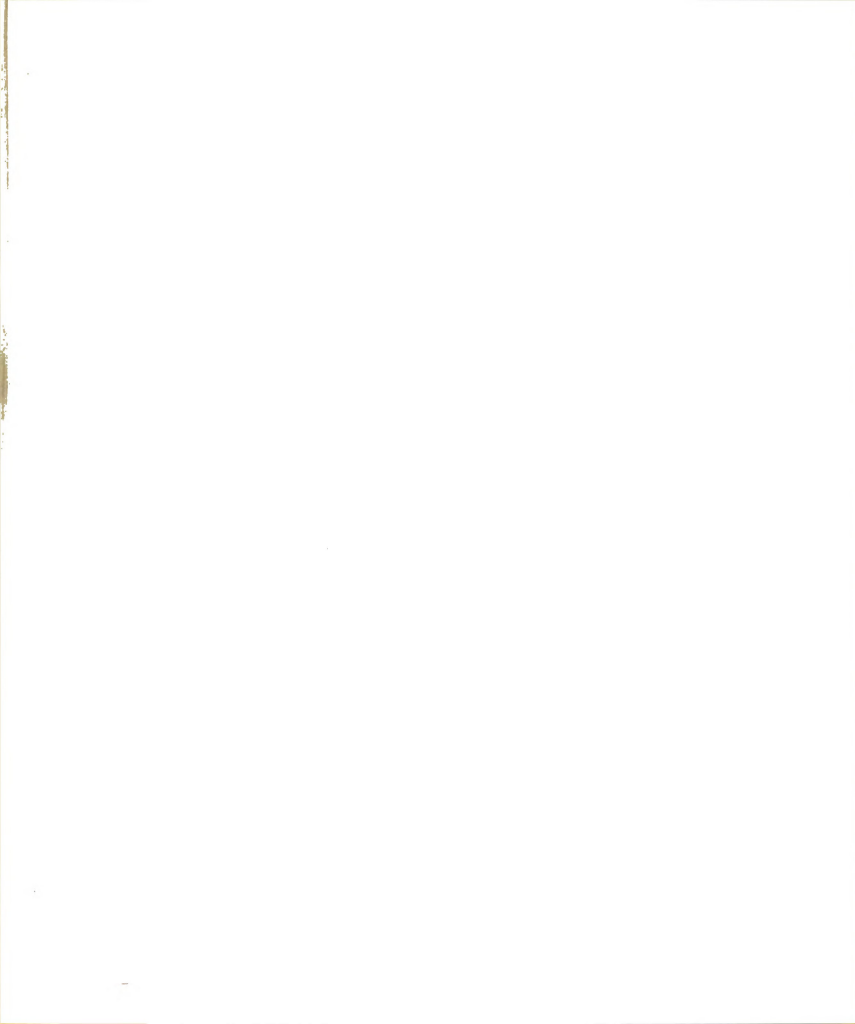
A second problem with the data base may be attributed to a lack of clear objectives for the main supplier of agricultural data--

¹It is difficult to consider the first stage as a census because it was based on a sample survey. Also the two stages of the census did not relate to one year.



the Economic Studies and Statistics Department. The main responsibility of this department, as described by its head, is that of data collection (including questionnaire design), and data analysis of all agricultural data. It is also expected to carry out economic and marketing studies, if and when necessary. The objectives of the department are not well defined. As a result, the data that are collected are targeted toward meeting the needs of the public sector. While this approach was justifiable twenty years ago, when private demands for data were limited, the changing nature of the current agricultural system demands a broader approach which will require the identification of all potential users of the data collected and their specific needs. On the other side, all data suppliers and the types of data they supply need also to be identified. This identification will facilitate better communication between data suppliers and data users for both the public and private sectors. In the end resources devoted to the collection of unwanted data could be saved and better utilized for other purposes. It is recognized that because of the public nature of information, public agencies, funded by public institutions will continue to be the major data suppliers.

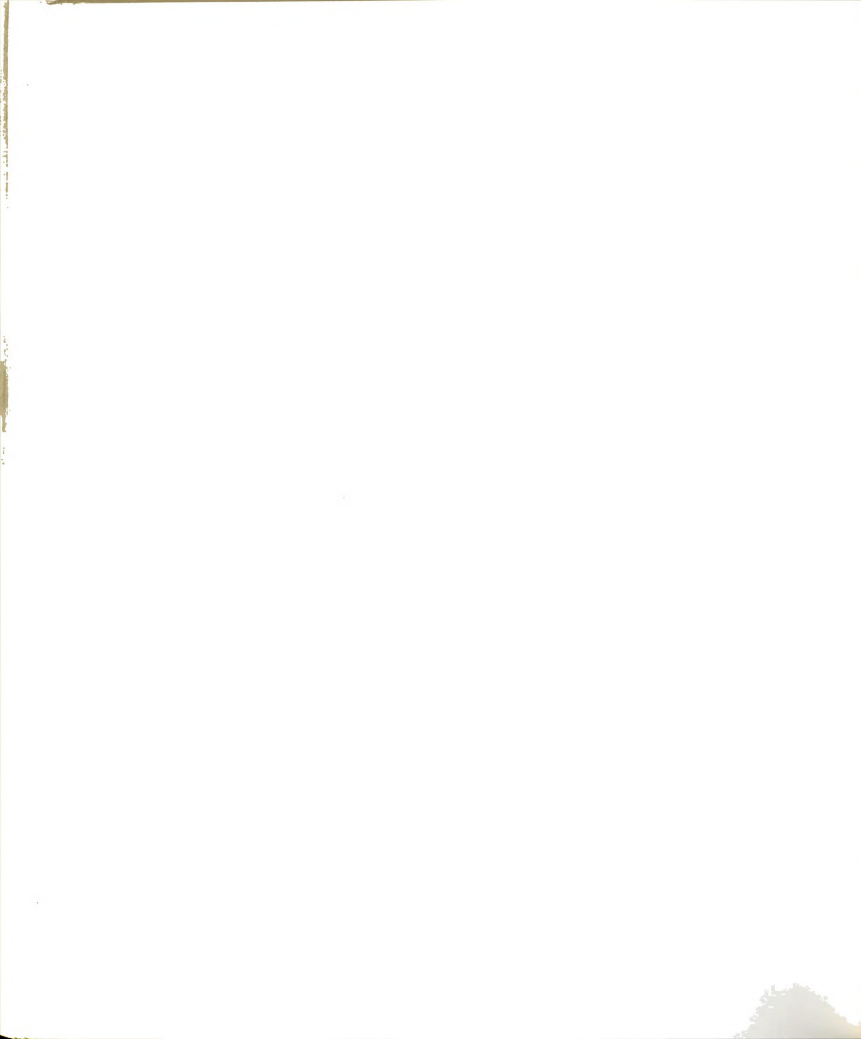
Answers to questions of why the data are collected, whom do they serve, what are the national priorities, and what are the needed indicators are a necessary first step before any data are collected. There are unlimited numbers of data elements that can be collected, but the resources to collect these data elements are certainly not unlimited.



Inadequate institutional arrangements are another major obstacle to an efficient operation of the information data base. Census legislation, for example, constitutes one of the most important instruments in facilitating the conduct of a census and is a first step in the planning of any census. This legislation, however, is nonexistent in Saudi Arabia, even though about two censuses have already been carried out.

Census legislation will empower the department of Economic Studies and Statistics to conduct censuses at fixed intervals of time on a regular basis. The legislation will detail out such matters as the scope of the census, the obligation of enumerators, or others handling the data with respect to their protection and penalties for noncompliance and disclosure of information. Farmers, in turn, can be required to fully cooperate when information is being solicited from them. They must be assured of the confidentiality of the information and of the use of the information. Most importantly, farmers need to know that the information obtained from them will be used purely for statistical purposes and will not be used for the collection of zakat; for property registration nor for any other purposes that can threaten their individual rights.

The institutional arrangements are such that there is a lack of coordination of activities between the different suppliers of data. The need for accurate, reliable, and timely information is not limited to agriculture alone, and the production of data for agriculture is not confined to the Ministry of Agriculture and Water. Other sectors



of the economy have their own information systems which provide data that relates directly or indirectly to agriculture. In drawing up the functions and responsibilities of these ministries and agencies, there is a need to consider the interdependence between these agencies and to establish a link of direct communication between them. This arrangement can lead to several advantages. At the minimum, the overlap and duplication of efforts can be minimized. At present, several agencies devote the limited available resources in collecting data that could be obtained from other agencies at little or no cost. A clear and unambiguous objective for each supplier of data and an open link of communication between agencies could result in a wider scope of data collected as different agencies devote time and energy to the collection of other data that might be needed, but is unavailable.

Another advantage of a well-coordinated inter-agency activity is related to a unified use and definition of certain concepts and variables. Consider, for example, an independent researcher who is forced to use secondary data for certain concepts such as farm, farm income, labor force, or prices. If the data for any given concept or variable are obtained from different sources where they were perceived or defined differently, then a researcher who assumes that the concepts or variables are homogeneous may make erroneous recommendations. This can be illustrated by an example. Suppose that a researcher wished to study the factors affecting "farm income" during the last two decades. He hypothesizes that farm income, Y , is a function of N



independent variables, $X_1, X_2 \dots X_n$. In obtaining data for farm income, assume that the researcher gets data for the first decade from Source A and for the second decade from Source B, and that both sources defined farm income differently. Failure to recognize the differences in the definitions of the farm income concept may lead to misleading results.

To allow for comparability and to enable the analysis of different indicator parameters for the same time span and region, both temporal and geographical dimensions need to be taken into account when different agencies are being formed, and when different information systems are being designed. In Saudi Arabia, these dimensions have long been neglected. For example, the first agricultural census was conducted in 1971-72 for current data and in 1973-74 for basic data. On the other hand, the first population census was carried out in 1974. There is a difference of at least two years between the current data of the agricultural census and that of the population. Even though the second agricultural census was conducted in 1981-82, the second population census has yet to be carried out. This difference in time of conducting census makes it difficult for the population census data to be used together with the agricultural census data.

The reporting of data by regions also offers difficulty in comparing different data sources. For administrative purposes, the country is divided into fourteen districts. The results of the first population census were reported according to the fourteen administrative districts. However, the results of the first agricultural

census were reported differently. The first stage of the agricultural census on current statistics was reported for twelve different Amarats (regions) while the second stage on basic statistics were reported for seventeen Amarats. The annual sample surveys for the current data in 1970-75 were reported for twelve principal Amarats, while the same statistics for 1976-77 were reported for eleven principal Amarats. The Agricultural Bank reports its data for the whole nation based on its twelve branches. The Ministry of Labor and Social Affairs report their statistics for five regions. The geographical inconsistency in reporting the national statistics does not allow for comparability between regions and for the simultaneous use of these statistics for one region.

Conceptualization

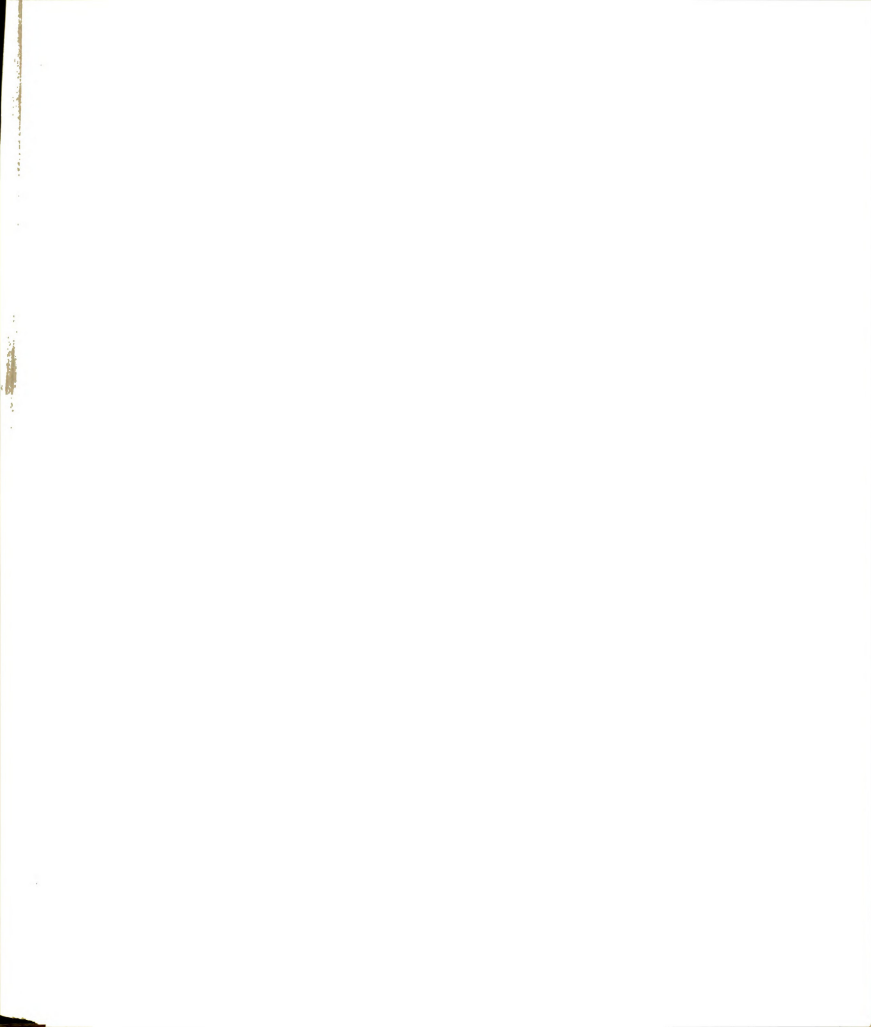
The first step in the building of an information system is the development of the appropriate concepts as was described earlier. Concepts are abstract constructs, in one's mind, which purport to represent reality. Because of the dynamic nature of the social system and the environment, reality changes over time and so must the concepts. When concepts remain static and reality changes, then there is a problem of conceptual obsolescence. In an operating information system, conceptual obsolescence can be of two types. First, a concept becomes obsolete when it fails to represent adequately the reality of the situation for which it is designed. A second type of obsolescence occurs when a concept fails to meet the needs of a



decision maker as the issues facing the decision maker change. Hence, data concepts can become obsolete when either reality (actual or perceived) changes or when the agenda facing decision makers changes (Bonnen, 1977; Riemenschneider, 1978). These problems are often related, but not necessarily so and causality may run in either or both directions (Klein, 1979).

In the Saudi Arabian agricultural information system, examples of the two types of conceptual obsolescence abound. Conceptual obsolescence becomes evident as data systems age. Although it is only ten years between the first and second agricultural census, the rapid economic growth and the rapidly changing government agricultural policies have resulted in a need to reconsider the concepts upon which these censuses were based. An example of conceptual obsolescence is evident in the concept of the basic unit of observation, the farm or agricultural holding.

The concept of holding in 1982 is different from what it was twenty years ago. This difference, however, has not been reflected in the operationalization of the concepts. In 1960 farmers were more or less homogeneous in several characteristics and production was of the subsistent nature with farmers totally dependent on their farms for their family's livelihood. During the 1970's a new phenomenon of specialization and commercialization began to emerge in Saudi Arabian agriculture. Farmers no longer had to produce all of the food their family needed on their farms. Also the introduction of new technology and the investments of millions of Saudi Riyals facilitated



the commercialization of farms. Some farmers, on the other hand, have even abandoned their farms as food production units or as main sources of income and have instead relied on other, more lucrative, sources of income while using the farm for recreation or residential purposes. These changes in the farmers' perception of their farms resulted in a conceptual obsolescence of data as related to the concept of holdings.

Another example of a failure at the conceptualization stage is related to the concept of arable land. In 1965, Draz, based on earlier estimation, reported that total arable land available in Saudi Arabia was more than 368,000 fedans or more than 1.5 million hectares. This estimation is still the official estimate of arable land. In 1982 the Saudi Arabian Agricultural Bank reported, for example, the total arable land to be between 1.5 and 2.0 million hectares. Regardless of the method used in arriving at these figures, this kind of estimation implicitly assumes a static concept of arable land. In theory, the amount of arable land available is limited by the physical land that is available. However, the arable land that is available at any given period of time is dynamic in nature. It is easy to see why specification of the amount of arable land available can become obsolete if no time span is indicated. Changes in technology and other socio-economic factors all affect the amount of arable land that is available.

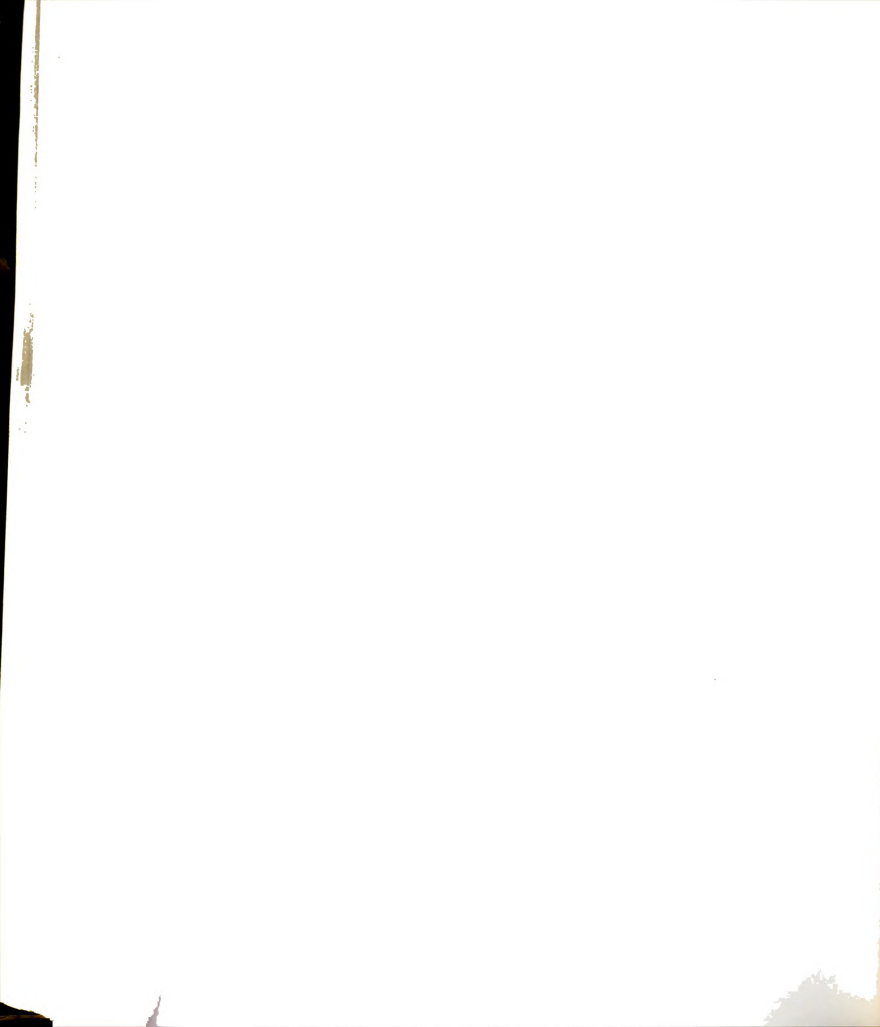
Assuming that arable land means land which can generate sufficient income to keep farmers operating that land, then the availability of such land for a given region or country may increase or decrease



over time as a result of natural occurrences--floods, earthquakes, and volcanoes,--technological changes or socio-economic changes. The application of the available technology and/or the development of new technology can bring about new land into cultivation which was heretofore considered nonarable. The proper and adequate use of fertilizer and other maintenance schemes would likely bring marginal land into what would be classified as arable land. Also the use of the new and efficient method of sprinkler irrigation, for example, would bring more land into cultivation which was previously uncultivable due to water scarcity.

Economic changes can also play a role in determining the size of available arable land. In the case of Saudi Arabia, the increase in agricultural output prices, the reduction in production costs through various subsidy programs, and the increase in demand due to increased income and population would likely induce the cultivation of land previously classified as marginal. On the other hand, the use of rich agricultural land for urban and industrial purposes, because of higher return in this sector, is likely to reduce the amount of arable land available. In practice, all the above factors interact to change the size of the arable land.

With the above discussion in mind and taking into consideration the rapid changes that have taken place in Saudi Arabia in the past two decades or so, estimated arable land prior to 1965 can hardly adequately represent the realities of 1982 and beyond unless the shaky assumption that an equal amount of arable land has been lost and gained to agriculture is made. Such an assumption, however, is



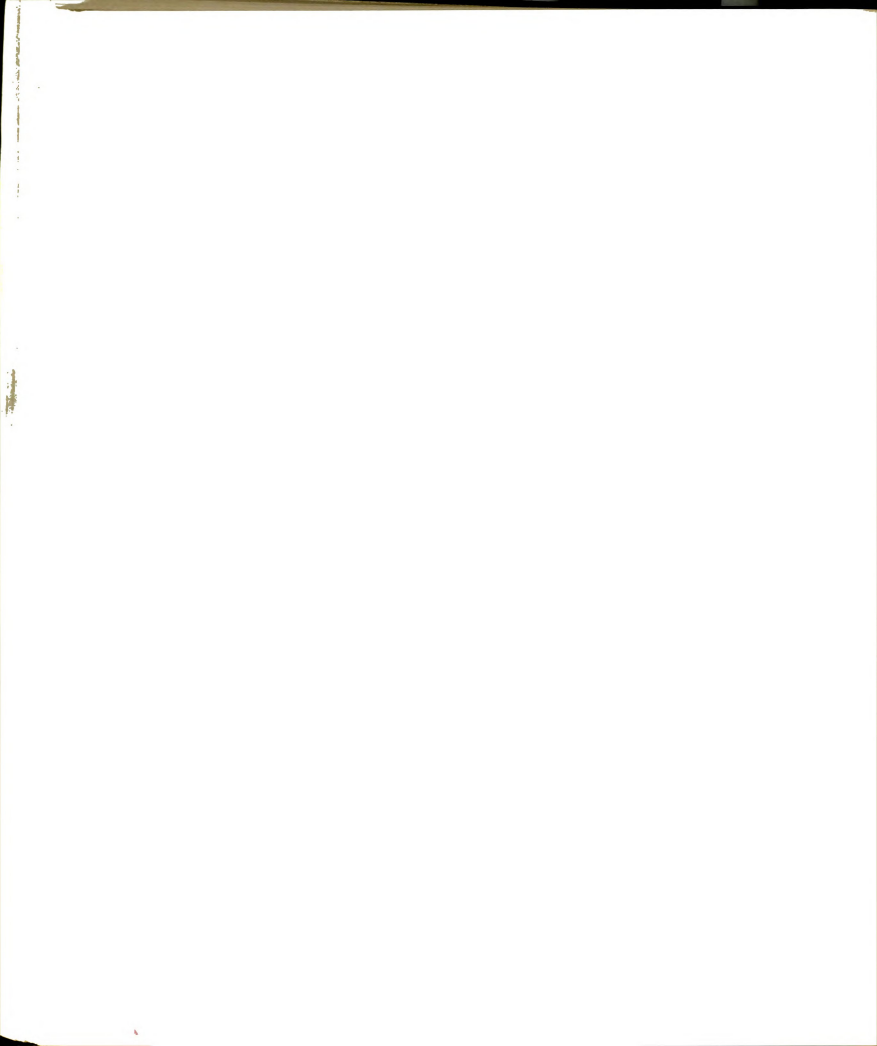
tenuous. Reality has changed, but the same estimate made twenty years ago, of an obsolete concept is still being used by the Agricultural Bank and is the basis of Saudi Arabian planning for agriculture.

Another source of conceptual obsolescence is related to the inadequacy of the data, provided by the Ministry of Agriculture and Water, to answer new questions and issues facing both private and public decision makers. One of the main objectives of the country's agricultural development, and which was explicitly stated in the third national development plan (1980-85) is to provide the opportunities for attaining a reasonable agricultural income and to raise the welfare of rural people so as to achieve a balance between the economic and social rewards attainable in rural and urban areas. In order to formulate sound policies that are designed to achieve this objective, the government would need at its disposal a set of detailed data on farm and nonfarm incomes and expenditures. Such data must not only allow for inter- and intra-sectoral comparisons, but must also lend itself to inter- and intra-spatial comparisons. Such data are not solicited in the questionnaires for the second census in 1982 and for the annual surveys in 1980-81. Without this kind of data, it is almost impossible to give an accurate estimate of the aggregate income generated from the agricultural sector. Therefore, comparisons between the agricultural sector and other sectors of the economy and comparisons within the agricultural sector itself are almost impossible.



The Ministry of Finance and National Economy provides estimates of the Gross Domestic Product (GDP) by industrial origin. If these estimates are reliable, then it is possible to make comparisons between the agricultural sector and other sectors in the economy. However, the accuracy of these data is suspect especially when there is no document to show how the estimates were made and how the data were collected. Most of the agricultural data from the Ministry of Finance and National Economy can best be described as educated guesses. More accurate and reliable data on the agricultural sector can be obtained from the Ministry of Agriculture and Water if the census and survey questionnaires are redesigned for this purpose. In addition, aggregation of data by industrial origin tends to mask a lot of information which can be useful in designing policies that will help to narrow the rural-urban income gap.

Policies that are based on industrial aggregates tend to be misleading. Within the agricultural sector, for example, there exists a wide range of regional income differentials. It will be erroneous to assume that farm income is homogeneous across all variables. In addition to regional differences, there are also differences in farm size, and commodity cultivated that will lead to substantial differences in income within the agricultural sector. Farm income, in the Eastern part of the country may be higher than farm income in the north. Within the same region the farm income of wheat producers may be higher than that of date producers and for farmers cultivating the same crop, farm income of large farmers may



substantially differ from those of small farmers. Sound policies will need to take these differences into consideration.

The new government trend which develops legislation on commodity by commodity basis emphasize the need to have a detailed, rather than aggregate data. For example, wheat producers are guaranteed a price of SR 3.5 per kilogram by the grain silos and flour mill corporations. This price is close to three times the international market price. Also livestock and poultry producers can buy feed at very low subsidized prices. The current data subsystem is obsolete as it has failed to change with changing government policy and emphasis.

The Ministry of Finance provides data on the average wholesale and retail price of all imported agricultural commodities. No such information is available for the domestically produced agricultural commodities. This is despite an open demand for such information by both private and public decision makers. There are large seasonal price fluctuations and regional price differences due to poor market information. These have been accentuated by poor agricultural infrastructure, inadequate transportation systems, and poor storage facilities. The lack of specialized transportation systems for perishable commodities such as milk, eggs, and vegetables is also a contributing factor. This lack of needed data in the Saudi Arabian Information System is another example of conceptual obsolescence that has plagued that system.

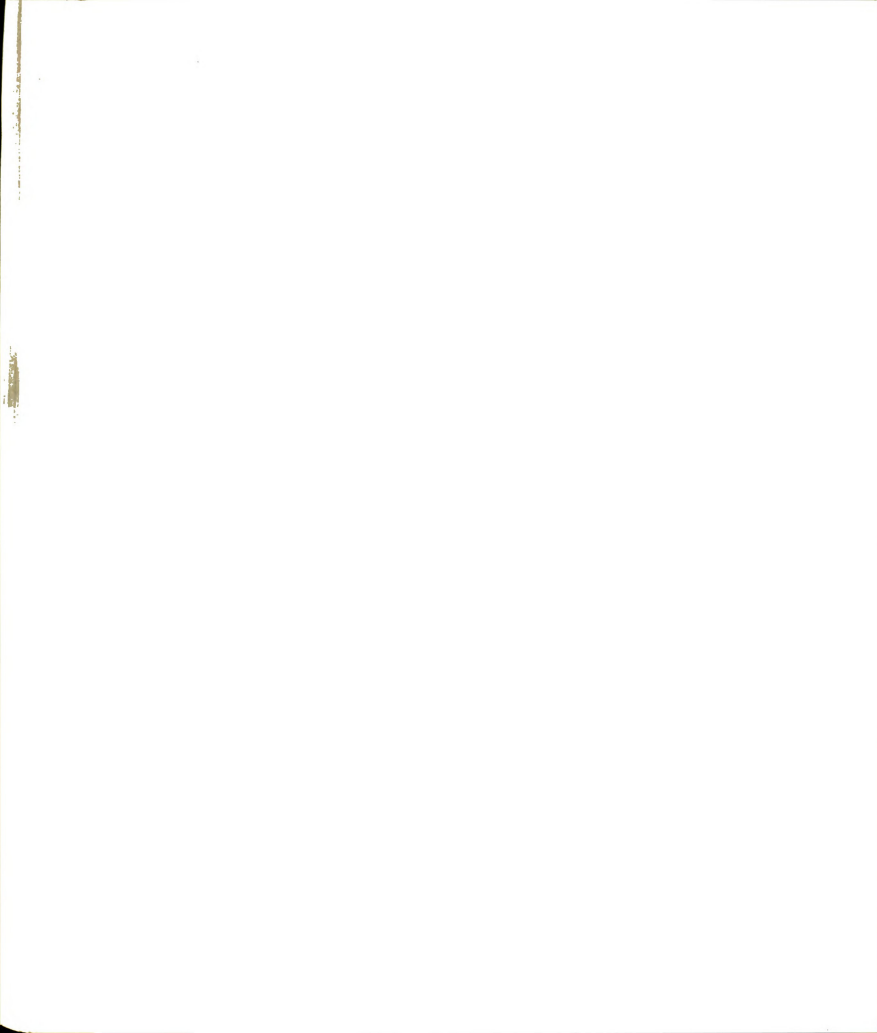


Operationalization of the Concepts

The first step in the process of producing data and then information is to either implicitly or explicitly develop a set of concepts to portray and reduce the nearly infinite complexity of the real world in a manner that can be grasped by the human mind. However, concepts cannot be measured directly. Instead, concepts are operationalized by defining variables which are as highly correlated as possible with the reality of the object of inquiry (Bonnen, 1975).

One cannot over-emphasize the importance of this step in the process of information production. The agricultural data base in Saudi Arabia suffers major deficiencies at this stage. In designing the questionnaires for the agricultural censuses and surveys, for example, some variables are either not precisely defined or due to the lack of interdepartmental coordination, the definition of one variable may differ from source to source.

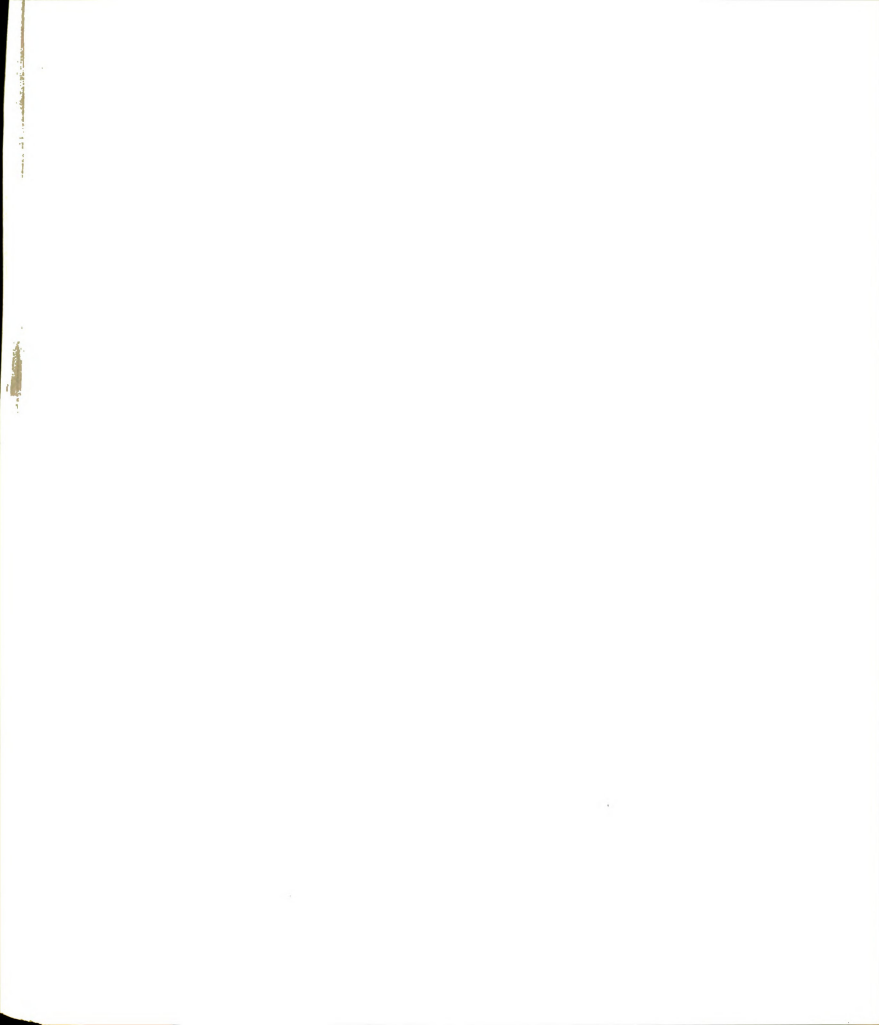
Again the basic unit of observation--the land holding--can be used as an example here. Since 1960, Saudi Arabia has been using the FOA's definition of operational holding as its basic unit of observation with very little modification. In the 1974 census of agriculture in Saudi Arabia, the land holding was defined as land which is wholly or partly used for agricultural production and may consist of one parcel of land or more and managed by one operator. The operator may be private or government firm, cooperative, or tribal holding, and the operator may own or rent the land. In 1982 the holding was redesigned as land within one village which is wholly or partly used for



the purpose of animal or agricultural production and may consist of one parcel of land or more, but administratively and technically managed as one unit by one operator or with others without regard to ownership, legal form, and size.

There are several shortcomings in the above definitions of the holding for agricultural census purposes. As defined in the last two censuses, the holding has no upper or lower limits which makes the inclusion of a wide range of holdings with different sizes possible. Practical considerations may dictate that limits be set. For example, it may be possible to limit the enumeration of holdings only to those above a given minimum size. This minimum size could be set as low as possible because most of the holdings are very small. For example, Abu-Baker (1976) presented a table derived from the 1974 census which showed that 4,216 holdings or 52 percent of the holdings in the Alhasa oasis in the Eastern part of the country had farm sizes of less than 5 donum, but they accounted for only 14 percent of the cultivated land or 12 percent of the total land holdings. However, the minimum should not be set too low as to adversely distort the results of the census. The establishment of a minimum size is advocated here not only because there will be cost savings and reduction of logistical problems, but also because inclusion of very small holdings may result in a downward bias of the results reported.

Idaikkadar (1979) contends that if no minimum limit is placed house compounds with a few fruit trees, kitchen gardens growing some vegetables and households keeping a cow or a few birds for eggs would all become eligible for inclusion. These would increase costs, delay



the results and seriously distort the averages. Similar arguments against the inclusion of very large holdings can also be made. Where a few of the farmers own a large proportion of the land, their inclusion will tend to have an upward bias in the averages reported.

Although the land holding may be precisely defined at a given period for specific purposes, their comparison from one census to another or from one agency to another might be difficult. The above definitions of land holding in the two censuses differ in the sense that in 1974, the land holding of a farmer had no village restriction, while in 1982 this restriction was added. This means that in 1982 a farmer who owned land in more than one village may either be double counted or the size of his land holding might be reduced even though he might be owning the same size of land he owned in 1974.

For statistical purposes different agencies may define the farm differently in accordance with each agency's specific objectives. Under the scheme for redistributing barren land, the Ministry of Agriculture and Water (MOAW) assumed a minimum size of 50 donum per family. From the MOAW point of view, this implicitly determined the minimum size of land capable of supporting an average farm. In giving out loans, the Saudi Arabian Agricultural Bank defines three different farm sizes as follows:

1. small farms--farms which either do not exceed 100 donum or the investment does not exceed SR 500 thousand
2. medium farms--farms with more than 100 donum, but less than or equal to 500 donums or with investments that

are more than SR 500 thousand but less than or equal to SR 2.5 million

3. large farms--refer to those that either exceed 500 donums or have investments of more than SR 2.5 million (Saudi Arabia, N.D.c)

The types and size of loan received is determined by the size of the farm.

The Ministry of Finance and National Economy collects zakat from farmers or livestock owners who possess the Nisap. This represents the minimum taxable income from a given product. These kinds of differentiations show what each agency considers its criterion for the establishment of a minimum farm for its purposes.

As the few examples above show, there is no universally accepted method of determining the minimum size. Several criteria such as land size, value of production, value of investment, number of livestock, or trees or a combination of two or more of these could be used. For statistical purposes, it is necessary for Saudi Arabia to have a national definition of a holding. Depending on the structure of the agricultural sector, some countries have attempted to establish a guideline for the definition of a farm. In Indonesia, for example, a holding is considered a farm if the farmer operates one-tenth of a hectare in crops, or ten heads of cattle/buffalo, or 50 goats/sheep or 100 birds. In Sri Lanka a holding of one-eighth of an acre is considered a farm (Idaikkadar, 1979).



In the United States, the farm is defined as any place from which \$1,000 or more of agricultural products were sold or normally would have been sold during the census year (U.S., 1982).

Among the different definitions, one may ask, which one of them could be adapted for Saudi Arabia? The criteria used in Indonesia is inappropriate because each agricultural product has a different criteria. Most farmers are involved in the production of more than one product. The land criteria used in Sri Lanka is also inadequate because it does not take cognizance of the variations in soil fertility and moisture availability. In order to avoid these problems, but at the same time capture their effects on the farm, Saudi Arabia may have to adopt a definition that establishes a minimum money value. But determining a minimum money value is problematic especially when censuses occur only once every decade. This means that the minimum value may have to be updated every time a census is taken. Thus, the criteria adopted must be flexible enough to be updated without loss of consistency.

Loss of consistency is exemplified in the United States' definition of a farm. This definition has been changed nine times since 1850 when the minimum criteria defining a farm for census purposes were first established. The second to the last definition defined the farm as any place with less than 10 acres from which \$250 or more of agricultural products were sold or normally would have been sold during the census year or any place of ten acres or more from which \$50 or more of agricultural products were sold or normally would have been sold during the census year (U.S., 1981). When this



definition and the most recent definition are compared, it is evident that there is an inconsistency. The first definition had both a land size and product value restriction. In the most recent definition, there is no land size restriction.

From the different criteria used by the Ministries in Saudi Arabia, only that used by the Ministry of Finance and National Economy has an implicit minimum value of production based on the Nisap. As shown in the second chapter, however, there are different Nisaps for different products each with a different money value. To overcome this problem, the average value for selected product Nisaps could be used as a minimum money value. A combination of this average with the definition used in the 1974 census could be an appropriate definition for Saudi Arabian farms. Thus, the farm holding could be defined as follows:

Any land which is wholly or partly used for agricultural production and may consist of one parcel of land or more and managed as one technical unit from which the value of an average Nisap (VAN) or more of agricultural products were sold or normally would have been sold during the census year, regardless of title, legal form, or size.

The value of an average Nisap (VAN) in time t is calculated as follows:

$$(VAN)_t = [(VNS)_t + (VNW)_t + (VND)_t]/3$$

where

$(VAN)_t$ = the value of an average Nisap at time t

$(VNS)_t$ = the value of Nisap of sheep at time t

$(VNW)_t$ = the value of Nisap of wheat at time t

$(VND)_t$ = the value of Nisap of dates at time t

The value of Nisap of sheep in 1995, for example, would be determined from the value of 40 average sheep at 1995 market prices.

This definition is dynamic, easy to understand and update, and is consistent. The concept of Nisap is easily understood by Saudi officials and farmers. The selection of the three commodities to be included in the average Nisap is not random. They represent the three most cultivated products in the three major agricultural categories of livestock, grain, and fruits. In 1981, the total number of sheep in Saudi Arabia was estimated at 2.7 million, making it the highest among the livestock. Dates and wheat are the single most important crops in the fruit and grain categories, respectively. In addition, the three products are cultivated almost everywhere in Saudi Arabia.

Another concept that presents operational problems is that of the labor force. Labor is the most important factor of production in traditional Saudi Arabian agriculture. However, by its very nature, the definition and analysis of this factor of production has in the past presented some problems, and to present there is no universally



accepted method for dealing with it. There is a need to distinguish between the amount of labor available, which is a stock concept, and the amount of labor actually utilized, which is a flow concept.

The definition of how much labor is available is somewhat arbitrary and it depends on who is included in the labor force and how many hours they are able and willing to work. The size of the family labor force depends upon the age at which children are expected to help on the farm and in other productive activities and whether women and old people are included. The size of the labor force will also depend on the definition of the farm.

In the two censuses conducted, agricultural work was defined to include all agricultural activities of the holder or the manager and the workers in the holding or other people and includes field work, planning, feeding, and caring for livestock and poultry, supervising agricultural workers, keeping farm records, taking farm products to market, and repairing and constructing farm buildings, and similar activities. The agricultural worker, then, included any person who was engaged in agricultural work and was either paid in cash or kind; or any unpaid worker who worked for his family or for others. Agricultural workers were classified into (a) permanent workers--those who worked for six months or more during the census year; (b) temporary workers refer to those who worked for three months or more, but less than six months during the census year; and (c) occasional workers referred to those who worked for less than three months during the census year.

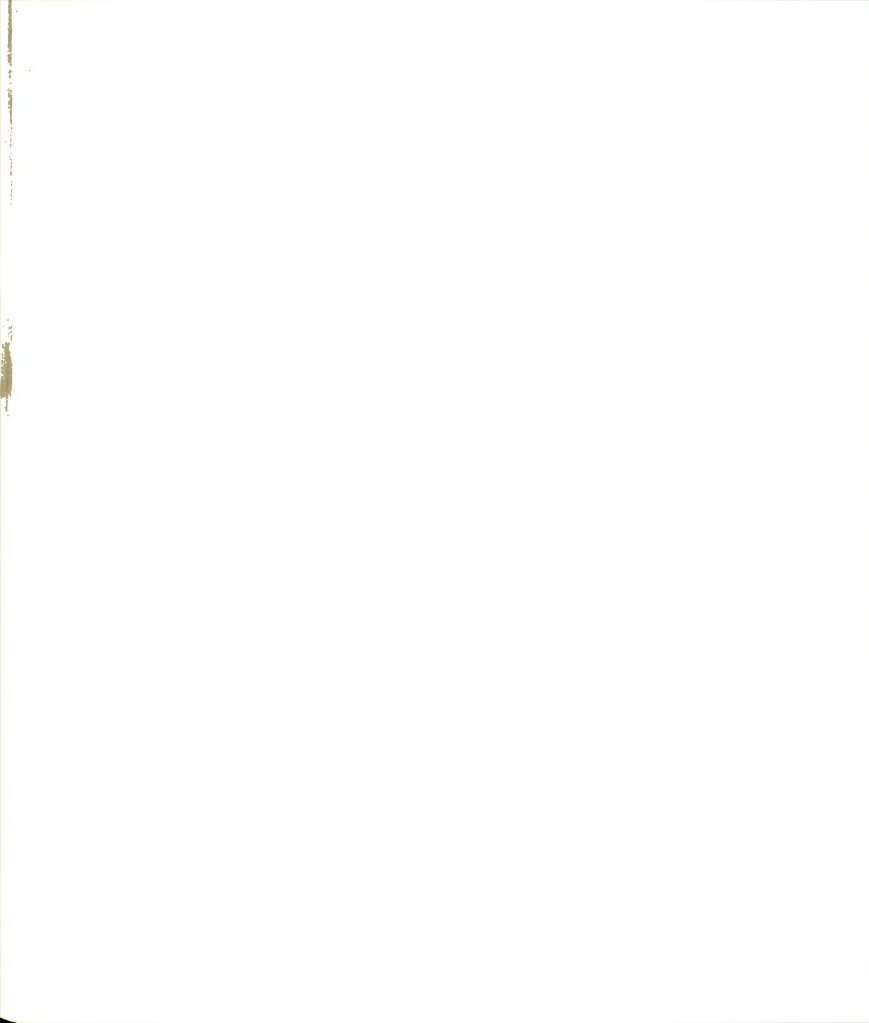


Unlike the census of 1974, the one in 1982 neglected the age of the worker in collecting the stock information and there was no attempt to estimate labor input in the holding. The 1973/74 census questionnaire (see Appendix A) divided agricultural workers into three age groups--less than 15, 15 to 64 years, and 65 and over. These divisions were not taken into consideration in 1982 (see Questionnaire in Appendix B). Also, the labor force section in the 1974 census referred to employment of workers during the census week while that of 1982 referred to employment during the whole year of the census. In 1977 the Central Department of Statistics conducted a survey on the labor force, including agricultural labor, in Saudi Arabia. This survey obtained stock information for only people who were twelve years or older. In addition to the problem of the inconsistency of the data obtained, all the data collected could only be used to estimate the stock of labor.

The stock concept, however, gives a misleading picture of the labor force. The important factor to consider is the flow concept, which identifies the number of hours of actual work. This gives a better representation of employment or unemployment in Saudi Arabian agriculture than the stock concept. It may be necessary to categorize the labor flow by sex, age, and type of farm work.

Data Collection

Data collection and measurement is an important step in the data subsystem of an information system. When reality is conceptualized and operationalized, the next step is that of actual observation and



measurement. A superb questionnaire design based on clear and refined concepts, and well defined variables is certainly incomplete if the data collection is incompetent. Competency of the data collection, however, is essentially a function of the enumerators and the ability of farmers to communicate. Although this stage enjoys considerable attention, when compared to other stages in the Saudi Arabian agricultural information system, it still suffers from major problems. In this section some of the problems encountered in obtaining accurate and reliable data will be highlighted. Before discussing these problems, the administrative organization for conducting censuses in Saudi Arabia will be presented.

For the 1982 census the country was divided into six regions to which a general supervisor was assigned for each region. These general supervisors held various permanent positions in the Department of Economic Studies and Statistics and had to directly report to the head of the department who was responsible for planning and implementing the various aspects of the census. Each general supervisor had a chain of supervisors who, in turn, supervised a number of enumerators. The number of supervisors and enumerators in each region depended on the tasks they were expected to accomplish. The functions and responsibilities of each position--general supervisor, supervisor, and enumerator--are detailed out in the reference manual for the census. The chain of command was made very short and flexible in order to avoid bureaucratic red tape (Saudi Arabia, 1982).

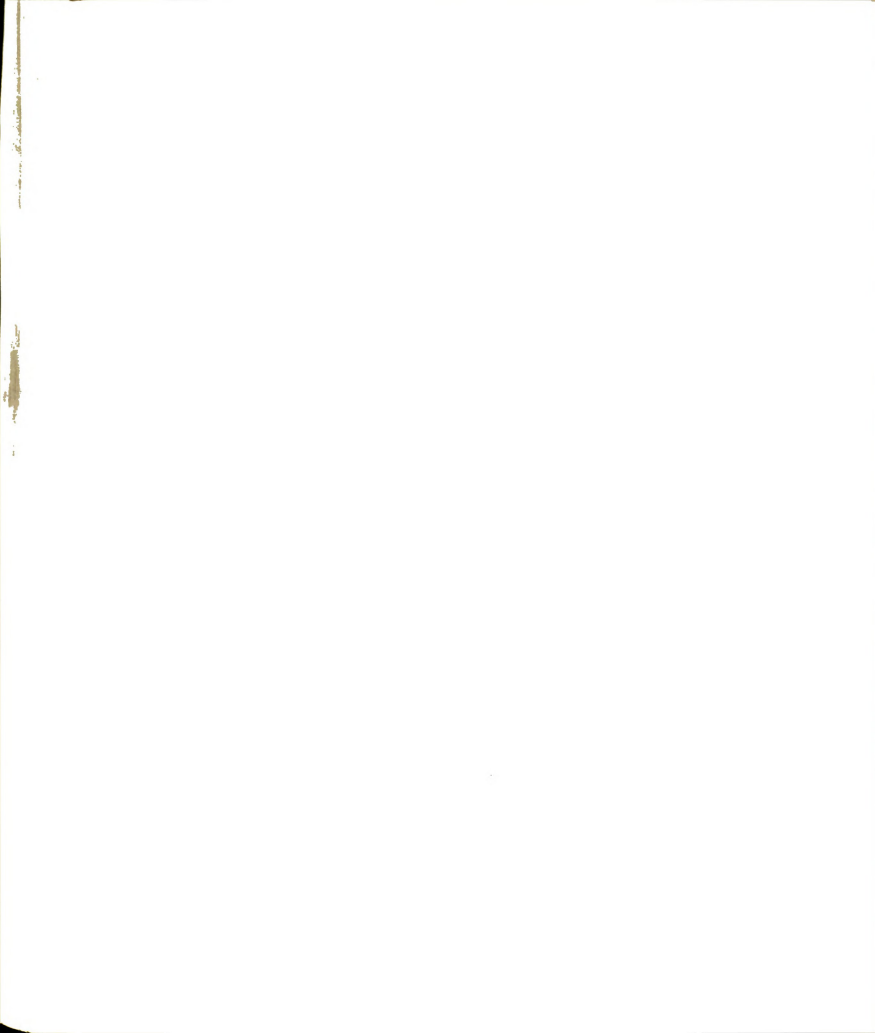
Measurement errors are generally of two types--sampling errors and nonsampling errors. Sampling errors arise as a result of making



incorrect inferences about the population from a nonrepresentative sample. Sampling errors include both errors in precision, as well as bias in the sample frame. The last decade, 1971-81, in Saudi Arabia has seen an improvement in sampling methods for the annual surveys. For the first five years, 1971-75, the sampling unit chosen was a cluster of holdings or villages. The sample frame consisted of 8,000 villages, with a total of 190,000 holdings, divided into twelve principle Amarats. Independent samples of the villages with probabilities proportional to the size of the village (number of holdings in the village) were drawn from each Amarat with replacement. The allocation of the sample size to various Amarats was also made in proportion to its size. The size of the sample was not indicated, except that it was determined purely on the basis of available resources of personnel, funds, and other materials (Saudi Arabia, N.D. d).

Based on the agriculture census of 1974, the sample frame was updated in 1976-79 to include 8,820 villages containing approximately 180,670 holdings. The sample frame was then stratified into eleven principal Amarats, instead of twelve. A two-stage sampling procedure was then adopted. In the first stage, independent samples representing 20 percent of the total villages in the country, with probabilities proportional to the size of the village were drawn with replacement. In the second stage, a sample of 10 percent of the total holdings in each village was selected (Saudi Arabia, N.D. E).

In 1980 and 1981, the sample frame was updated again to include 8,880 villages containing about 203,910 holdings. The sample

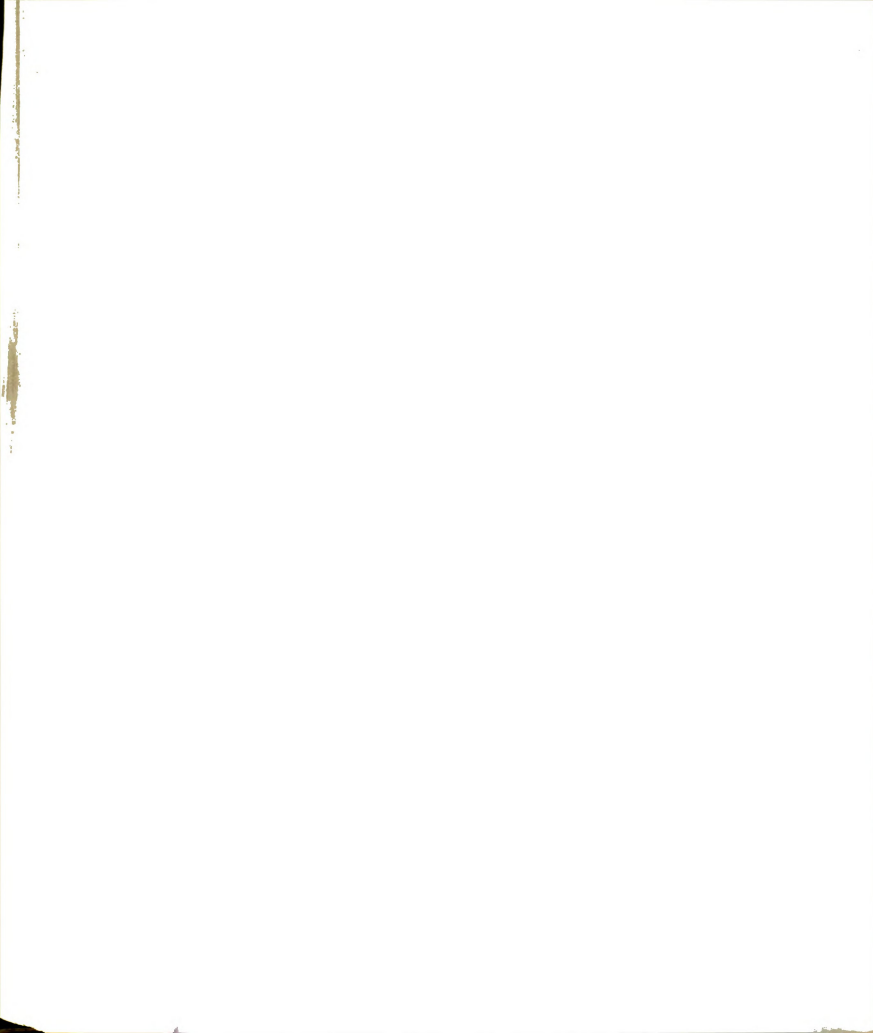


frame was again stratified into eleven Amarats and a two-stage sampling procedure adopted. The proportion of villages at the first stage was still 20 percent, but the proportion of holdings in the second stage was increased to 50 percent. Thus the total sample size was equal to 10 percent of the holdings in Saudi Arabia (Saudi Arabia, N.D. F).

It is encouraging to see that the sample size has been increasing from one survey to another. The increased sample sizes, if done correctly, will help to minimize sampling errors and make inferences about the population more reliable.

Some nonsampling errors in Saudi Arabia are directly related to both the enumerators or interviewers and the farmers or respondents. One of the major problems at the data collection stage in Saudi Arabia has been the lack of adequately trained and qualified personnel in the scope and purpose of the census, understanding of the questionnaire, and in interviewing techniques. The reliance on unqualified enumerators with little or no agricultural background and no knowledge of the socio-cultural setting of the rural population is likely to introduce biases in the estimated parameters.

Coupled with the lack of trained personnel is the lack of adequate and efficient transportation system for enumerators. There are about 200,000 farms scattered in more than 9,000 villages and distributed over two million square kilometers. Some villages are so remote that enumerators had to use donkeys or camels or even walk to reach their destinations.



The problem of the shortage of qualified personnel could be reduced if university students, especially those in agricultural colleges, are encouraged to participate in the surveys as enumerators. In addition to earning a salary, university students could be granted academic credits as an added incentive or be expected to participate in the surveys as a requirement for summer training. Based on the author's experience, students could benefit from such a program as it gives them the opportunity to interact with farmers they will have to serve in the future.

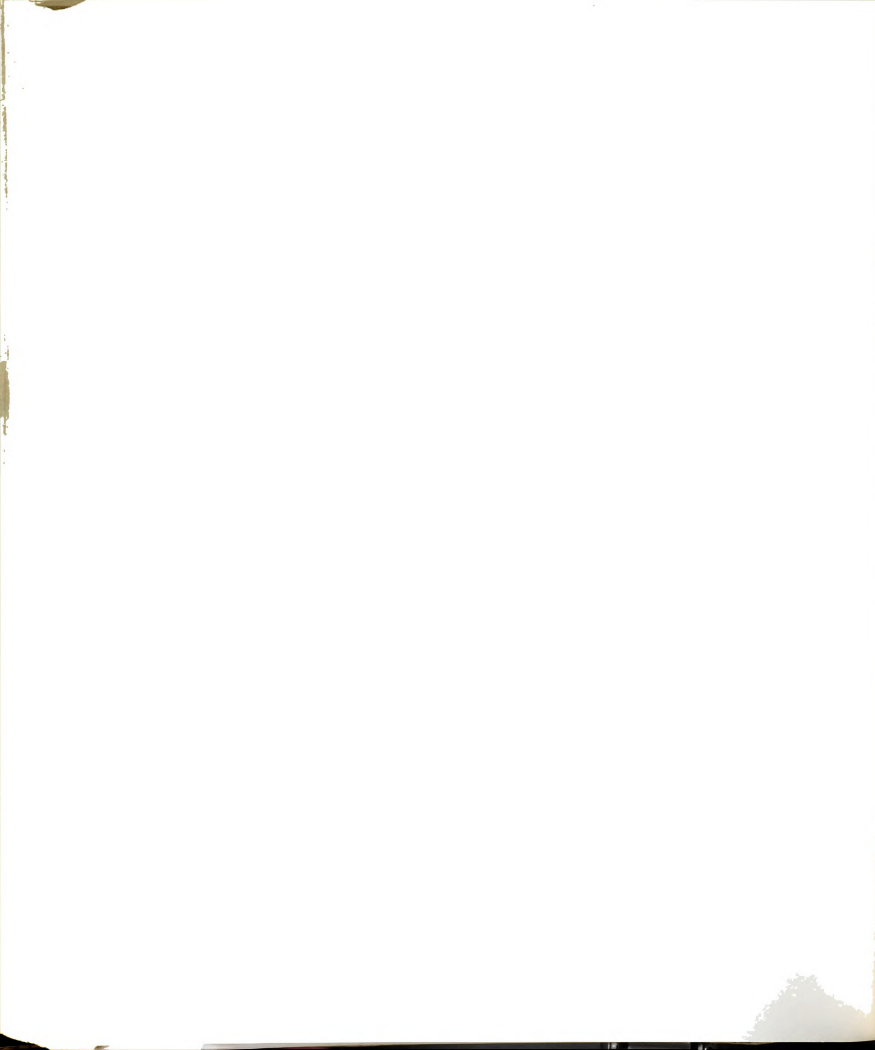
There are some data collection problems that are specific to the holders or farmers. Holders are not accustomed to answering questions about their families, production, credit, and other topics, nor are they aware of the benefits they will derive from the data. It is also very difficult for the Saudi Arabian farmer to divorce his social obligations from his farm as a business to be operated for profit. During the censuses, for example, farmers considered the enumerator as a guest who was to be treated with the same hospitality accorded to other guests. As a result, many farmers killed a sheep or two for the dinners of the enumerator-guests. The extent of this practice led one enumerator to comment that "there were more sheep in the country before the census started than there were after the census." Such hospitality which develops a close link between interviewer and respondee is likely to affect the objectivity of the enumerator and holder in completing the questionnaire. This may introduce what the author would refer to as "hospitality bias." Farmers may lack



knowledge of information in the question, yet they will provide answers just to be cooperative and helpful. In other words, they want the enumerator to feel happy and welcomed. This hospitality is not only costly on the side of the farmers, but it also encroaches on the enumerator's limited time because he often feels obligated to spend some time visiting with a hospitable farmer.

Another problem arises from the fact that most farmers can neither write nor read. As a result, the farmer has no records on his farming activities. The accuracy of the information given by the farmer is a function of how much he can remember which, in turn, depends on the type of information, time span, age of farmer, and other factors. The farmer may unknowingly give the wrong answer to questions, simply because the information requested is not well-registered in his mind, or too much time has elapsed since the event occurred or because the information requested has no significant effect on his life or pattern of living. Nonsampling errors can also be introduced during the processing and analysis of the data. These can include errors in entering or coding data, punching of data on cards, and general fatigue of people handling the data.

Several steps could be taken to minimize the kind of problems discussed in this section. The Department of Economic Studies and Statistics prepared a reference manual to be used by enumerators. This manual contained sections that explained the concepts and definitions of terms used in the questionnaire, a description of the survey instrument, and detailed instructions, on how each question on each section was to be completed. This manual was not exhaustive and



should therefore be regarded as a complementary instrument, rather than as a substitute for a thorough enumerator's training program. The questionnaire should be designed to include "I do not know" as a valid response. Also, enumerators should be familiar with the rural farm setting and should have an idea of what is known, in what form or terms, and by whom.

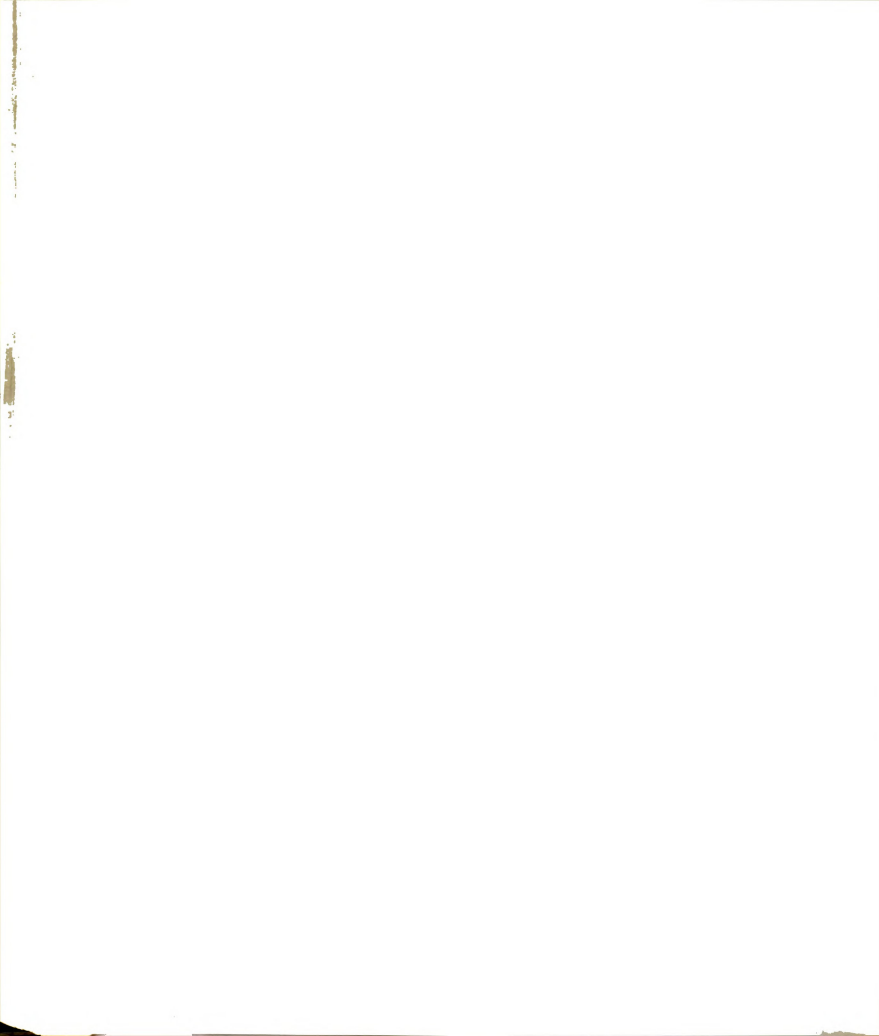
As an example, farmers in Saudi Arabia do not know the date they were born, but they are able to relate the year of their birth to some historical event that occurred at that time. This event could be the death of an important and well-known person, a battle, or some natural disaster. If enumerators know the dates of these events, it could be used to estimate the age of a holder. The kind of events and dates might differ from region to region. Another example employed by Spencer (1972), but which could equally be applied to Saudi Arabia, is that of estimating time spent in the field from the Muslim prayer time. Utilization of this type of knowledge could be used to improve the estimation of several variables from local units. This is currently being used on a limited scale to estimate land holding from Mah-ad and Rakib.

In the 1982 census, enumerators were faced with new problems which were not encountered in the 1973 census. There were a large number of absentee-farmers. These are farmers who had taken jobs in other sectors of the economy and only work on their farms on a part-time basis. Another problem was created by the dependence on other nationalities as agricultural workers. Since foreign nationals could neither speak nor understand the Arabic language fluently, direct



communication between the foreign worker and enumerator was nearly impossible. This could form another source of error in the data.

The natural consequence to all these problems is a dependence on subjective methods of data collection. The first attempt to collect agricultural data in Saudi Arabia was in the first half of the 1960's when the MOAW carried out censuses in each region. The method of data collection at this time was mostly subjective in nature. A group interview technique was used to obtain data from farmers or holders. This technique was described by the Central Statistics Department in their 1968 statistical yearbook. Census teams contacted farmers by calling a village meeting of all holders in the presence of the Emir (Chief of the village). At this meeting the census team explained the purpose of the census and the procedures to be followed. After that a questionnaire was completed for each individual holder in the presence of other holders and the Emir. The comprehensiveness of the enumeration was ensured by having the Emir declare that all farmers in his village had given the necessary information about their holdings. This method of data collection has all the short comings of a one-time interview with the possibility of very large observational errors and the short comings of group interview techniques where the farmers' responses are directly influenced by the presence of others. To verify the results of the census teams, a special survey group joined the census teams in some districts where they took a random sample of about 1 to 2 percent of the holders and conducted actual measurements. It is claimed that the results of



these survey groups showed only a difference of 2 to 4 percent from those obtained by the census teams. It is difficult to disclaim this assertion, because the measurement method in the sample survey is not indicated and no mention is made of which variables were affected.

By the time of the first national census in the early 70's, the country was already moving in the direction of what Idaikkadar (1979) refers to as stage two in the development of statistical improvements. In this stage both subjective and objective methods of data collection were employed. For example, in the first census a sample was employed to collect current data and a total census was used to collect basic data. A similar method is also being used in the second census. Instead of using the group interview technique, enumerators in these censuses were required to interview each holder individually. This at once eliminated the bias that is introduced when farmers have to respond to questionnaires in the presence of others. However, the problems do not end there. The estimation of several variables in 1982 were still based on subjective methods. Land area, for example, was determined by eye-estimation, a method which, even if used by the most experienced researcher, is subject to large margins of error. Most enumerators were inexperienced in this method and farmers had more than one field which were mostly irregular in shape. Eye-estimation under these kinds of conditions could only add insult to injury.

While current conditions, for example, lack of well-trained national personnel, make it impossible to move into purely objective



methods of estimation, it is suggested that the Department of Economic Studies and Statistics emphasize these methods when and wherever possible.

The Inquiry Subsystem

One fundamental question in any information system has to do with the nature of inquiry--the process whereby man acquires answers to normative and nonnormative questions. This forms the inquiry subsystem of the information system described in Chapter III. Of the three subsystems, the inquiry subsystem is probably the least developed in the Saudi Arabian Agricultural Information system. In addition to encompassing the stages of conceptualization and operationalization of concepts, the inquiry subsystem also includes the specification and testing of an analytical framework and the interpretation and analysis of the data. All the shortcomings of conceptualization, operationalization, and measurement are directly transferred to the inquiry subsystem in addition to its inherent problems.

At present, the inquiry subsystem in the Saudi Arabian agricultural information system is limited to a low level of analysis which basically consists of a high level of aggregated data by region and commodity, presented in the form of tables. There is an urgent need for better and more rigorous analysis of the data. Today a number of analytical methods have been developed to assist agricultural and resource economists in transforming data into information. Most of these methods can be adopted for use in Saudi Arabia. In the next chapter an attempt is made to demonstrate how some of these methods



could be applied to improve the decision-making process in Saudi Arabia.

As will be seen in the next chapter, the inquiry subsystem requires a highly trained and well-equipped analyst not only in the available analytical techniques and tools, but also in the agricultural and economic institutional and political background of Saudi Arabia. However, such personnel are not and may not be available in the near future for work in the Department of Economic Studies and Statistics. To overcome this serious problem, it is suggested here that a strong working link be established between the Department of Economic Studies and Statistics and the Departments of Agricultural Economics in all the Colleges of Agriculture in Saudi Arabia. There are currently three agricultural colleges and a fourth will soon be opened to increase the coverage of most of the agricultural regions. Faculty members in these departments have easy access to computer and other university facilities. Analysis of data could be made on a regional basis because of the wide diversity between regions.

The Decision-Making Subsystem

The ultimate purpose of any information system is to reduce uncertainty in problem-solving by providing decision makers with accurate, reliable, and timely information on the problem in question. To the extent that the system lends itself to this task, the system may be regarded as successful. Decision makers in Saudi Arabia can basically be divided into two categories--public sector and private sector. Public decision makers include the government and all other

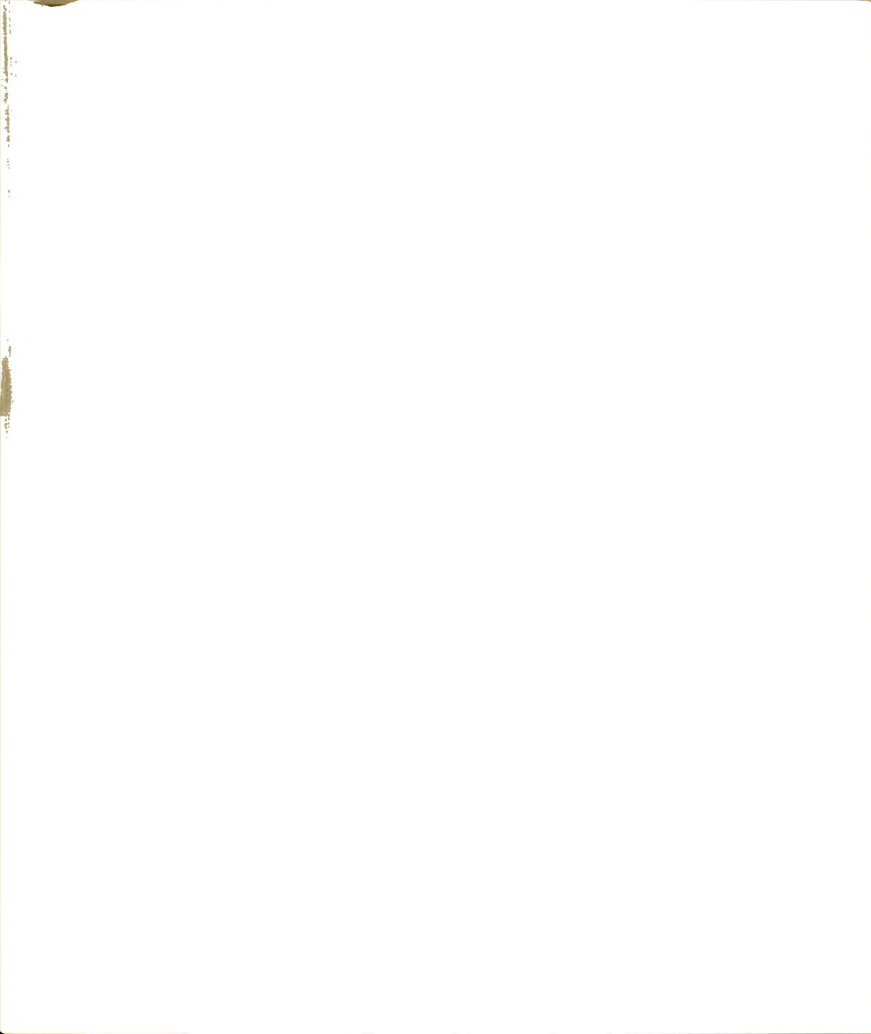
quasi-government institutions. It thus encompasses several ministries including Agriculture and Water, Municipal and Rural Affairs, Planning, Finance, and National Economy, and Commerce; Banks, and other government agencies. The private sector decision makers are mostly made up of individual farmers, suppliers of farm inputs and farm output traders and importing and exporting firms of agricultural commodities.

The process whereby decisions are made, whether by the public sector or private sector, is basically the same and is the subject of Johnson's (1967) paper entitled, "Contributions of Economists to a Rational-Decision-making Process in the Field of Agricultural Policy." No attempt is made to discuss that process in this study. A problem has to exist before data are collected. Individual decision makers may have different problems which need to be solved and they, therefore, require different sets of data, methods of analysis, and information flow. The usefulness of the information to any one of them may depend on (a) the scope of data coverage; (b) the type and level of analysis; (c) the method of dissemination, presentation, and interpretation of the data; and (d) on the credibility of the source of information.

Today the available agricultural data in Saudi Arabia are so limited, both in scope and coverage, that decision makers can hardly make use of the data for solving day-to-day problems. Since the agricultural information system is designed for and operated by government decision makers who form the bulk of the public sector, the

private sector is at a greater disadvantage as it often has to depend on fragmentary and often unreliable information. For example, data on wholesale and retail prices of domestically produced agricultural commodities are of greater interest to private decision makers than to public decision makers. These data, however, are unavailable. Data of this type could greatly influence the disposition of available supplies of agricultural commodities and their distribution over time and space. The demand for such data in Saudi Arabia increases with an increase in seasonal and regional price variation. Producers can use price information in deciding how to allocate their limited resources to various production activities and also in deciding when and where to sell their products. In general, both producers and consumers benefit in that prices will tend to even out in time and space. Benefits from price information can also accrue to public decision makers in that development plans for improving the production of certain commodities, and the construction of agricultural marketing infrastructure could be tailored to the response of farmers to prices.

To allow for comparison over time, Sarma (1976) suggests that the prices should relate to a commodity of standard specification at a specific point in time. In a weekly price report, for example, the data should relate to a peak marketing period on a fixed day of the week. The above is just one example of highly needed and useful data that are unavailable to decision makers in Saudi Arabia. Input prices and sources of agricultural inputs are another example. These data are relatively easier and inexpensive to obtain or collect than the data obtained in censuses, yet there has been a total neglect of

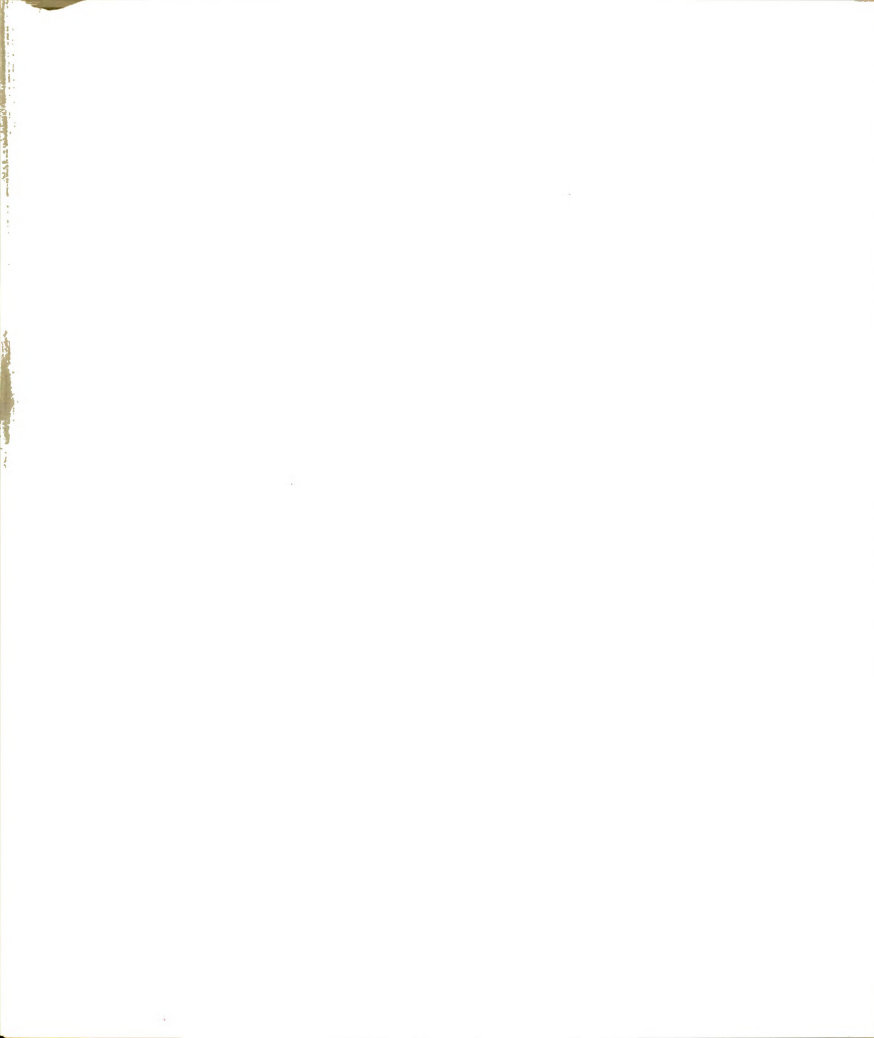


this aspect of information. While no suggestion is made to collect all data necessary for agricultural decision making, as it can be very expensive and practically impossible, it is, nevertheless, emphasized that a little reorganization of data suppliers' priorities could go a long way in closing the gap between needed information and available information.

Decision makers can hardly use raw data per se for solving problems. For raw data to be useful, they have to be analyzed, interpreted, and put in an information context for the solution of specific problems. Where the data collector, analyst, and decision maker are separate, the final information will have to be communicated to the decision maker for him to act on the decision and finally bear the responsibility of his decisions. As was indicated in a previous section, the level of analysis of even the available data in Saudi Arabia is very limited. For example, the Department of Economic Studies and Statistics simply aggregates data by region and/or commodity and are published in the form of tables. No further attempts are made to apply rigorous analytical techniques that will elucidate more information from the data.

The usefulness of such macro-level aggregation of data is only limited to public decision makers who work at the national or regional level. Private decision makers, especially individual farmers, may have little use for such highly aggregated data, as lower levels of aggregation, say at the village level, are more useful to them.

For information to be utilized as a decision making tool, it has to be communicated to the decision maker. There are so many times



or cases in Saudi Arabia when data have been collected, analyzed, and the documents simply put on shelves to gather dust. The documents have never reached the appropriate decision maker. While this is a general problem, private decision makers are more adversely affected. This is due both to the institutional structure, which almost exclusively caters for the public sector, and to the very characteristics of the private sector.

There are several public decision-making units that do not know what information is available. It should be no surprise to anyone familiar with the structure of information in Saudi Arabia to find that the results of past censuses are not available in the libraries of agricultural colleges.

When the head of the Department of Economic Studies and Statistics was asked if it were possible for private decision makers to use the agricultural information in his department, he emphatically answered, "if anyone requests them, he will get them." This negative attitude is exemplary of the lack of communication of information to the private sector. The extension service is the only channel between the MOAW and the farmer, but the proportion of farmers to extension workers is so high that only a small fraction of the farmers can be reached. Even those farmers who are reached can hardly find the information useful. Most farmers are illiterate and can hardly make sense out of a very aggregated information.

Finally, when decision makers can make sense out of the fragmentary information made available to them, they have to worry about



the credibility of the source of information and the reliability of the information. Riemenschneider (1978) discussed this problem in relation to USDA farm income data. A decision maker can only know the value of information when it is received and utilized. This means that the principal way of judging information, before receiving it, is by the previous reliability of the data source. There is a short history of information production and suppliers of information are few in Saudi Arabia. This makes it difficult for users to evaluate the reliability of data from one source or compare the reliability of data from different sources. An important way of assessing the accuracy and reliability of data is to evaluate the method used in collecting the data. However, in the case of Saudi Arabia where there is little documentation of the data collection procedure and there is little understanding of the data estimation procedures, determining the accuracy and reliability of data to predict the value of information can be critical.

As is now evident from the discussions in this chapter, the accuracy and reliability of agricultural data in Saudi Arabia is suspect. Fortunately, this is recognized by government officials when they state in the third development plan that "the data base for agriculture remains inadequate and all estimates must be taken as indicative, rather than firm." Indicative in the sense that they are unreliable. Unreliability of available data is especially discouraging for private decision makers who must make decisions on problems which allow for very little margin of error. These problems could be minimized by improving the data collection methods and



through interactive communication between suppliers and users of information before, during, and after the production of information.

Summary

In this chapter an attempt was made to evaluate the Saudi Arabian agricultural information system in relation to the idealized information system paradigm. The structure of the supply of data in Saudi Arabia is more concentrated than the demand for data. The Ministry of Agriculture and Water is the main supplier of agricultural data.

The Saudi Arabian agricultural information system is yet in its infancy and it suffers from several general problems. The information system can best be described as a data base or repository of agricultural data. Some of the problems with the information system are lack of experience, ambiguous objectives of agencies collecting the data and an inadequate institutional arrangement. The data subsystem suffers from both conceptual and operational problems.

The inquiry subsystem is the least developed. The decision making subsystem is composed of both private and public organizations. The whole information system is designed to serve the public sector while the interests of the private sector are ignored.



CHAPTER V

THE ANALYTICAL FRAMEWORK

Introduction

However reliable the data, they are of little use to the decision maker until they are analyzed and interpreted. Before the necessary analysis and interpretation can take place, an analytical framework must exist. Investment in the process of data collection without a commensurate investment in analytical procedures is likely to result in a waste of resources.

It is important to emphasize that data collection, analysis, interpretation, and decision making should occur within the context of an overall integrated system such as the information system described in Chapter III. This integration of analytical procedures within an overall system has been neglected in the Saudi Arabian agricultural data base.

In this chapter the lack of integration of the analytical component in Saudi Arabia's Information System is discussed. It will point out the importance of the role of agricultural economists and their analytical tools in bridging this gap. In order to understand and address problems, agricultural economists have at their disposal analytical techniques which make use of economic, statistical, and mathematical theories. Analytical approaches include linear



programming, econometric forecasting models, and evaluation techniques such as benefit-cost analysis, to name a few.

The techniques of linear programming, benefit-cost analysis, and econometric models will be used as examples to facilitate the discussion of the shortcomings of the Saudi Arabian data base. Each of these tools will be discussed within a hypothetical problem context in Saudi Arabia. In each case, the model will be applied to the problems, the possible results of the model will be interpreted in policy terms, and a delineation of the actual data requirement for the models will be given. In addition, each model's assumptions, strengths, and weaknesses will be discussed.

It should be pointed out here that elaborate techniques will not compensate for either poor data quality or for misinformation. Analytical models alone cannot supply missing information. These models, like all other analytical models, obey the rule of garbage-in-garbage-out (GIGO). It is the role of the analyst to make sure that the appropriate data, in appropriate form, are fed into the appropriate models. In some cases, there is no need for a special formal model to analyze data beyond that required for simple tabulation, as shown in Figure 3.1. One can move directly from the data output to interpretation and analysis. In many cases, however, one must utilize one or more analytical tools.

Linear Programming

Linear programming (LP) originated in the early 1940's as a means of solving military logistic problems. The Simplex Algorithm

for solving LP problems was developed between the late 1940's and early 1950's.

Linear programming is useful in solving problems involving numerous alternatives. It has been used as a research technique by agricultural economists to determine the optimal organization of farm resources and to suggest means of farm reorganization for maximum profitability. LP has also been used to calculate minimum-cost ration formulation in the livestock industry. This supplies important information as to the types of nutrients, the feed components, and the amounts needed for the rations, at minimum cost. LP models, particularly the transportation model, are used extensively in business applications and in agricultural marketing to provide solutions to the problems of supply-demand matching in various regions and store locations.

This section is primarily concerned with LP models as analytical tools in information systems, as opposed to the theory and methods of solving LP models. In particular, a problem context directly related to information systems in Saudi Arabia will be presented and the usefulness of LP in solving this problem will be discussed. A step-by-step method, beginning with the formulation of the model and continuing to implementation and interpretation of the results, will be presented. Since no actual data will be used here for model evaluation, the discussion will emphasize the importance and types of data needed for proper implementation of LP techniques.



Assumptions of Linear Programming

The major assumptions implicit in a basic linear programming model are divisibility, proportionality, additivity, and certainty (Black and Hlubik, 1980; Hillier and Lieberman, 1980). Divisibility means that activity units can be divided into any fractional levels, so that noninteger values for the decision variables are permissible. However, in many agricultural problems, decision variables make sense only if they have integer values. It is often necessary to assign men, machines, and animals to activities in integer quantities. This restriction is difficult to handle in basic linear programming, but through mixed integer linear programming models, some progress has been made in developing solution procedures where the decision variables must have integer values.

Proportionality is an assumption about individual activities considered independently of others and must not be confused with the assumption of additivity which is concerned with the effect of conducting activities jointly. The assumption of proportionality states that for a given activity, each additional unit of output requires the same quantity of input. But, in farm production, there are many instances where diminishing marginal returns are present. The amount of output per unit of input is not always constant. The problem of non-proportionality can be handled realistically by reformulating the problem. For example, wheat produced with a median level of fertilizer can be treated as one activity and wheat produced with a high level as another.

The proportionality assumption is not enough to guarantee that the objective function and constraint functions are linear. Cross-product terms will arise if there are interactions between some of the activities that would change the total measure of effectiveness or the total usage of some resource. Additivity assumes that there is no such interactions between any of the activities (Hillier and Lieberman, 1980, p. 25).

The additivity assumption requires that for any given activity levels, the total amount of inputs used and the total output produced is equal to the sum of the inputs used and outputs produced by each activity conducted by itself. In real situations, however, interactions between inputs occur to produce nonlinear relationships.

The certainty assumption is that all the parameters of the model are deterministic. Basic linear programming, therefore, does not take into account the imperfect knowledge situations under which the farmers operate. For this reason, it is usually important to conduct a thorough sensitivity analysis after finding the basic linear programming solution with the assumed parameter values. The purpose of this is to identify the relatively sensitive parameters--those that cannot be changed much without changing the optimal solutions--to try to estimate these more closely and then to select a solution which remains a good one over the ranges of likely values of the sensitive parameters.

Problem Statement

Saudi Arabian government policies, due to lack of necessary information, are often in the form of blanket policies applied to all farmers of the country, regardless of individual differences.

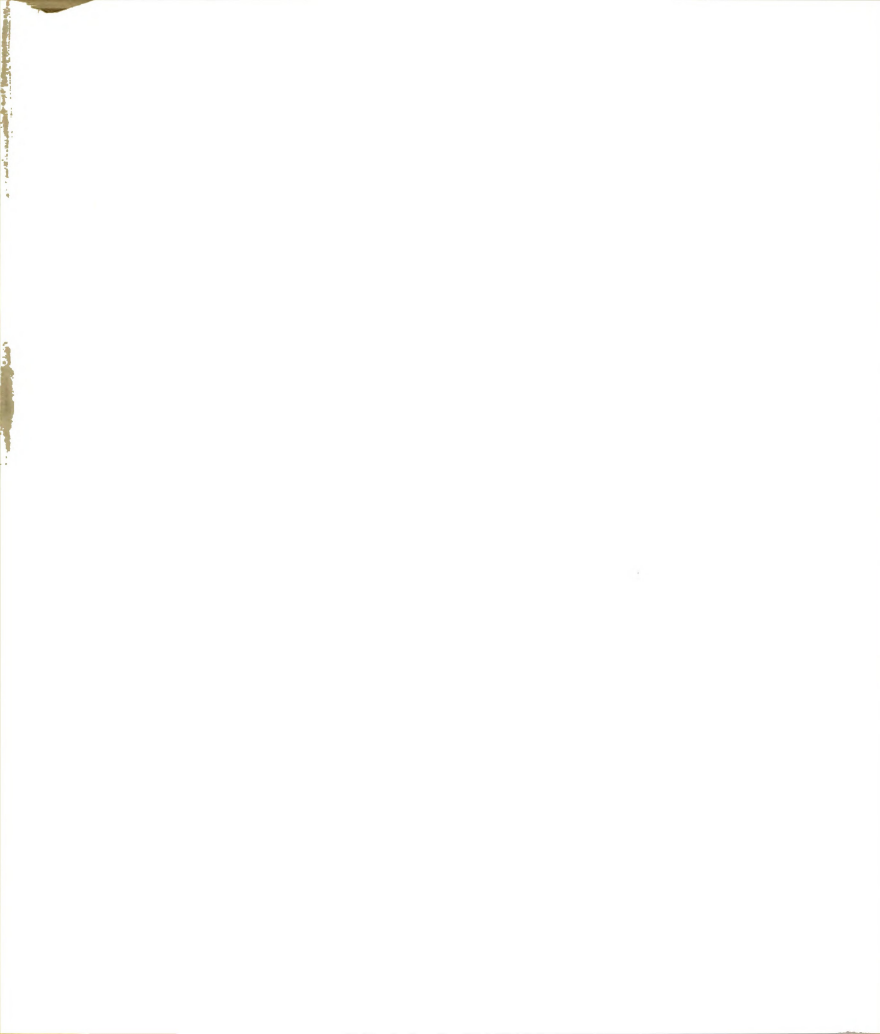
However, individual farm differences in terms of soil, weather, farm size, and labor availability are prominent. Under such circumstances, the use of policies that don't take these differences into account inevitably leads to undue waste of scarce resources. In this section, an application of an LP model that can be utilized to minimize this problem is presented.

This problem can be approached by dividing the farmers into homogeneous strata based on similarity in natural endowments and economic criteria. Next, one of these strata can be selected and used to draw up the details of the model based on a representative farm. The application to this stratum can easily be replicated in other strata by making the adjustments to the cost and constraint coefficients.

The objectives in the chosen stratum are (1) to determine the most profitable way for farmers to organize their farms given the current available resources and level of technology, and (2) to identify the production potential of the farms under conditions of increased resource availability, improved technology, changes in prices, and changes in government policies. The model is presented below.

The Basic Model

The basic linear programming model can be stated as shown on the following page.



$$\text{Maximize } Z = \sum_{j=1}^n C_j X_j$$

$$\text{Subject to } A_{11}X_1 + A_{12}X_2 + \dots + A_{1n}X_n \leq b_1$$

$$A_{21}X_1 + A_{22}X_2 + \dots + A_{2n}X_n \leq b_2$$

.

.

.

$$A_{m1}X_1 + A_{m2}X_2 + \dots + A_{mn}X_n \leq b_m$$

and

$$X_1 \geq 0, X_2 \geq 0 \dots, X_n \geq 0$$

The X_j 's represent levels of the decision variables. The B_i 's represent the amount of the i th resource available for allocation to alternative decision uses. The a_{ij} 's represent the amount of the i th resource required for the production of a unit of the j th activity. Z represents the overall desirability or effectiveness of different activity combination, in this case, the profit, while the C_j 's represent increases in Z that would result from unit increases in the associated X_j 's.

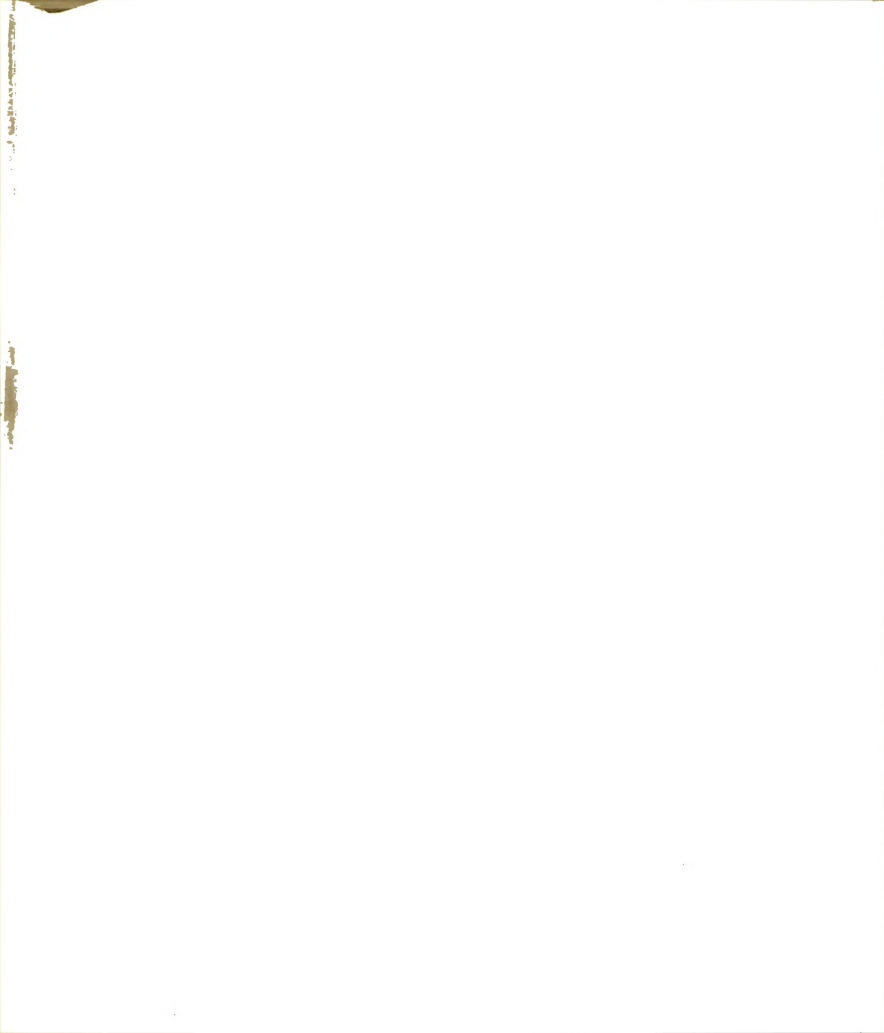
Model Construction

The theoretical model formulation in Table 5.1 is used to construct the problem's data matrix. In the matrix, the activities (which may vary from stratum to stratum) are represented as activities X_1 to X_n . Examples of common activities include growing wheat, corn,

TABLE 5.1.--Schematic Representation of the Model

Resource/Activities	x_1	x_2	- - - - -	x_n	R.H.S.
Irrigated Land					
Jan.	a_{11}	a_{12}	- - - - -	a_{1n}	$\leq b_1$
Feb.	a_{21}	a_{22}		a_{2n}	$\leq b_2$
.					
Dec.	.	.		.	.
Rain-Fed Land					
Jan.	.	.		.	.
.					
Dec.	.	.		.	.
Range Land					
Jan.	.	.		.	.
.					
Dec.	.	.		.	.
Labor					
Jan.	.	.		.	.
.					
Dec.	.	.		.	.
Capital					
Jan.	.	.		.	.
.					
Dec.	.	.		.	.
.					
Water					
Jan.	.	.		.	.
.					
Dec.	a_{m1}			a_{mn}	$\leq b_m$

Objective Function



alfalfa, vegetables, livestock, and fruit. When different technologies are used to produce a commodity, each method of production can be considered an activity. Seasonal variation can also be used to differentiate activities that would otherwise be regarded as one, e.g., winter wheat should be regarded as a different activity from spring wheat. Furthermore, each production process can be broken down into its components with each component forming an activity. An example of this is the production of wheat, where land preparation, plowing, planting, weeding, and harvesting can each be considered a separate activity.

The second component of the formulation of the LP model is made up of the available resources. These, of course, differ from one stratum to another, but generally include land, labor, capital, and water.

Possible land categories include irrigated, rain-fed, range, woodland, and nonarable land. Availability of the various land categories differs seasonally; therefore, time variables could be used to further differentiate them. For example, rain-fed land is available only during the rainy season.

Labor can come from various sources, such as the operator, his family, and/or hired labor. The availability and composition of labor varies over the study period, and thus is also broken down by time period. An example of this is the availability of children's labor during the summer when they are not in school--reflected in higher family labor for the summer.



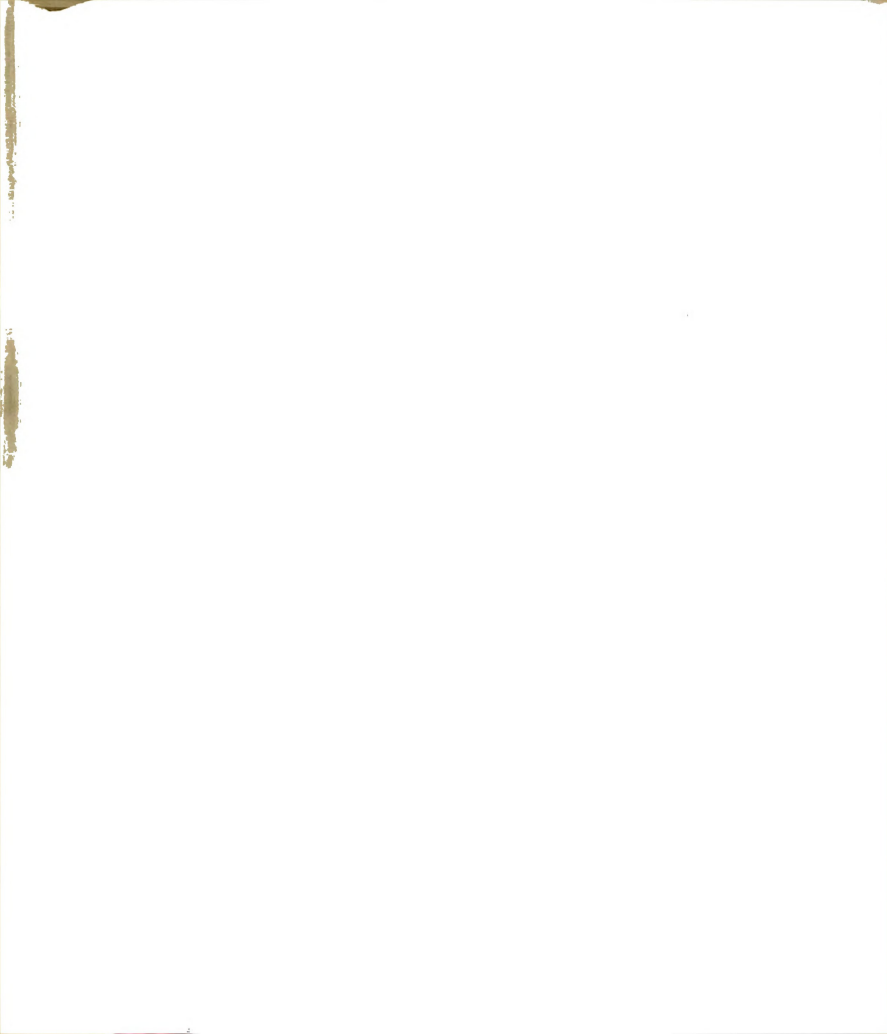
Likewise, capital can be divided according to its source, e.g., farm income, off-farm income, and loans. Water can come from wells, rain, and irrigation projects, so there is both seasonal and annual variation in available water.

There are other categories of resources that can be added to the list, but in each case, the resources are limited by the maximum amount available, as reflected in the right-hand-side (RHS) column.

Another important part of the model is the set of technical (input-output) coefficients (denoted a_{ij}) which represent the amount of resource, i , that is needed to produce one unit of activity, j . For example, the technical coefficients associated with the production of a donum of irrigated wheat might look like this:

1. one donum of irrigated land
2. six hours of January labor
3. 100 Saudi riyals as capital
4. 50 cubic meters of water in January, and so on

The final part of the model is the objective function--the sum of the contributions of all the activities in the model put together. Each activity's contribution is the product of its activity level in the solution and the return or cost of one unit of the activity. For example, if the final solution has five donums of spring wheat and the price per donum of wheat is SR 100, then the contribution from this activity in the objective function will be SR 500.



Information from Model

Solution of the model would achieve the first objective: given existing resources, policies, and price relationships, what is the optimal farm plan? In this optimal plan, information is obtained on the maximum farm income possible, as well as the details of the activities that will be needed to achieve it. Furthermore, the model indicates which input resources are scarce, as well as those which are abundant, and estimates their economic costs.

The economic costs of resources are often called shadow prices. They indicate how the objective function would change if an additional unit of an exhausted resource were available. For example, if all available labor has been exhausted in the model, and the solution indicates a shadow price of two Saudi Riyals per hour for labor, then the objective function will be increased by two Saudi Riyals if one more hour of labor is added to the labor available in the model. It is advantageous to pay up to two Saudi Riyals per hour to the available hired labor for its services.

Shadow price estimates are useful in identifying potential opportunities for government policy interventions and the limits for these interventions. For resources where the shadow price is high compared to the cost of acquiring an extra unit of the resource, the decision maker(s) might consider policies designed to make more of that resource available. If, as is common in certain situations, more of the resource cannot be acquired, then alternative technologies which make more efficient use of the scarce resource can be tested in the model; ultimately, policies designed to encourage this



new technology can be implemented. For example, the introduction of a more efficient method of irrigation in an area where water cannot be increased can reduce the amount of water needed per unit of activity. Thus more units of the activity could be produced with the same amount of water.

Another application of the results on shadow prices could be the existence of idle labor during some part of the year. This will be reflected by a shadow price of zero during the slack period. The government could intervene to provide seasonal industrial employment which improves the welfare of the farmers.

A final example of the use of information from the model pertains to the determination of subsidies designed to encourage the production of certain crops. Information from the model will show the cost of adding a unit of crop production. This incremental cost could be used as an approximate indicator of the subsidy necessary to induce farmers to raise more of the crop. This is especially important to Saudi Arabia, where the government is issuing a number of subsidies to encourage the production of certain crops.

Other information from the model includes results from sensitivity analysis, which indicate how stable the model solution is. These results also indicate the impact of changes in resource availability, input-output coefficients, price changes, and modifications of restrictions relating to minimum or maximum requirements. A sensitivity test may be prompted by changes in price relationships which entail the rerunning of the model with the new price; this will



show the effects these changes have on the optimal solution. Another example is where the model includes a minimum requirement of a certain product, say to meet family consumption. If the average family's consumption of the commodity is not known precisely, then various levels can be tested in the sensitivity analysis and results analyzed to determine the best course of action.

The use of linear programming, however, has its limitations. In addition to those discussed by Dillon and Hardaker (1980), Beneke and Winterboe (1973), and those highlighted in the assumptions, Eicher and Baker (1982) have discussed three other problems with the use of LP techniques in analyzing data for SubSahara Africa. These are equally applicable to Saudi Arabia. First is the assumption of profit maximization which even when constrained by minimum food requirements and by setting resource constraints to the average observed values, may lead to model results which bear little resemblance to observed patterns of resource allocation. In the case of Saudi Arabia, in particular, it is difficult to assign a value or price for some benefits such as recreational use and the social status attached to the ownership of farm land. These are usually implicitly included in the farmer's objective function. Second is the problem of inferring region or country-wide policy implications from the results of individual farm models. The third problem is that most LP models only take into account optimal plans for annual crops over a one-year horizon and ignore interannual resource flows, household activities, interaction between crop farming and animal husbandry, and the cash



flow problems associated with the introduction of large capital purchases.

Other attacks on linear programming have been made on the basis that basic linear programming does not take into account the imperfect knowledge situations under which the peasant farmer operates. A number of studies have now found linear programming which includes considerations of simple risk and uncertainty useful in developing such models. The first attempt to take explicit account of risk in a programming formulation used quadratic linear programming (Anderson et al., 1977). In this formulation risk is considered only in relation to activity net revenues; the constraints are considered deterministic. The relevant statistics are the mean, variances, and covariances of the activity net revenues.

Other attempts have been made to develop linear programming models that take account of the stochastic nature of activity net revenues. The results of such models often show optimal production plans much closer to the actual plans used by farmers than those which emerge from basic linear programming. Nevertheless, the methods utilized are not easy to use for they require many data which are not generally available in Saudi Arabia. Also the strengths of linear programming do not lie in its ability to incorporate risk and uncertainty in its analysis, but rather in its ability to handle a large number of interrelated activities (Low, 1978).



Forecasting

The second example of the set of available tools for the agricultural economist is economic forecasting. Forecasting methods are widely used to predict the most likely set of future events, and to assess the impact of alternative policies and economic events. Forecasting methods have been used to predict prices and quantities of crops and livestock based on statistically-estimated parameters.

The importance of forecasting in Saudi Arabia cannot be over-emphasized. The country is experiencing rapid growth in domestic production of various crop and livestock products, but it is still dependent on outside sources for the bulk of its domestic consumption. There is a strong need to establish the proportions of these products supplied by domestic and outside sources and to set targets for self-sufficiency in the short-, medium-, and long-term. Due to the need to forecast the supply of and demand for crop and livestock products in Saudi Arabia, reliable, and appropriate forecasting methods are necessary.

The statistical estimation of economic relationships to provide a method for prediction and analysis of policy proposals is of great importance in Saudi Arabia. Governments need forecasts to evaluate the likely impacts of their policies on prices and economic performance. Forecasting is essential to individual firms involved in agriculture, where such methods can reduce uncertainties regarding demand and prices. However, in order to be useful to the decision maker, the forecasts must be available on time.



Prerequisites of Forecasting

There are a number of prerequisites to the use of any forecasting model. According to John Ferris (1974), the following points are of the utmost importance in the development and application of a forecasting model:

1. knowledge of the industry
2. knowledge of basic economic principles
3. knowledge of appropriate statistical tools
4. knowledge of the decision makers who will use the forecasts
5. knowledge of people who are informed about the industry and the forecasting methods
6. knowledge of new information, and hence, the ability to update the model

These points clearly indicate that an agricultural economist will need to be well-versed in statistics, in economic theory, and with the Saudi Arabian agricultural sector, to be an effective forecaster. Knowledge of the natural processes in the agricultural sector, such as rainfall patterns, crop growth cycles, livestock, and biological and economic production patterns, are also prerequisites to successful forecasting. This background knowledge must be coupled with an understanding of government policies and programs related to the particular industry. Finally, specific formulation of the model will depend on the particular decision-making problem that the model is to address.



The role of the agricultural economist does not stop with the formulation and estimation of the model, but includes interpretation and analysis of the forecasts. In this study the author intends to present a forecasting model and show how it is used to predict the supply and demand of wheat in Saudi Arabia. Emphasis will be on the clear presentation of the model's assumptions, details of the model's specifications, the estimation methods, the output, interpretation of the output, and a detailed description of the data requirements. These same methods and models can be used with other Saudi Arabian crops and livestock after appropriate changes are made.

In presenting the forecasting model for the supply and demand of wheat in Saudi Arabia, the method of Ordinary Least Squares (OLS) is used for the estimations, since it has been shown to have a number of characteristics useful in such models. These characteristics include its ease of use as well as certain statistical properties such as its ability to produce best linear unbiased estimators. This simply means that the estimates have minimum variance and that they converge on their true population values as the sample size increases.

OLS is based on the following assumptions:

Given that

$$Y_i = B_0 + B_1X_{1i} + B_2X_{2i} + B_3X_{3i} + U_i$$

then



1. The expected value of the error term is zero:

$$E(U_i) = 0$$
2. The error terms are uncorrelated:

$$\text{Cov}(U_i, U_j) = 0 \text{ for } i \neq j$$
3. The variance of the error term is constant, i.e., it is homoskedastic:

$$\text{Var}(U_i) = \sigma^2 \text{ for each } i$$
4. There is no correlation between the error term and the independent variable:

$$\text{Cov}(U_i, X_{2i}) = \text{Cov}(U_i, X_{3i}) = 0$$
5. The independent variables are linearly independent, i.e., there is no multicollinearity

Demand Model

The demand for and supply of wheat in Saudi Arabia is used as an example for discussion in this section.¹ The demand for wheat can symbolically be represented as follows:

¹The demand and supply of wheat models are derived from K. Al-Hamoudi, "Analysis of the Demand and Supply Function of Wheat in Saudi Arabia: Projection of Supply and Consumption through 1985," Masters Plan B Paper, Department of Agricultural Economics, Michigan State University, 1979.



$$Q_{dt} = f (P_t/CPI, P_{st}/CPI, Y_{pt}/CPI, D)$$

where:

Q_{dt} = Quantity of wheat demanded (consumption per capita)
in year t (Kg)

P_t = Price of wheat in year t (SR/Kg)

P_{st} = Price of substitute (rice) in year t (SR/Kg)

Y_{pt} = Per capita disposable income (SR)

CPI = Consumer Price Index (Base Year = 100)

D = Dummy variable for change in consumer taste

($D = 0$ for 1973 and earlier years

$D = 1$ after 1973)

Selection of Demand Variables.--The criteria used in the selection of the variables in the demand model included economic theory and background knowledge about Saudi Arabian economy.

Per capita consumption of wheat has been used as the dependent variable and also as a proxy for the quantity of wheat demanded in Saudi Arabia. The four explanatory variables suggested are the price of wheat, the price of rice as a close substitute for wheat, the income per capita, and the dummy variable for the effect of changes in taste. All prices and the income were deflated by the consumer price index to remove inflationary effects. Hence, all monetary figures are in real base year values.

Economic theory suggests that there is an inverse relationship between the price of a commodity and the quantity of the commodity demanded, except for Giffen goods, which are commodities whose



demand is positively related to price. Wheat does not seem to be a Giffen good in Saudi Arabia. Therefore, the coefficient of the price of wheat is expected to be negative, as it is for any normal good.

Economic theory also indicates that substitutes are those products whose consumption and prices increase as the result of an increase in price of another product. Rice substitutes for wheat in traditional Saudi Arabian dishes. This means that if wheat and rice are true substitutes, the price of rice will be positively related to the quantity of wheat consumed; thus, the rice price coefficient is expected to be positive.

The relationship between the quantity of a commodity demanded per capita and the disposable income per capita is hypothesized to be positively related for normal goods, which account for most commodities. However, the relationship is negative for inferior goods. Since we assume wheat to be a normal good in Saudi Arabia, then the expected sign of the income coefficient is positive.

Finally, the dummy variable, D , will have an algebraic sign which is related to the changes in consumers' tastes for wheat and wheat products before and after 1973. If the demand for wheat has increased since 1973 due to a dramatic shift in taste when compared to the pre-1973 period, then one would expect the sign of the dummy variable D to be positive. If there were shifts away from wheat consumption, then D should have a negative sign.

A word of warning is in order here. Since the estimated demand function is really a relationship of average consumption to average prices and income per capita, the demand function will vary

for different income groups within the same population. This is especially true when income distributions are highly skewed, making the average figures misleading. Thus, although wheat may be a normal good on average, it may be an inferior good for the highest income groups of the population. This should be considered in the interpretation of coefficients derived from average population figures.

Supply Model

The model specification chosen to forecast the supply of wheat in Saudi Arabia is made up of two independent equations. One of the equations predicts the area of wheat harvested, while the other projects the yield of wheat per hectare. The product of the two equations provides a forecast of the supply of wheat in Saudi Arabia. Formally, the model is specified as follows:

$$1. A_{wt} = f(P_{wt-1}, P_{st-1}, A_{wt-1}, D_t)$$

$$2. Y_{wt} = f(R_t, F_t, T)$$

where:

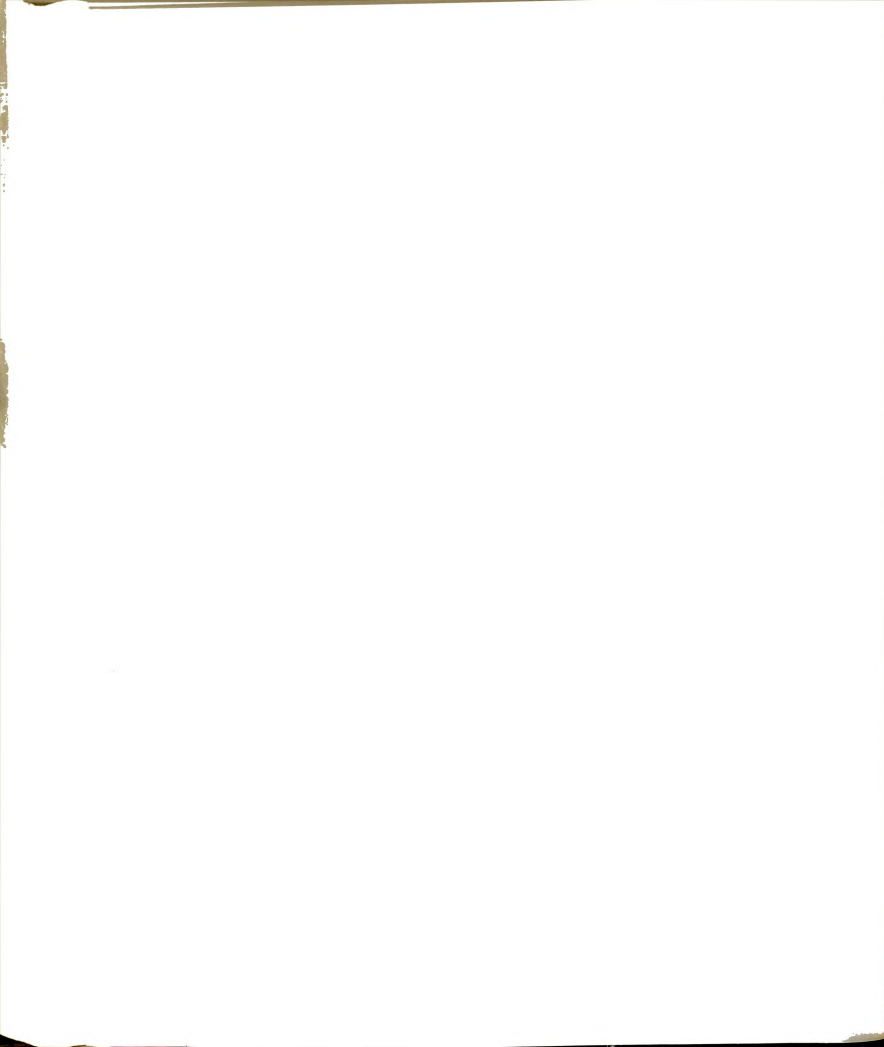
A_{wt} = Number of hectares of wheat harvested in year t

P_{wt-1} = Deflated farm price of wheat lagged one year
(SR/ton)

P_{st-1} = Deflated farm price of barley lagged one year

D_t = Dummy variable--reflects shifts in the allocation
of cultivated land. $D = 0$ for 1973 and earlier
years, $D = 1$ after 1973.

Y_{wt} = Yield of wheat in year t (tons per hectare)



R_t = Rainfall in year t (millimeters)

F_t = Amount of fertilizer applied per hectare in year t

T = Dummy variable for technology. $T = 0$ for 1972

and before, $D = 1$ for 1973 and after.

The product of the two equations provides an estimate of the supply of wheat:

$$3. \quad Q_{swt} = A_{wt} \times Y_{wt}$$

where:

Q_{swt} = Quantity of wheat supplied in year t

Selection of Supply Variables.--Although the supply of wheat can be estimated directly by regressing prices and other economic variables against production, we have opted for the use of separate area and yield equations because it will provide more information. With the two-equation model, both the changes in total supply and the source of the changes--hectarage and yield changes--can be observed.

In the area equation, the number of hectares devoted to wheat is assumed to be determined by the area of wheat cultivated last year, and the dummy variable for long-term changes in land resource allocation among crops and last year's wheat and barley prices. Economic theory indicates that prices influence the crop area planted by farmers, i.e., the higher the price, the more the quantity supplied. However, due to the nature of agricultural production, there is a lagged relationship between last year's crop prices and this year's



crop area. Since last year's prices affect this year's allocation of hectareage to the crop, lagged wheat prices were used, rather than current year prices. The coefficient of lagged wheat price is expected to have a positive sign.

Since barley competes with wheat for available cropland, an increase in the price of barley will lead to an increase in the area devoted to the production of barley, and ultimately to a reduction in the area devoted to wheat. Therefore, the coefficient of the lagged barley price is expected to have a negative sign in the hectareage equation. The inclusion of barley price is important, since farmers must consider the alternatives available to them in their attempts to maximize profits on existing cropland.

The number of hectares of wheat grown last year is hypothesized to positively affect the current-year hectares devoted to the crop. This specification suggests only a partial adjustment by farmers to changing economic conditions, due to the existence of some fixed costs in the crop production processes. Over the long run, however, all fixed costs become variable costs.

The dummy variable D_t in the wheat hectareage equation reflects the influence of subsidy policies that started in 1974. The variable reflects shifts toward the production of wheat from 1974 onwards, assuming the subsidies were as effective when it began as they were in later periods; therefore, the expected sign of D_t is positive.

Equation 2, the wheat yield equation, is formulated to show that wheat yield is a function of the amount of rainfall, greater use of inputs--represented by fertilizer used per hectare and changes in



technology--as depicted by the dummy variable T . Rainfall is a critical factor since moisture availability is usually dependent on rainfall, even the amount of irrigation water used is indirectly affected by the level of rainfall. Since yields of wheat are hypothesized to be positively related to rainfall, the coefficient of R_t is expected to be positive.

Yields of wheat are also expected to be positively related to the level of fertilizer application; therefore, the coefficient of F_t is also expected to be positive.

Finally, to investigate the effect of technology on yields, the dummy variable T is used. T reflects the introduction of Mexi Pak wheat variety, which increased the yields from 1.5 to 2 tons per hectare of the local varieties to 4 to 5 tons per hectare for the new variety. The variety was introduced in 1972, so T has a value of one (1) for 1972 and after, and a value of zero (0) for earlier years. The introduction of Mexi Pak is also accompanied by an increased demand for complementary inputs such as fertilizers and improved water control. Hence, the effect of the dummy variable T can appropriately be regarded as the influence of the level of technological changes. Since the effect of increased use of fertilizer has been explicitly taken into account by the variable F_t , T accounts for all other technological changes.

Information from the Demand and Supply Models

Supply and demand models, when appropriately specified, provide a substantial amount of information which is useful in decision making.



Much of this information can be derived from the values and signs of the estimated coefficients in the models. The two most important types of information from demand and supply models pertain to the concepts of elasticities and projections.

Algebraic manipulation of the resulting coefficients provides estimates of supply and demand elasticities. The price elasticity of demand for a product is given by the percentage change in the quantity of the product demanded, given a 1 percent change in the price of the commodity. Demand for wheat, for example, is said to be elastic when a 1 percent increase in the retail price of wheat leads to a larger than 1 percent decline in the quantity demanded. On the other hand, demand for wheat is inelastic if an increase in the price of wheat by 1 percent leads to a less than 1 percent decline in quantity of wheat demanded. It is worth noting that the estimated elasticities are relevant only within the usual range of prices; therefore, the elasticities are generally estimated at the statistical mean of the price observations. Such elasticities are useful tools in the policy-making process. For example, if the demand for a commodity such as wheat is found to be inelastic, then a policy measure aimed at reducing the consumption of wheat would be ineffective if it relied on increasing the price of wheat, since doing this will achieve only a slight reduction in the quantity consumed.

Another useful economic concept, the income elasticity of demand, refers to the percentage increase in the quantity of wheat demanded given a one percentage increase in per capita disposable income.



Income elasticity of demand estimates are very useful in the projection of demand. An income elasticity for wheat can be derived from the income coefficient in the demand model. Its use will be discussed later in the paper.

Estimates of cross-price elasticities of demand are also provided by the demand model. The cross-price elasticity of demand for wheat with respect to the price of rice is the percentage increase in the quantity of wheat demanded given a 1 percent increase in the price of rice. The cross-price elasticity estimate could provide useful information regarding the level of price increase in rice needed to increase wheat consumption. This is particularly important in Saudi Arabia, where most of the wheat is produced domestically and has a high potential for expanded production, while all the rice is imported, and the prospects for rice production within the country are very limited. Rice needs a lot of water for proper growth, but water is a very scarce resource in Saudi Arabia.

Similar elasticities and corresponding policy applications are also available with respect to supply. For example, the supply elasticity of wheat can provide policy guidance. If it is inelastic, then increasing the producer price of wheat will do little to increase production of wheat. The supply elasticity can also provide an indication of the level of price increase necessary to achieve a given production target. One important consideration about supply elasticities is that their values depend on the length of time under consideration. Short-run supply elasticities are generally more inelastic than their long-run counterparts. This is because of the



greater number of opportunities for reallocation of resources which exist in the long run as compared to the short run.

The next important concept is that of demand and supply projections. After individual demand and supply equations are estimated, they can be used to predict demand and supply levels in the future. Expected values of future independent variables are entered into the estimated equations to predict the level of demand or supply. Another method of predicting demand in the long run is based on the following equation:

$$D_t = D_0 (1 + d)^T$$

where

D_t = Demand of wheat in year t

D_0 = Demand of wheat in the base year

d = $g + NY$

g = Population growth rate in Saudi Arabia

N = Income elasticity of demand for wheat

Y = Annual rate of growth in per capita income

T = Number of years

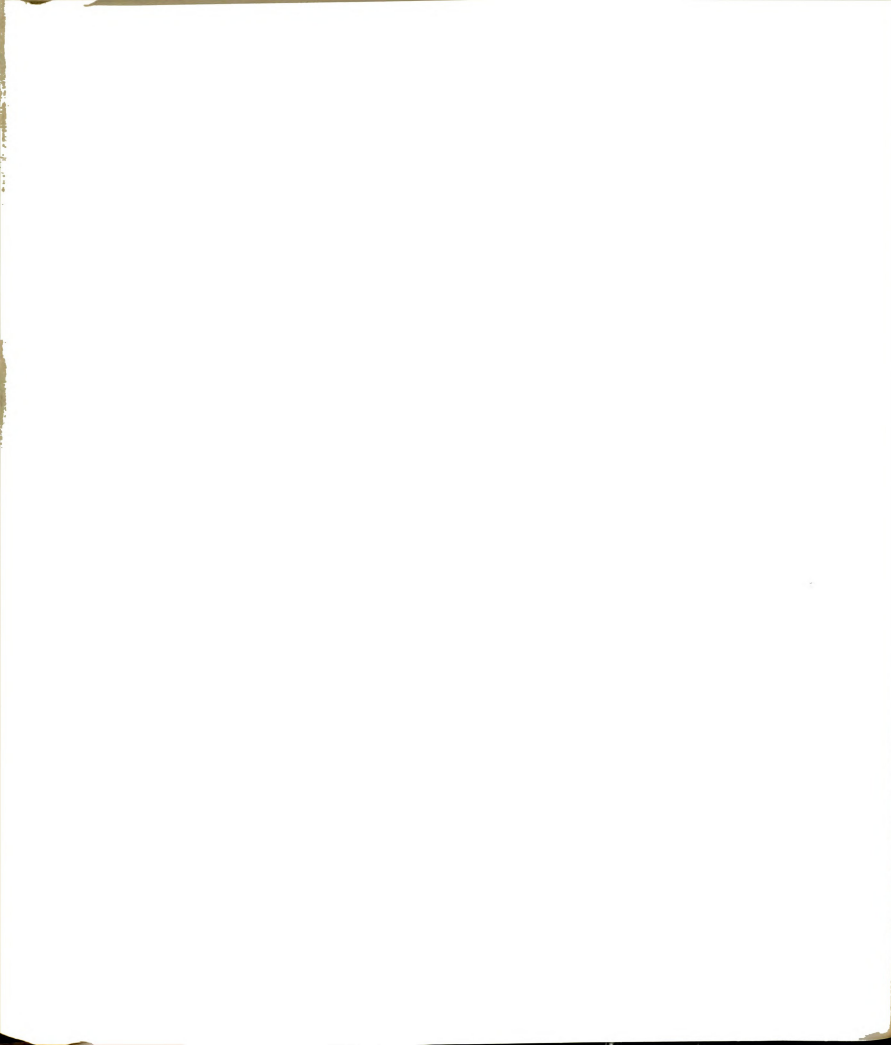
The difference between this long-run demand equation and the estimated equation is the exclusion of all price parameters. This implies that wheat price variations will not affect the level of consumer expenditures if the price of substitutes (rice in this case) increase proportionately. The income elasticity of demand is obtained directly from the estimated demand equation.



From the projected demand and supply, it is easy to estimate a pattern of future wheat surpluses or deficits, information that is very useful for agricultural planning. If a deficit is anticipated, there is a need for measures to compensate, including possible arrangements with foreign suppliers. Anticipated deficits could also trigger the issuance of incentive prices and other policy measures to increase domestic supply. On the other hand, if surpluses are expected, measures with regard to export promotion and increased domestic consumption are appropriate. If currently there are subsidies in production or if such subsidies are being planned, it is advisable to consider their reduction or even their elimination.

The forecast model can also be used to analyze alternative scenarios--sets of assumptions about the model variables which reflect possible economic events in future years. For example, policymakers may not only be interested in the average surplus or deficit of wheat in the next ten years, they may also want to know the sizes of the largest surplus and deficit that are likely to occur in that period. This information could be useful in planning the amount of storage capacity needed to store unusually large surpluses, or to maintain a reserve large enough to see Saudi Arabia through an especially poor harvest.

These best- and worst-case scenarios are accomplished by setting each of the independent variables in the supply and demand equation to the highest and lowest levels observed in the estimation period. In the worst case, the farm price of wheat in the previous



period would be set at a low level, while the barley price would be set at an historically high level. Similarly, rainfall and fertilizer application rates would be set at a low level. The result would be an estimate of how poor the wheat harvest could conceivably be, given current technology. Income growth could be raised to historical highs, which would provide an estimate of how large the quantity of wheat demanded could be. The combination of unusually large demand and drought-reduced supply would provide policy makers with an indication of the potential size of a crop shortfall. By reversing the direction of the changes in the independent variables, the size of a surplus could be derived in a similar manner.

Other questions can be examined using this same approach, for instance, the effect of government policies which support farm prices while they subsidize consumer prices. The supply and demand forecast models provide decision makers with a powerful and flexible analytical tool.

The discussion in this section has only highlighted the usefulness of forecasting models and regression analysis in the inquiry subsystem for Saudi Arabia. However, the use of this analytical technique can be limited by several problems which are not addressed here. For example, the choice of an appropriate functional form which agrees with both logic and theory and the availability of appropriate data, can often pose serious problems. Also possible errors in forecasting when these methods are employed have not been discussed. Interested readers can consult with any standard intermediate econometric textbook, like Gujarati (1978), Maddala (1977), and Kmenta



(1971) for a discussion of these problems. Despite the weaknesses of the accuracy and reliability of time series data for Saudi Arabia there are now a number of studies, by Saudi Arabian students studying abroad, that have employed this method. Hafiz (1981) Quotah (1979) and Duwais (1983) are just a few of the currently available studies.

Benefit-Cost Analysis

Benefit-cost analysis (B-C) is a way of evaluating projects, policies, and other public actions with respect to their contribution to predetermined objectives. The method is widely used by governments and international development agencies, such as the World Bank, and also by the private sector, in assessing the feasibility of future projects. B-C analysis answers such questions as, should the project be undertaken or not, or at what scale should the project be carried out? B-C analysis can also be used to compare alternative projects and to select those which make the greatest contribution to the objective function, given limited availability of funds.

Saudi Arabia is carrying out a large number of projects, including those directed at agriculture. Since there are a number of alternative projects, each needs to be carefully appraised using a common standard method so that the overall benefit can be maximized. These standard methods of appraisal have to take into account the objectives and priorities of the country in which they are being used, or in other words, the country's definition of "benefit." Some countries, for example, emphasize GNP growth, while others emphasize



growth with equitable income distribution. The important thing is that once these priorities are set and appropriately incorporated into the method of appraisal, the same methods should be applied to all projects being appraised. This is necessary in order to avoid using different criteria for different projects, thus leading to lack of comparability between projects, which could result in misinformation and faulty decision making.

It should be noted that B-C analysis is only one of many criteria used in aiding decision making. Used alone, B-C is often not sufficient for final decision making. Other criteria include consideration of aspects of the institutional system in the B-C analysis such as the framework of rules and regulations, religion, political considerations, etc., which are basic to the overall system, and environmental considerations.

Methods of Benefit-Cost Analysis

Benefit-Cost analysis is done using a number of methods to measure the worth of a project. The most popular ones are "Net Present Value," "Benefit-Cost Ratio," and the "Internal Rate of Return." The Net Present Value (NPV) is the present value of the stream of benefits minus the present value of the stream of costs over the entire life of the project. In the case of B-C ratio, the simplest way to calculate it is by dividing the present value of the benefits by the present value of the costs. The internal rate of return is the discount rate that will bring the net present value of the investment to zero.



The decision criteria in the case of NPV is to accept all independent projects with zero or positive net present value when discounted at the opportunity cost of capital. An obvious problem with this measure is that the decision criteria cannot be applied unless there is a satisfactory estimate of the opportunity cost of capital. Since NPV is an absolute and not a relative measure, it cannot be used to rank projects. In the case of B-C ratio, the criteria is to accept a project with a ratio equal to or greater than one. Among a number of projects, the one with the highest ratio is chosen. But using B-C ratio alone may be misleading, since a B-C ratio does not take into account the size of the project. A small project with a large B-C ratio may not necessarily be preferred to a larger one with smaller B-C ratio, since the latter exhausts the investment resources more fully and gives a larger net present value. Although there are a number of ways to calculate one B-C ratio, a single method must be selected and used for all projects which are compared to avoid misinformation.

The decision criteria with regard to IRR differ depending on whether the IRR is for the public or the private sector. In the case of a private investment, the appropriate decision criterion is to equal or exceed the market rate on borrowed funds. In the case of public projects, the decision criterion is not as straightforward. It requires that the IRR be equal to the social discount rate, which is often lower than the market discount rate. This is due to the difference in planning of the society as compared to that of the private sector. Social rate of discount is an idealized concept



that is extremely difficult to operationalize. In a large project involving the public sector, as well as individual participants, it is typical to calculate IRR in two ways. First, Internal Economic Return (IER) is calculated based on society as a whole, then Internal Financial Return (IFR) is calculated with respect to the individual participants.

Application of Benefit-Cost Analysis

With the large number of agricultural projects in Saudi Arabia such as dams, irrigation projects, agricultural production projects, livestock projects, and so forth, there is a need for a sound system of analyzing and choosing from among these alternatives.

In general, the most important aspect of a B-C analysis is to obtain a comprehensive and accurate list of all direct and indirect costs and benefits. These are the crucial inputs, no matter which method of choice is employed.

In Saudi Arabia irrigation and dam projects are receiving considerable attention due to water scarcity. It is important to examine several considerations in analyzing the costs and benefits of such projects. We will use an irrigation scheme as an example for a discussion of costs and benefits and the type of information that B-C supplies. However, since the discussion is equally applicable to other projects, the general applicability of the method should be borne in mind.



Costs of a project include the initial investment costs as well as maintenance and operation costs. Costs can also be divided into direct and indirect costs, where direct costs are those that involve direct monetary expenditure and are quantifiable, while indirect costs are generally not quantifiable in dollars and cents. Likewise, there are direct and indirect benefits.

In an irrigation project, expenditures will include building the dams, irrigation, and drainage channels, and the cost of pumps, building, and land as the major investment costs. Operational costs include payment for labor, fuel, agricultural inputs, and depreciation. Indirect costs include loss of natural scenery and wild life and disease from standing water. A direct benefit of the irrigation project is increased production of agricultural crops. Indirect benefits include employment, water conservation, and improved production skills. These are, of course, just the general components of the costs and benefits; more detailed enumeration is needed for any project. After detailed costs and benefits are assembled over the entire expected life of the project, the measures of project value can then be calculated.

Information from the Model

Information from the B-C analysis will give the overall internal rate of return as well as the rate of return with respect to individual participants. The analysis also allows one to undertake a sensitivity analysis by varying some of the cost and benefit assumptions. For example, the costs can be assumed to vary within



the range of 10 percent. A recalculation will show the effect of this or the viability of the project. Similarly, yield variations can be incorporated. One major strength of B-C analysis is the disciplined method of organizing project information.

Sometimes the results of one or more of the analysis techniques described previously can be effectively married with B-C analysis. For instance, information from LP models can be used to estimate the costs and benefits from increasing the amount of irrigation water available to farms in a particular area. The results of solving the LP model can then be used as measures of the costs and benefits when B-C method is used to analyze an irrigation project. Similarly, the demand and supply models can be used to develop projections of future food requirements, which may influence the value attached by decision makers to the benefit of additional grain production. These hypothetical examples are meant to illustrate how several methods can be effectively employed to solve a particular problem.

Data Requirements

For the appropriate utilization of the models discussed, one needs specific sets of data that are not currently available in Saudi Arabia. The data system is an important component of the information system, since the data requirements for the various models differ substantially in volume as well as type. The analytical models discussed will be of very limited use without the data sets needed to test them. The decision maker depends on the use of data in the



analytical models to supply the information necessary for decision making, and the type of data needed depends on the decision maker's needs. This section will discuss the data requirements for linear programming, forecasting, and benefit-cost analysis models. The data needs discussed below relate either directly to the problems presented earlier or to hypothetical problems.

The data requirements for the LP model can be broken down into the following:

1. objective function coefficients
2. resource constraints
3. input-output coefficients

The first step in setting up a problem is to identify all of the possible activities competing for the available resources.

Objective function coefficients for an individual representative farm are derived from the prices of outputs and inputs for the activities. Coefficients in the objective function can be positive or negative depending on whether they are benefits or costs.

To derive resource constraints, the availability of such resources as land, labor, and capital are quantified as shown in Table format 5-1. This table can be derived from more detailed listing of the required resources as shown in the format tables of Appendix C.

Table C-1 in Appendix C gives a general summary of the total resource inventory for the representative farm. Table C-2 gives the detailed availability of the land resource. Land is separated into



irrigated, rainfed, range, forest, residential, and waste land categories. Similarly, Table C-3 gives the breakdown for labor by source and period. Sources of labor include operator, family, and hired labor. Table C-4 separates capital into period and source. Sources for capital include farm income, off-farm income, and various types of loans. Finally, water as a resource is enumerated in Table C-5 by source and period. Potential sources include rainfall, wells, and irrigation projects.

One of the most critical types of data needed for LP analysis is the appropriate set of input-output (IO) coefficients for each activity. Such input-output coefficients are often difficult to obtain. Here we will give a detailed example of the activity of producing one donum of irrigated wheat. Appendix C, Table C-6, shows a breakdown of the various resources by period, with the cells being the places that the IO coefficients are entered. Labor, capital, and water needed to produce the donum of irrigated wheat are given for each month of the year. For some resources in particular periods, the IO coefficients will be zero. There are a number of problems associated with IO coefficient measurements. For example, the labor figures may come from both male and female adults, as well as children. Some interpretation is often needed to standardize the labor units, say to man-hours. Choice of conversion factors is often left to the individual researcher, and the factors vary depending on the type of activity.

Forecasting models such as the one developed to predict the supply and demand for wheat in Saudi Arabia have their own unique



data requirements. Model specification clearly indicates that time series data on prices, quantities of wheat, income, population, weather variables, fertilizer use, hectarage, consumer price index, and other variables are necessary to develop the desired model.

Finally, Table D-1, Appendix D, gives some idea of the data needed to carry out B-C analysis. For each of the years in the life-time of the project, data are needed on the gross costs and gross benefits as well as a discount rate. The gross costs are made up of investment, operations, and maintenance costs, while gross benefits are composed of similar benefit components. The details of the relevant costs and benefits depend on the specific project.

Data for these analyses can be divided into a number of sources. Surveys of farms can provide information on resource availability and input-output coefficients. These surveys can also provide some idea of the farmers' objective function. Other surveys can help in developing the objective function coefficients more precisely. In the case of time series data, the sources are generally public, such as the Central Department of Statistics and other government sources. Agricultural experiment stations are also good sources of data relating to various farm items, including some time series data, but especially for technical IO data.

The Role of the Agricultural Economist

While the agricultural economists' role in the overall information system has already been mentioned, this role is so important that further discussion is in order. As evidenced in Figure 3-1, the



agricultural economist is central to the system, even though he/she is generally associated only with the analytical systems. However, for the development of the correct analytical framework, the agricultural economist is also involved in the development of the theoretical concepts and their operationalization, which are the foundations of the data system. As far as the decision-maker is concerned, the agricultural economist is involved in the interpretation and analysis of model results. This puts the results in a form easily understood by the decision maker. The agricultural economist also serves as an important link between the decision maker and the rest of the system, thereby giving important feedback to the system.

To make a maximum contribution to the system, the agricultural economist must be informed regarding developments in the field of modeling and model solution. Most of the models now utilize high-speed computers, so that the agricultural economist must keep up with the emergence of new software and hardware available for computations.

Summary

This chapter has briefly examined three analytical techniques that can be employed in the analysis of data for Saudi Arabia--linear programming, forecasting, and benefit-cost analysis. The discussion was not intended to be an exhaustive presentation of analytical techniques, but rather as examples of methods that can be used in answering these important questions. Questions related to optimum use and



allocation of resources could be answered from linear programming, those related to future expectations could be answered from forecasting models, and those related to choice of projects are the subject of benefit cost analysis. It should be noted that the usefulness of these methods are strictly dependent on the availability of data.



CHAPTER VI

SUMMARY, CONCLUSIONS, RECOMMENDATIONS AND DIRECTIONS FOR FURTHER RESEARCH

Summary and Conclusions

Saudi Arabia depends almost entirely on crude oil as a source of income. At present crude oil production accounts for more than 70 percent of the gross domestic product and is the principal earner of foreign exchange. Government officials are aware that dependence on one commodity as a source of income can be a risky adventure and so they have committed themselves to diversifying the country's economic base.

At present agriculture and its related fields appears to be the only other viable and nonexhaustible alternative as a source of income. Prior to the oil boom, agriculture provided the mainstay of the economy, generating both employment and a source of income for the rural population. At present, agriculture provides employment for about 25 percent of the labor force even though its contribution to the gross domestic product has declined to a little over 1 percent.

Although domestic agricultural production has increased, it has not kept pace with the increase in demand. The increasing income derived from an increased oil wealth, coupled with a rapidly growing population and a high influx of foreigners has contributed to a high and diversified demand for food. Because of the low productivity,



high demand situation Saudi Arabia imports approximately half of its annual food requirements. In fact, since the late 1970's Saudi Arabia has been one of the world's three leading importers of poultry products, barley, soft drinks, and fruit juices. In a world with at least one billion people presently regarded as undernourished and a rapidly increasing world population, Saudi Arabia cannot hope to permanently depend on other countries for half of its food needs. For this reason the country is committed to developing its agriculture to the point of food self-sufficiency. The third five-year development plan called for an investment of nearly SR 72 billion in agriculture and water.

Incentives are also being provided to attract private local investments in agriculture. The response so far has been encouraging. Local production of certain products has increased by more than 300 percent. These increases in agricultural production which may be associated with increases in specialization and commercialization are associated with an increase in demand for agricultural information. The data base, however, from which information can be derived is inadequate in Saudi Arabia. This is explicitly recognized in the third development plan which has called for an improvement in the data base. Indeed, the topic of this study was chosen as a result of the author's frustration in an attempt to obtain data for another topic. The main objective of the study was to evaluate the Saudi Arabian agricultural information system. The specific objectives were to:

1. describe the agricultural sector in Saudi Arabia; its potential and limitations



2. present an agricultural information system paradigm as an idealized model to be used as a frame of reference in evaluating or designing any agricultural information system
3. use the paradigm in evaluating the existing data base in Saudi Arabia
4. discuss the analytical framework as a subsystem of the agricultural information system
5. delineate some of the agricultural data needed for certain specific problems and decisions in Saudi Arabia

The whole study was centered on one of the most frequently used paradigms of agricultural information systems. This paradigm was first developed by J. T. Bonnen in 1975 and has since become a basis for the evaluation of several other information systems. The paradigm is an idealized information system and it consists essentially of three subcomponents--a data subsystem, an inquiry subsystem, and a decision-making subsystem. These subsystems are not isolated, but rather interact to form the whole information system. The primary value of Bonnen's paradigm is in its demonstration of the steps necessary to develop information from data.

Every data system involves an attempt to represent reality empirically. Since reality is nearly infinite in its variations--and configurations and is not readily grasped by the human mind, it is necessary to break down experiential phenomena into a set of categories or classes that can be counted or measured. The phenomena to



be counted or measured depends on the decisions to be made. Thus, there must be a concept of reality to be measured and to be meaningful this concept must be capable of accurately systematizing and categorizing reality so that it can be understood by those using the data. This categorization must also be such that the concepts are relevant to the decisions being made.

Although data presupposes a concept, concepts are abstract ideas and it is not possible to measure concepts as such. Instead, it is necessary to operationalize and define these concepts so that the definitions are as representative as possible of the chosen concept. There are thus three distinct steps which must be taken before one can produce data which purport to represent reality. These are (a) conceptualization, (b) operationalization of the concepts, and (c) measurements. These essentially are the components of the data subsystem.

The data subsystem is only part of an information system. To become information, data must be analyzed and interpreted and placed in a decision-making context. In this sense the demand for data is derived from the need to make decisions on problems. Information systems then can be viewed as a process which imposes form and gives meaning to data.

The analysis of any given problematic situation in agriculture usually starts with a received body of theoretical concepts which purport to represent reality. The concepts are operationalized through the definition of variables that are often specified formally in a model. The model is then tested against the data and conclusions



are drawn. Hence data production must share the conceptual ground with the analytical system of inquiry if an empirical test is to be valid or even possible.

Information possesses certain characteristics of a public good which makes its analysis through the use of neo-classical economic theory very difficult. The characteristics of uncertainty, indivisibility and nonappropriability which are peculiar to information, all violate the classical properties of purely private goods. Uncertainty is inherent in the definition of information. Since information is an indivisible good, the difficulty of achieving efficiency in its production and consumption results from the fact that the marginal cost of adding an additional consumer of information is zero, once the information has been produced. The nonappropriability of information is related to the problem of property rights. The producer or owner of information does not realize the exclusive benefits of the property alone.

A description of the demand for and supply of data in Saudi Arabia showed that the supply side of agricultural data was highly concentrated and consisted mostly of ministries and other government agencies. The Ministry of Agriculture and Water is perhaps the most important source of agricultural data in Saudi Arabia. This ministry carries the major responsibility for developing and implementing agricultural plans and programs. The Department of Economic Studies and Statistics is mainly responsible for the collection and analysis of agricultural data. The data provided by this department can be



classified into basic data, current data, and special needs data. In collecting agricultural data, the department relies on decennial censuses and annual agricultural surveys.

The demand for agricultural data is simply part of a larger demand for information on all sectors of the economy. It is difficult to separate the users and suppliers of data in Saudi Arabia because most of the data collected is targeted toward meeting the specific needs of the agency collecting the data. Nevertheless, the data collected is usually available for use by both the private and public decision makers.

The Saudi Arabian agricultural information system is yet in its infancy. Although it is possible to separate the three subsystems --data, inquiry, and decision maker--it is sometimes difficult to separate the actors of these subsystems. Also, there is no single subsystem that has developed to the extent of earning both a national and international respect.

In general, the agricultural information system can best be described as a data base or a repository of all agricultural data that is scattered among the suppliers of the data. Because data for all agricultural aspects are not readily available and the available data are not sufficiently analyzed, the agricultural information system in Saudi Arabia falls short of meeting the needs of the decision makers and is plagued by several problems which include a lack of experience, ambiguity of agency objectives, and an inadequate institutional arrangement.

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1876

The rapidly changing agricultural sector has placed a heavy demand for agricultural data on a system that is set on a primitive stage with a very short experience in data collection. To date, there have only been two national censuses of agriculture. This is hardly enough experience on which to establish confidence in the accuracy and reliability of the data collected. The objectives of the Department of Economic Studies and Statistics are tailored to meeting the needs of the public sector while ignoring private demands. In addition to the lack of a census legislation, there is also a lack of coordination of activities between the different suppliers of data. This often leads to a duplication of efforts and a waste of much needed resources.

A close examination of the Saudi Arabian agricultural information system showed some serious problems with conceptual obsolescence. The use of the concept of a holding or a farm has not kept up with recent changes in the way the farmer views his farm. In the early 1950's and 1960's farmers were purely subsistent in nature and produced all of their family's needs on the farm. In recent times, however, farmers have begun to specialize in farm production and have entered the market economy. Some farms are even used for recreational purposes. These changes require a re-evaluation of the concept of farm or holding. Another example of conceptual problems is that of arable land. This concept is dynamic in nature in that the available arable land at any given point in time can be affected by changes in technology, economic, social, and natural conditions. In Saudi Arabia,



however, the estimate of arable land made about twenty years ago is still the basis of agricultural planning.

Conceptual obsolescence is also encountered when the agenda facing policy makers changes. Government objectives with regard to agricultural development has changed and this requires a parallel change in the type of information made available to decision makers. These changes have not taken place. Detailed data on farm income and expenditures, for example, which are indispensable to policy makers are currently unavailable.

The operationalization of concepts, which is another stage in the information system, was discussed in the context of the questionnaire used in the censuses. Some problems with the definition of certain concepts were observed. The land holding as defined in the last two censuses had no upper and lower boundaries which made the inclusion of a wide range of holdings possible. Also, the definition of a holding differed from one census to another which made comparison between censuses very difficult. A definition which combined the value of an average nisap and the definition used in the 1974 census was suggested. Thus, the holding was defined as any land which is wholly or partly used for agricultural production and may consist of one parcel of land or more and managed as one technical unit from which the value of an average nisap or more of agricultural products were sold or normally would have been sold during the census year, regardless of title, legal form, or size.

Another example of a concept that presented some operational problems was that of the labor force. There is a need to distinguish



between the stock concept of labor and the flow concept of labor. Enumerating the number of people in a holding can only give an indication of the stock of labor available. In order to determine the labor input in Saudi Arabian agriculture, it is necessary to estimate the number of hours actually devoted to agriculture. This is the flow concept. The flow concept gives a better approximation of employment or unemployment in agriculture.

Even the definition of the stock concept--the agricultural worker--was suspect. It included any person who was engaged in agricultural work and was either paid in cash or kind. This definition erroneously included even people who participated in farm work as recreation and those who did farm work for less than one day in the whole year.

Data collection and measurement is an important step in the data subsystem of an information system. Although this stage enjoys considerable attention, when compared to other stages in the Saudi Arabian agricultural information system, it still suffered from major problems which are mainly related to the enumerators and farmer respondents. Sampling errors are being minimized periodically as the sample size relative to the population is being increased from time to time. The sample size in the annual surveys has been increased from 2 percent in 1976-1979 to 10 percent of the population in 1982. Despite these improvements in the sample size, enumerators are still not adequately trained and lack of adequate and efficient transportation increases the demand on the enumerator's already limited time. Because most



farmers are illiterate and keep no farm records they cannot recall all the information that is being solicited in the surveys. Some of these problems could be minimized by use of university students who are well trained in agriculture and measurement methods. It is also suggested that a move toward objective, rather than subjective, methods of measurement be pursued.

Decision makers in Saudi Arabia are basically of two types --public and private. Public decision makers are better served than private decision makers because the public sector controls most of the data suppliers. The usefulness of information to any decision maker depends on the scope of the data coverage, the type and level of analysis of the data, and the method of dissemination, presentation, and interpretation of the data. Most of the data collected and analyzed in Saudi Arabia does not reach the decision makers; rather documents of information are shelved away to gather dust.

Agricultural and resource economists have a number of analytical methods that could be employed in producing information from data in Saudi Arabia. Some of those methods--linear programming, forecasting and benefit cost analysis--were discussed to show how they could be used in Saudi Arabia. Linear programming was developed by military specialists in the early 1940s as a tool for minimizing the cost of transportation. Today it has been popularized by agricultural and resource economists as a tool for the determination of the optimum allocation of limited resources in the farming business. Its main strength lies in its ability to incorporate several activities



in one solution. An example of how linear programming could be used to determine resource allocation at the farm level was discussed. Interpretation and use of the results obtained were also presented.

Forecasting models are useful in determining what the future outlook for the demand for and supply of a given commodity would be. The demand for and supply of wheat was used as an example to demonstrate the usefulness of these models. The results of the forecasting model could be used to make short- and long-run policy changes with respect to a given commodity.

Benefit-cost analysis is a useful tool that can serve as a guideline in the selection and implementation of projects. Three measures of project worth--net present value, internal rate of return, and benefit/cost ratio were discussed. The usefulness of all three measures depends on the selection of an appropriate discount or cut-off rate.

Recommendations

The Kingdom of Saudi Arabia is a country with a very rapid pace of development. The role of the government in society and in the economy as a whole has greatly expanded. In the last three decades, there has been a large increase in the number of ministries, departments, and government agencies and programs which require data and information to make relevant decisions. Agriculture, for example, has assumed a new priority status and agricultural investments are rapidly increasing. In order to make national policy decisions on the complex problems facing the agricultural sector, the government



has had to increasingly depend on quantitative measurements to identify and understand these problems. Failure to provide accurate, reliable, and relevant quantitative descriptions and analyses of problems, now results in unnecessary policy confusion and waste of resources.

Reliance on the current information system is unsatisfactory. There is a current lack of policy relevance in the data collected. Suppliers have no clearly defined priorities for data collection, and it is not known to what extent the data are subjected to actual or perceived manipulation which may destroy the integrity of the data suppliers. The quality and quantity of data currently collected are inadequate. During the discussions in the previous chapters, some suggestions were made on how to improve the current agricultural information system in Saudi Arabia. In this section, specific recommendations will be made to reinforce the suggestions made earlier.

Establishment of a Planning and Coordinating Committee

The need for government-wide planning and coordination of agricultural data and information is long overdue. It is, therefore, recommended that a Planning and Coordinating Committee be established either as an independent body or as an establishment within the Central Department of Statistics. The committee may be made up of representatives of all Ministries and Departments that are directly or indirectly involved and interested in the agricultural data collected. The committee should also include representatives from all the agricultural colleges--and if feasible, external organizations, like the Food and



Agriculture Organization should be represented. These organizations have encountered several problems in other countries that might not be foreseen by the committee. Their representation may probably help in avoiding a repetition of such problems in Saudi Arabia. The interests of the private sector should also be fully represented.

The main objectives of the committee will be to ensure the policy relevance, quality, and integrity of all the data and information produced by all data suppliers; to develop plans so that all suppliers, public or private, will be able to meet current and future data and information needs efficiently in the face of a changing technological, social, and economic environment; to maintain a proper balance between protecting individual rights to privacy and confidentiality, and meeting the information needs for public and private decision makers through legislation; and to coordinate all data suppliers on the one hand and data suppliers and users on the other.

The committee should be empowered to coordinate, plan, and even prepare budgets for all major data collection exercises in Saudi Arabia. This means that the committee will have to develop legislation--and make regulations and guidelines for collecting data; make long-term plans for adapting and unifying concepts, definitions, and data collection methods to a changing structural and technological environment; and review the statistical quality of all data collection aspects. It will identify all data sources and specify the scope of data collected by each source.

With respect to users, the committee will ensure the maximum utilization of all data collected through objective analyses of the



available data. It will maintain for users a central inquiring service for identifying and gaining access to appropriate data and establish and monitor standards to ensure maximum accessibility and utility of data to all users. Identifying data users and their needs will be an important part of the committee's function. The committee will also act as a focal point for the receipt of and the response to requests from international agencies.

It will be the responsibility of the committee to establish and monitor standards to ensure the quality, integrity, and comparability of the data and analytical methods employed by data suppliers. Also, temporal and geographical comparability of data collection and data reporting methods should be considered. Where feasible, compatibility with international standards should be encouraged. The committee should have the capacity to provide technical assistance in statistical methods as needed to agencies undertaking or sponsoring data collection.

The functions of the committee should be reviewed periodically to make additions and subtractions when necessary. The general public must have a high level of trust in the committee. For this reason, the committee must be impartial in its work and be perceived by the public as neutral. That neutrality should be protected by broad accountability. Adequate authority must be vested upon the committee if it is to properly execute its functions. The committee must be viewed as a permanent and not an ad hoc institution.



Close Link Between All Agricultural
Colleges and the Department of
Economic Studies and Statistics

The study has made it clear that the Department of Economic Studies and Statistics alone is incapable of handling the entire agricultural information system in Saudi Arabia efficiently. It lacks both the facilities and the trained manpower to do it. These deficiencies, however, could be satisfied from the Colleges of Agriculture that are strategically located throughout the country. Thus, it is recommended that a close chain of communication be established between all Agricultural Colleges and the Department of Economic Studies and Statistics. There is a dual advantage in this kind of arrangement. The Department of Economic Studies and Statistics will benefit from the analytical capacity that is currently present in the Agricultural Colleges. Since the Agricultural Colleges are located in different regions, faculty members have a better understanding of the local conditions within their respective regions than do professionals in the Department of Economic Studies and Statistics in the capital city. This knowledge of local conditions could be utilized by having college faculty and students participate in collecting and analyzing data in the region in which they are located.

Faculty members will benefit from the fact that their students will have the opportunity of gaining an in-the-field experience when they participate in collecting the data. Interaction with farmers will also increase the student's knowledge of local farming conditions. This is important because at present, there is very little contact



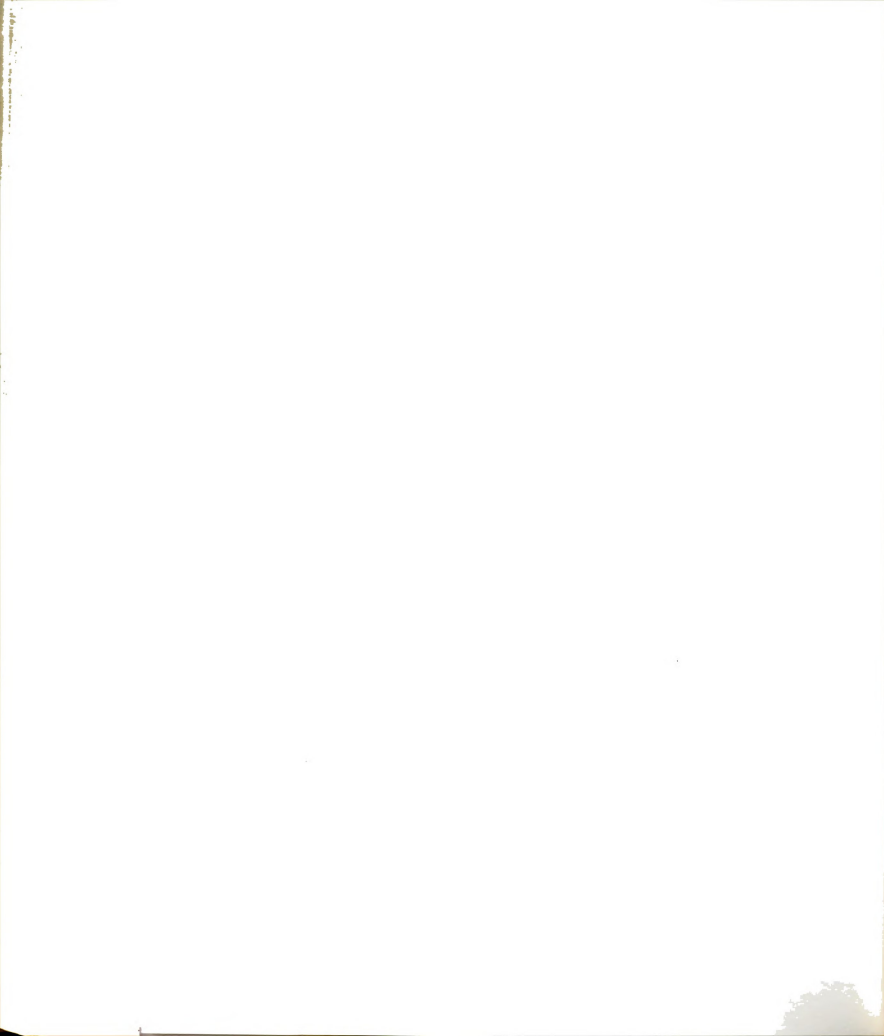
between the faculty and students of the agricultural colleges and the farmers.

In addition to the advantages enjoyed by the two parties, a link with an academic institution will tend to enhance the credibility of the data and information generated as the general public will feel the data are not being manipulated for political reasons.

Redefinition of the Department of
Economic Studies and Statistics
Objectives

It is suggested that the Department of Economic Studies and Statistics redefine its objectives in the light of current conditions. As a public institution, the department is supposed to serve both the public and private sectors equally. This can only be done by a redefinition of the department's objectives which will explicitly take cognizance of the needs of the private sector.

In addition, the department should reconsider the length of time between censuses. Saudi Arabia is undergoing rapid technological and economical changes in its agricultural sector. This makes it imperative that data be collected more often than the decennial censuses currently used. It is suggested that censuses be conducted every five years in order to adequately capture short-term changes in the structure of the agricultural sector. Also in the interest of saving resources, it is recommended that the census be conducted in one stage instead of the current two stages.



Directions for Further Research

This study is far from a complete and thorough discussion of the Agricultural Information System in Saudi Arabia. It has, however, succeeded in pointing out some of the short comings and problems of the Saudi Arabian Agricultural Information System and it thus serves as a basis for further research.

On the purely theoretical aspects is the problem of the economics of information. Although several studies have been devoted to this topic, there is yet no universally accepted method for dealing with the economics of information. At the center of the problem is a way of determining the value of information. Research on this topic should concentrate on how decision makers can value information prior to investing resources in acquiring the information.

On the home front, in Saudi Arabia, research is needed on more specific aspects of the agricultural sector. This study approached the agricultural information system at the macro-level by looking at the entire agricultural sector. Further work is now needed to study the information systems at a micro-level by evaluating the information systems of individual crops, prices of commodities, and others.

There is also a need for work to be done in determining the needs of data users and the relative importance of different types of information to the users. The results of such studies could be used by data suppliers to establish data collection priorities that reflect data demands.



APPENDICES

APPENDIX A

1973 CENSUS QUESTIONNAIRE



1973-74 CENSUS OF AGRICULTURE - THE QUESTIONNAIRE

(If a member of the family or anyone else responds for the holder, be sure that all the information is given for the holder)

Identification

Name Amarat Name Sub-Absar Name Village Name Holder Card Number 1 12

General Information

Age of holder 1 Unit of Area for this holding 15 Total number of local units of Area for this holding 19 How many separate parcels are there in all 23

Land Utilization

- How many local units of land were in fields and tracts from which crops were harvested this year? 25
- How many local units of cropland were in temporary fallow? 29
- How many local units of land were under other waste land? 33
- How many local units of land were under permanent crops? 37
- How many local units of land have not been accounted for? 41
- How many local units of land were under following crops:

i) Wheat (Irrigated) 45 ii) Wheat (Not Irrigated) 48 iii) Dry Ontons 51

iv) Sorghum 54 v) Alfalfa 57 vi) Dates 60

Fertilizers and Soil Dressings

The amount of fertilizers used and area treated by the following this year

	Area in local units	Amount Applied	
		Unit	Weight in kilograms/Unit
1. Inorganic fertilizers	63	66	69
	72	75	78
2. Organic manure			

Source: Reproduced from Ali S. Abu-Bakr, Cost-Size Relationship and Efficiency of Palm Groves in Al-hasa Oasis, Saudi Arabia. Doctor of Arts Dissertation, Department of Geography, College of Arts and Sciences, University of Northern Colorado, 1976.



11/3-74 CENSUS OF AGRICULTURE - THE QUESTIONNAIRE

(If a member of the family or anyone else respondent for the holder, be sure that all the information is given for the holder)

Identification

Name Asaret 1 Name Sub-Asaret 1 Name Village 5 Name Holder 9 Card Number 2 12

Farm Population

1. Members of the holder's household

1) Under 15 years of age Male 11 Female 12 11) 15 to 64 years of age Male 17 Female 18 11) 65 years of age and more Male 19 Female 20

2. Other persons living on the holding

1) Under 15 years of age Male 21 Female 22 11) 15 to 64 years of age Male 23 Female 24 11) 65 years of age and more Male 25 Female 26

Source of Irrigation

1. What was the source of irrigation water used on this place this year?

1) Artesian Well Yes 1 37 No 2 38 11) Flooding by collected rain water Yes 39 No 40 11) Local Well Yes 1 41 No 2 42 11) Spring Yes 1 43 No 2 44

2. Total area of land actually irrigated.

41

Employment in Agriculture

A. Employment in Agricultural work on the holding during the Census week.

1. Holder and unpaid members of his household

1) Permanent workers

11) Temporary workers

111) Occasional workers

REMARK					
Under 15 years of age		15 to 64 years of age		65 years of age and more	
Male	Female	Male	Female	Male	Female
45	47	49	51	53	55
57	59	63	65	67	69
71	73	75	77	79	81



1973-74 CENSUS OF AGRICULTURE - THE QUESTIONNAIRE

(If a member of the family or anyone else responds for the holder, be sure that all the information is given for the holder)

Identification

Name of holder Name of holder Name of holder Card number

Employment in Agriculture (Continued)

2. Persons working for pay on the holding

	Under 15 years of age		15 to 64 years of age		65 years of age and more	
	Male	Female	Male	Female	Male	Female
i) Permanent workers						
ii) Temporary workers						
iii) Occasional workers						

B. Extent to which the Agricultural Work on the Holding is carried on by the holder's household or by persons working for pay.

1. How the Agricultural work was done on your holding?

i. All work done by the members of the holder's household (including work exchanged with others)

ii. The bulk of work done by the holder's household, but persons working for pay are also employed

iii. The bulk of work done by persons working for pay.

2. About how many hours last week did you do farm work or chores on this place?

i. None

ii. 1 to 15 hours

iii. 16 hours or more

3. How many other members of your family did 16 hours or more of farm work or chores on this place last week without receiving cash wages?

4. How many hired persons did any farm work or chores on this place last week?

5. Do you employ a manager for this holding?

6. To the holder:-

i) A Civil Person

ii) A Corporation

iii) A cooperative or consciously planned collective.

iv) Other

7. In the holding, mainly producing for home consumption

8. How many local units of land do you own or hold in owner-like participation?

9. How many local units of land do you rent from others for cash or share of the crop or livestock production?



1937-38 CENSUS OF AGRICULTURE - THE MIDDLE STATES

(If a member of the family or anyone else responds for the holder, be sure that all the information is given for the holder)

Identification

Name As usual	Name Sub-As usual	Name Village	Name Holder	Card Number
1	1	5	9	17

Agricultural Power and Machinery and General Facilities

A. Use and Source of Power on the Holding

1. Was the agricultural work in the field or elsewhere on this holding done

(1) By animal power	Yes 1	No 2	(11) By mechanical power	Yes 1	No 2	(111) By main power	Yes 1	No 2
	11	12		13	14		15	16

B. How many of the following are on this place?

	Number owned by the holder at a specified date	Number used on the holding during the year	Number provided by private contract or otherwise	Number provided by Govt. or other authority			
1. Internal combustion engines less than 10 H.P.	01	02	03	04	05	06	07
2. Internal combustion engines more than 10 H.P.	08	09	10	11	12	13	14
3. Electric Motors	15	16	17	18	19	20	21
4. Track-laying Tractors less than 10 H.P.	22	23	24	25	26	27	28
5. Track-laying Tractors more than 10 H.P.	29	30	31	32	33	34	35
6. Wheel Tractors less than 10 H.P.	36	37	38	39	40	41	42
7. Wheel Tractors more than 10 H.P.	43	44	45	46	47	48	49
8. Water Pumps	50	51	52	53	54	55	56
9. Portable Water Pumps	57	58	59	60	61	62	63
10. Tractors (Engine-operated)	64	65	66	67	68	69	70
11. Harrows (Hand-operated)	71	72	73	74	75	76	77
12. Combines (Harvesters-Threshers)	78	79	80	81	82	83	84
13. Barrows	85	86	87	88	89	90	91
14. Other power or other motor vehicles	92	93	94	95	96	97	98



بسم الله الرحمن الرحيم

الملكة العربية السعودية
وزارة الزراعة والمياه
ادارة الاجاثا والتنمية الزراعية
قسم الاحصاء الزراعي

استمارة

التعداد الزراعي الشامل لعام ١٩٧٣ - ١٩٧٤

١٩٧٤ / /	تاريخ زيارة العداد	اسم العداد
١٩٧٤ / /	تاريخ مراجعة الشرف	توقيع العداد
		اسم الشرف
		توقيع الشرف



التعريف :

١٠ رقم الحساب ٩ اسم الملتزم ٨ اسم القرية ٧ اسم المزرعة ٦ الادارة القرية ٥ الادارة الرئيسية

معلومات عامة :

١١ عدد قطع بالمزرعة ١٢ وحدة المساحة الحقلية ١٣ مزرعة

استخدامات الأرض :

١٤ عدد وحدات المساحة الحقلية الزروعة بالمحاصيل ١٥ قروحة (بورد) عدد قاعة

١٦ عدد وحدات المساحة الحقلية الزروعة بالمحاصيل ١٧ عدد وحدات المساحة الحقلية قديمة لزراعة المحاصيل المؤقتة ولم تزرع هذه السنة

١٨ عدد وحدات المساحة الحقلية قديمة قروحة ١٩ لم تزرع قروحة قديمة

٢٠ قروحة (مروي) ٢١ نوع (غير مروي) ٢٢ نوع (مروي)

٢٣ قروحة ٢٤ قروحة ٢٥ قروحة

الاحصاء وخصائص القرية :كميات الاحصاء المستخدمة والمساحات المتعددة بها هذه السنة

كمية المستخدمة من السيل			نوع الوحدة	نوع السيل
وزن الوحدة بالكيلوجرام	عدد الوحدات	نوع الوحدة		
٢٦	٢٧	٢٨	٢٩	٣٠
٣١	٣٢	٣٣	٣٤	٣٥
٣٦	٣٧	٣٨	٣٩	٤٠
٤١	٤٢	٤٣	٤٤	٤٥
٤٦	٤٧	٤٨	٤٩	٥٠
٥١	٥٢	٥٣	٥٤	٥٥
٥٦	٥٧	٥٨	٥٩	٦٠
٦١	٦٢	٦٣	٦٤	٦٥
٦٦	٦٧	٦٨	٦٩	٧٠
٧١	٧٢	٧٣	٧٤	٧٥
٧٦	٧٧	٧٨	٧٩	٨٠
٨١	٨٢	٨٣	٨٤	٨٥
٨٦	٨٧	٨٨	٨٩	٩٠
٩١	٩٢	٩٣	٩٤	٩٥
٩٦	٩٧	٩٨	٩٩	١٠٠









APPENDIX B

1982 CENSUS QUESTIONNAIRE



In the name of Allah, the Beneficent, the Merciful

The Kingdom of Saudi Arabia
Ministry of Agriculture and Water, Department of Economic Studies and Statistics.
1981-1982 Census of Agriculture--The Questionnaire--Winter Season

Section One: Identification Data

1. Name of the Amarat						
2. Name of Sub-Amarat						
3. Name of Village						
4. Name of Holder						
5. Age of Holder			101			
6. Nationality of Holder					Saudi	1
7. Do you practice other occupation?	Yes	1	103	No	2	103
8. Address of the Holder						
9. Landlord's Name						
10. Landlord's Address						
11. Holdings Name (if any)						

Section Two:

A. Legal System of Holding and Management Type

12. Mark a ✓ in front of the Appropriate Legal system	Individual	Government firm	Tribal	Private company of firm	Cooperation	Other farms		
	1	104	2	104	3	104		
13. Management type	By the holder		1	105	Hired Manager	Saudi	2	105
					Non-Saudi	3		

B. Distribution of the Holding Land According to its Utilization

14. Name of Local Area Unit		
15. Equivalent in Square Meters	106	
16. Total Local Units (Total Holding Area) 17 + 18 + 24	107	
17. Number of Local Units Owned	108	
18. Number of Local Units Rented (19 + 20 + 21 + 22 + 23)	109	
19. Number of Local Units Rented in Cash	110	
20. Number of Local Units Rented in Kind	111	
21. Number of Local Units Rented in Cash and Kind	112	
22. Number of Local Units Rented by Share	113	
23. Number of Local Units Rented by Other Type of Rent	114	
24. Number of Local Units Under Other Legal System	115	
25. Number of Parcels of Land in the Holding Within One Village	116	

26. Main Purpose of Holding Production	Sale	1	117	Family Consumption	2	117	Sale & Family Consump	3	117
27. Is There a Specialized Agricultural Project in the Holding	Yes	1	118	No	2	118			
28. Did you Obtain Loan from the Agricultural Bank	For Proj.	Yes	1	119	Non- Proj.	Yes	1	120	
	No	2		No	2				

29. Date Provider			32. Enumerator			001
30. Relation to Holder			33. Supervisor			002
31. Date of Visit			34. Editor			003



Section Three: Land Use

35.	Total Number of area local units (Area of Holding)			201
36.	Number of area local units cultivated with seasonal crop this season			202
37.	Number of area local units left fallow during the time of visit			203
38.	Number of area local units cultivated with permanent alfalfa			204
39.	Number of area local units cultivated with permanent crops (Trees)			205
40.	Number of area local units of suitable agricultural land never cultivated			206
41.	Number of area local units of land unsuitable for agriculture			207

Section Four

A. Holder's family and other persons living in the holding

		Males		Females
42.	Members of holder's family less than 15 years	208		209
43.	Members of holder's family 15 to 64 years	210		211
44.	Members of holder's family 65 and older	212		213
45.	Other non-holder's family living in the holding (Saudis)	214		215
46.	Other non-holder's family living in the holding (non-Saudis)	216		217

B. Labor force

Type of Worker	Saudi				Non-Saudi			
	Male		Female		Male		Female	
	Paid	Unpaid	Paid	Unpaid				
47.	Permanent Worker	218	219	220	221	222	223	223
48.	Temporary worker (winter season)	224	225	226	227	228	229	229
49.	Occasional workers (winter season)	230	231	232	233	234	235	235

Section Five: System and source of water in the Holding

A. Irrigation System

If irrigation system is normal flow, then mark the type of channel used in the holding.

50.	Mud channel	1	259	Plastic lined Channel	2	260	Cement lined Channel	3	261	Pipe	4	262
-----	-------------	---	-----	-----------------------	---	-----	----------------------	---	-----	------	---	-----

If modern irrigation equipment is used, then mark the type used in the holding and fill in the number in the corresponding blank.

Type of irrigation system	No. of equipment	Total area irrigated by the equipment
51. Sprinkler Irrigation (rotating)	237	238
52. Sprinkler Irrigation (fixed)	239	240
53. Drip Irrigation system	241	242
54. Irrigation System by gravity flow	243	244
55. Other type of irrigation system	245	246

(Existing wells in the holding)

B. Source of irrigation water in the holding (Write total area irrigated by each of the following four sources)					
Bunded Rain			Unbunded Rain		
		247			248
Spring water			Other sources		
		249			250

56.

		247			248
--	--	-----	--	--	-----

Spring water			Other sources		
		249			250

57. Is there a drainage system in the holding?

Yes	1	258	No	2	258
-----	---	-----	----	---	-----



Section Six: Animals and Poultry

Type of Animal	Males		Females	
	Number		Number	
58. Camels Total number of camels		301		302
59. Camels three years old and above		303		304
60. Female milking camels				305
61. Sheep Total number of sheep		306		307
62. Sheep, one year old and over		308		309
63. Female milking sheep				310
64. Goats Total number of goats		311		312
65. Goats, one year old and over		313		314
66. Female milking goats				315
67. Cattle Total number of cattle		316		317
68. Cattle, two years and over		318		319
69. Female milking cattle				320
70. Horses Total number of horses		321		322
71. Poultry Total number of poultry		323		324

Section Seven: Seasonal, Winter Crop

Crop	Number of area local units harvested				Production		
	Area Irrigated		Rain-fed		Production Unit in Kilograms	Number of Units Produced	
	By wells and springs	Bunded rain	Unbunded rain	Production Unit			
72. Improved wheat	324	325	326		327	328	
73. Local wheat	329	330	331		332	333	
74. Pearl Millet	334	335	336		337	338	
75. Sorghum	339	340	341		342	343	
76. Maize	344	345	346		347	348	
77. Barley	349	350	351		352	353	
78. Sesame	354	355	356		357	358	
79. Tomato	359	360	361		362	363	
80. Eggplant	364	365	366		367	368	
81. Ono	369	370	371		372	373	
82. Squash	374	375	376		377	378	
83. Cucumber	379	380	381		382	383	
84. Watermelon/Lettuce	384	385	386		387	388	
85. Musk melon/Carrot	389	390	391		392	393	
86. Other Vegetables	394	395	396				
87. Dry onion	397	398	399		400	401	
88. Mixed crop/grain and fodder	402	403	404				
89. Winter fodder	405	406	407				
90. Other Crops	408	409	410				
*Ask only in Jazan and Tihama							
Seasonal Crop Under Permanent Crops							
91. Grain crop	411	412	413				
92. Vegetables	414	415	416				
93. Alfalfa	417	418	419				
94. Other fodder	420	421	422				

95. Did you grow wheat last year?

96. If yes, what was the amount produced in kilograms

97. Did you sell to the wheat mill last year?

Yes	1	423	No	2	423
424	Or what is the value in Riyal				425
Yes	1	426	No	2	426



Section Eight: Agricultural Machinery and Transportation Means		Machine Types		Machines Owned by the holder alone during the visit		Machines Used for This Season											
						Sole ownership by holder		Joint ownership with others		Offered to the holder by							
										Landlord		Rent		Cooperative		Govt. Agent	
No		No		No		No		No		No		No					
98	Engines up to 10 h.p.		501		502		503		504		505		506		507		
99	Engines 11 to 30 h.p.		508		509		510		511		512		513		514		
100	Engines 31 to 100 h.p.		515		516		517		518		519		520		521		
101	Engines 101 h.p. and more		522		523		524		525		526		527		528		
102	Water pumps		529		530		531		532		533		534		535		
103	Deep bore pumps		536		537		538		539		540		541		542		
104	Submersible pumps (Elect.)		543		544		545		546		547		548		549		
105	High pressure pumps		550		551		552		553		554		555		556		
106	Propeler pumps		557		558		559		560		561		562		563		
107	Water pump unit (Engine)		564		565		566		567		568		569		570		
108	Electric water pump unit		571		572		573		574		575		576		577		
109	Electric generators		578		579		580		581		582		583		584		
110	Crawler Tractor		585		586		587		588		589		590		591		
111	Wheel Tractor		592		593		594		595		596		597		598		
112	Self-powered Shovel		599		600		601		602		603		604		605		
113	Backhoe		606		607		608		609		610		611		612		
114	Threshers		613		614		615		616		617		618		619		
115	Combine harvesters		620		621		622		623		624		625		626		
116	Disc Harrows		627		628		629		630		631		632		633		
117	Disc plow		634		635		636		637		638		639		640		
118	Mouldboard plow		641		642		643		644		645		646		647		
119	Chisel plow		648		649		650		651		652		653		654		
120	Land plane		655		656		657		658		659		660		661		
121	Levelling blades		662		663		664		665		666		667		668		
122	Ditchers		669		670		671		672		673		674		675		
123	Border ridger		676		677		678		679		680		681		682		
124	Planters		683		684		685		686		687		688		689		
125	Fertilizer distributors		690		691		692		693		694		695		696		
126	Seed drill with fertilizer box		697		698		699		700		701		702		703		
127	Sprayers (engine)		704		705		706		707		708		709		710		
128	Sprayers (knapsack)		711		712		713		714		715		716		717		
129	Potato planters		718		719		720		721		722		723		724		
130	Potato harvester		725		726		727		728		729		730		731		
131	Fodder harvester		732		733		734		735		736		737		738		
132	Trucks and Cars		739		740		741		742		743		744		745		
133	Trailers		746		747		748		749		750		751		752		
134	Draft Animals		753														
Notes																	





بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

المملكة العربية السعودية

وزارة الزراعة والري

إدارة الدراسات الإقتصادية والإحصاء

استمارة التقدير الزراعي والسائل لغاية ١٤٠١ / ١٤٠٢ هـ

الموسم الشتوي

القسم الأول: البيانات التعريفية:

1	اسم الإمارة الرئيسية	
2	اسم الإمارة الفرعية	
3	اسم القرية	
4	اسم الحاش	
5	سن الحاش	
7	هل تزاول مهنة أخرى غير الزراعة	
8	عنوان الحاش	
9	اسم المالك	
10	عنوان المالك	
11	اسم الحيازة (المزرعة) إن وجد	

القسم الثاني:

أ- الوضع النظامي للحاش وأسلوب إدارة الحيازة.

12	صنع علامة ✓	شخص عادي	هبة أو منحة	عشرة أو قبيلة	مزرعة أو مزرعة	نفاذ	نظام آخر
13	أمام الوضع النظامي للحاش	1	2	3	4	5	6
	أسلوب إدارة الحيازة	1	2	3	4	5	6

ب- توزيع مساحة الحيازة حسب نظام الاستغلال:

14	اسم الوحدة المحلية للمساحة	
15	ماتساوية بالأمتار المربعة	
16	العدد الاجمالي للوحدات المحلية للمساحة (اجمالي ساعة الحيازة) ٢٤+١٨+١٧	
17	عدد الوحدات المحلية للمساحة المملوكة	
18	عدد الوحدات المحلية للمساحة المستأجرة (١٩+٢٠+٢١+٢٢)	
19	عدد الوحدات المحلية للمساحة المستأجرة نقدًا	
20	عدد الوحدات المحلية للمساحة المستأجرة عيني (حصة من الإنتاج)	
21	عدد الوحدات المحلية للمساحة المستأجرة نقدي + عيني	
22	عدد الوحدات المحلية للمساحة المستأجرة مشاركة	
23	عدد الوحدات المحلية للمساحة المستأجرة بنوع آخر من الإيجار	
24	عدد الوحدات المحلية للمساحة التي تخضع لنظام آخر	
25	عدد القطع المكونة لهذه الحيازة وتقع في قرية واحدة	

26	الفرع الأساسي من إنتاج الحيازة	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
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27	هل يوجد بالحيازة مشروع زراعي متخصص	
28	هل حصلت على قرض من البنك الزراعي	

29	معنى البيانات	32	جامع لبيان	33	شخص رئيس الحيازة	34	المرامح	35	تاريخ الزيارة	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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القسم الثالث : استعمالات الأرض .

٢٥	٢٠١	اجمالي عدد الوحدات المحلية للمساحة (اجمالي مساحة الحيازة)
٢٦	٢٠٢	عدد الوحدات المحلية للمساحة المتزرعة بحاصل مؤقتة (حقلية وخضروات) هذا المسم
٢٧	٢٠٣	» » » المتروكة للراحة وقت الزبارة
٢٨	٢٠٤	» » » للمساحة المتزرعة بالبرسيم الدائم
٢٩	٢٠٥	» » » بالمحاصيل الدائمة (أشجار ونخيل)
٣٠	٢٠٦	» » » للأراضي القابلة للزراعة ولم يسبق زراعتها
٣١	٢٠٧	» » » التي لم تصنف أعلاه وغير قابلة للزراعة

القسم الرابع :

٢ - أسرة الحائز والأشخاص المقيمون بالحيازة .

٤٢	٢٠٩	٢٠٨	أفراد أسرة الحائز أقل من ١٥ سنة .
٤٣	٢١١	٢١٠	» » » ١٥ سنة - ٦٤ سنة .
٤٤	٢١٣	٢١٢	» » » ٦٥ سنة فأكثر .
٤٥	٢١٥	٢١٤	أشخاص آخرون ليسوا من أسرة الحائز ويقيمون بالحيازة (سعوديون)
٤٦	٢١٧	٢١٦	أشخاص آخرون ليسوا من أسرة الحائز ويقيمون بالحيازة (غير سعوديون)

ب - العمالة :-

نوع العمال	سعودي				غير سعودي	
	عدد الذكور		عدد الإناث		عدد الذكور	عدد الإناث
	بأجر	بدون أجر	بأجر	بدون أجر		
٤٧	٢١٨	٢١٩	٢٢٠	٢٢١	٢٢٢	٢٢٣
٤٨	٢٢٤	٢٢٥	٢٢٦	٢٢٧	٢٢٨	٢٢٩
٤٩	٢٣٠	٢٣١	٢٣٢	٢٣٣	٢٣٤	٢٣٥

القسم الخامس : نظام - ومصادر مياه - الري بالحيازة :

١ - نظام الري :

إذا كان نظام الري عادي (غير) أشرع على نوع القنوات المستخدمة بالحيازة .

٥٠	قنوات ري ترابية	٢٥٩	١	قنوات ري حديدية	٢٦٠	٢	قنوات ري حديدية	٢٦١	٣	قنوات ري حديدية	٢٦٢	٤
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إذا كان نظام الري بأجهزة الري الحديثة أشرع على النوع المستخدم بالحيازة وأملأ البيانات المطلوبة :-

نوع نظام الري	عدد الأجهزة	المساحة التي تروى بالأجهزة
٥١	نظام ري بالرش (محوري)	٢٣٧
٥٢	نظام ري بالرش (ثابت)	٢٣٩
٥٣	نظام ري بالتنقيط	٢٤١
٥٤	نظام ري مدفي	٢٤٣
٥٥	نظام ري آخر	٢٤٥

(الآبار الموجودة بالحيازة)

النوع	عدد المستعمل	عدد الغير مستعمل
آبار ارتوازية	٢٥١	٢٥٢
آبار خزانة	٢٥٣	٢٥٤
آبار عادية	٢٥٥	٢٥٦
يستخدم بئر مشترك	نعم	٢٥٧

ب - مصادر مياه الري بالحيازة (أكتب المساحة التي تروى عن طريق المصادر الأربع التالية) :-

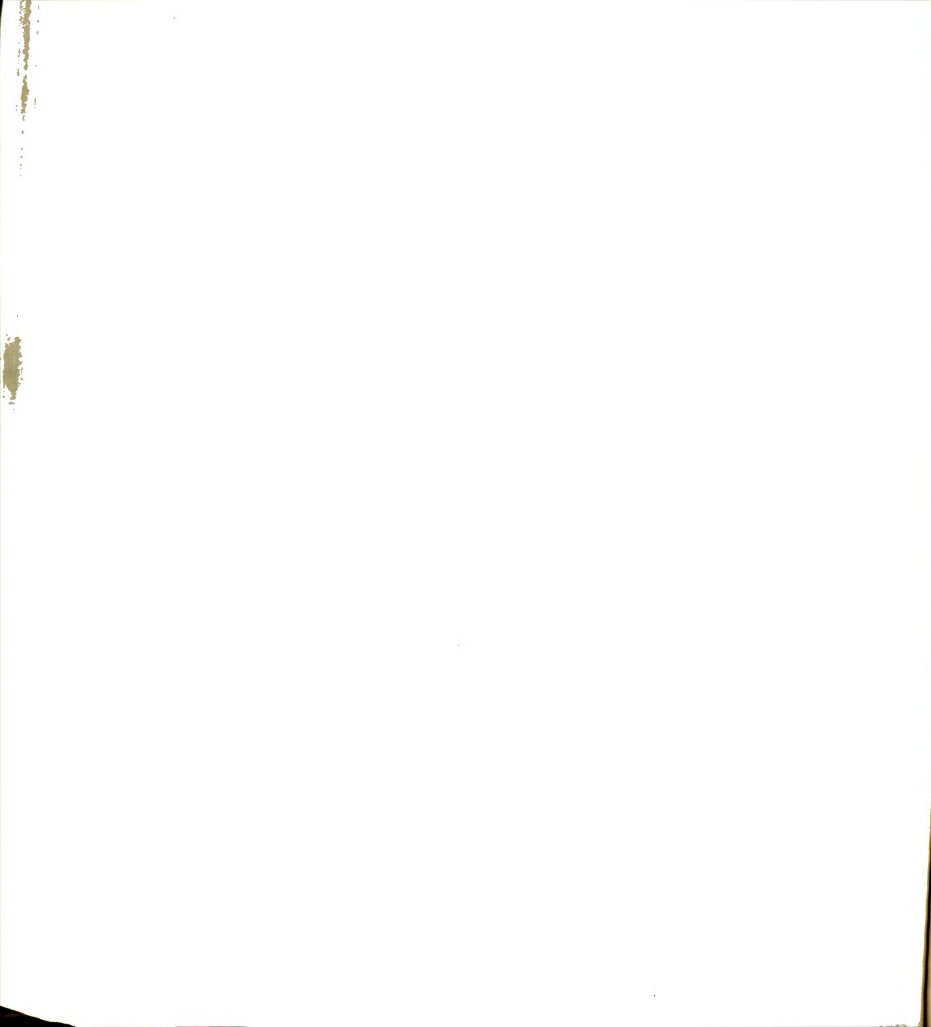
أمطار بعقوم	٢٤٧	أمطار بدون بعقوم	٢٤٨
عيون	٢٤٩	مصادر أخرى	٢٥٠

٥٧ هل يوجد نظام للصرف بالحيازة - نعم ٢٥٨ ١ لا ٢٥٨ ٢





الآلات المستخدمة هذا الموسم بالحيارة										ما يملكه المائز		أنواع الآلات			
المقدمة للحائز						بملكه الحائز		كلية (و بمفرده)							
من ممتلكات		من ممتلكات		من ممتلكات		من ممتلكات		عند الوزارة							
عدد	نفاذ	عدد	نفاذ	عدد	نفاذ	عدد	نفاذ	عدد	نفاذ						
٥٠٧		٥٠٦		٥٠٥		٥٠٤		٥٠٣		٥٠٢		٥٠١		٩٨	ماكينات قوتها تصل إلى ١٠ حصان
٥١٤		٥١٣		٥١٢		٥١١		٥١٠		٥٠٩		٥٠٨		٩٩	» من ١١ - ٣٠ حصان
٥٢١		٥٢٠		٥١٩		٥١٨		٥١٧		٥١٦		٥١٥		١٠٠	» » ٢١ - ١٠٠ حصان
٥٢٨		٥٢٧		٥٢٦		٥٢٥		٥٢٤		٥٢٣		٥٢٢		١٠١	» ١٠١ حصان فأكثر
٥٣٥		٥٣٤		٥٣٣		٥٣٢		٥٣١		٥٣٠		٥٢٩		١٠٢	مضخات سطحية عمودية
٥٤٢		٥٤١		٥٤٠		٥٣٩		٥٣٨		٥٣٧		٥٣٦		١٠٣	» أعماق عمودية
٥٤٩		٥٤٨		٥٤٧		٥٤٦		٥٤٥		٥٤٤		٥٤٣		١٠٤	» غطاس كهربائية
٥٥٦		٥٥٥		٥٥٤		٥٥٣		٥٥٢		٥٥١		٥٥٠		١٠٥	» دفاعية
٥٦٣		٥٦٢		٥٦١		٥٦٠		٥٥٩		٥٥٨		٥٥٧		١٠٦	» عمادية
٥٧٠		٥٦٩		٥٦٨		٥٦٧		٥٦٦		٥٦٥		٥٦٤		١٠٧	وحدات ضخ مياه
٥٧٧		٥٧٦		٥٧٥		٥٧٤		٥٧٣		٥٧٢		٥٧١		١٠٨	ماكينات مشبوكة بمولد كهرباء
٥٨٤		٥٨٣		٥٨٢		٥٨١		٥٨٠		٥٧٩		٥٧٨		١٠٩	مولد كهرباء متصل
٥٩١		٥٩٠		٥٨٩		٥٨٨		٥٨٧		٥٨٦		٥٨٥		١١٠	جرارات مجزير (تراكتورات)
٥٩٨		٥٩٧		٥٩٦		٥٩٥		٥٩٤		٥٩٣		٥٩٢		١١١	» بالجارات (مراشات)
٦٠٥		٦٠٤		٦٠٣		٦٠٢		٦٠١		٦٠٠		٥٩٩		١١٢	غراف ذات الحكة (شير)
٦١٢		٦١١		٦١٠		٩٠٩		٦٠٨		٦٠٧		٦٠٦		١١٣	» غير ذات الحكة
٦١٩		٦١٨		٦١٧		٦١٦		٦١٥		٦١٤		٦١٣		١١٤	حصادات
٦٢٦		٦٢٥		٦٢٤		٦٢٣		٦٢٢		٦٢١		٦٢٠		١١٥	حصادات ذرايات (كوبالين)
٦٣٣		٦٣٢		٦٣١		٦٣٠		٦٢٩		٦٢٨		٦٢٧		١١٦	محراث قديم مفتوح للتربة
٦٤٠		٦٣٩		٦٣٨		٦٣٧		٦٣٦		٦٣٥		٦٣٤		١١٧	محارث قرصية (للمراثة)
٦٤٧		٦٤٦		٦٤٥		٦٤٤		٦٤٣		٦٤٢		٦٤١		١١٨	محارث مطرحة (قلاب)
٦٥٤		٦٥٣		٦٥٢		٦٥١		٦٥٠		٦٤٩		٦٤٨		١١٩	محارث مشطية
٦٦١		٦٦٠		٦٥٩		٦٥٨		٦٥٧		٦٥٦		٦٥٥		١٢٠	آلة تسوية
٦٦٨		٦٦٧		٦٦٦		٦٦٥		٦٦٤		٦٦٣		٦٦٢		١٢١	سكين تسوية
٦٧٥		٦٧٤		٦٧٣		٦٧٢		٦٧١		٦٧٠		٦٦٩		١٢٢	آلة عمل سواق
٦٨٢		٦٨١		٦٨٠		٦٧٩		٦٧٨		٦٧٧		٦٧٦		١٢٣	آلة عمل بتون (بتانه)
٦٨٩		٦٨٨		٦٨٧		٦٨٦		٦٨٥		٦٨٤		٦٨٣		١٢٤	آلة بذار
٦٩٦		٦٩٥		٦٩٤		٦٩٣		٦٩٢		٦٩١		٦٩٠		١٢٥	آلة تسميد
٧٠٣		٧٠٢		٧٠١		٧٠٠		٦٩٩		٦٩٨		٦٩٧		١٢٦	آلة بذار وتسميد
٧١٠		٧٠٩		٧٠٨		٧٠٧		٧٠٦		٧٠٥		٧٠٤		١٢٧	ماتور رش
٧١٧		٧١٦		٧١٥		٧١٤		٧١٣		٧١٢		٧١١		١٢٨	آلة رش وتعفير يدوية
٧٢٤		٧٢٣		٧٢٢		٧٢١		٧٢٠		٧١٩		٧١٨		١٢٩	آلة زراعة بطاطس
٧٣١		٧٣٠		٧٢٩		٧٢٨		٧٢٧		٧٢٦		٧٢٥		١٣٠	آلة حصاد بطاطس
٧٣٨		٧٣٧		٧٣٦		٧٣٥		٧٣٤		٧٣٣		٧٣٢		١٣١	آلة حصاد علف
٧٤٥		٧٤٤		٧٤٣		٧٤٢		٧٤١		٧٤٠		٧٣٩		١٣٢	وسائل نقل: سيارات
٧٥٢		٧٥١		٧٥٠		٧٤٩		٧٤٨		٧٤٧		٧٤٦		١٣٣	مقطورات
												٧٥٣		١٣٤	حيوانات
														ملاحظات	



In the name of Allah, the Beneficent, the Merciful

The Kingdom of Saudi Arabia
Ministry of Agriculture and Water, Department of Economic Studies and Statistics.
1981-1982 Census of Agriculture—The Questionnaire—Summer Season

Section One: Identification Data

1. Name of the Amarat						
2. Name of Sub-Amarat						
3. Name of Village						
4. Name of Holder						
5. Age of Holder			101			
6. Nationality of Holder					Saudi	1
7. Do you practice other occupation?	Yes	1	103	No	2	103
8. Address of the Holder						
9. Landlord's Name						
10. Landlord's Address						
11. Holdings Name (if any)						

Section Two:**A. Legal System of Holding and Management Type**

12. Mark ☒ in front of the Appropriate Legal system	Individual	Government firm	Tribal	Private company of firm	Cooperation	Other farms		
	1	104	2	104	3	104		
13. Management Type	By the holder		1	105	Hired Manager	Saudi	2	105
						Non-Saudi	3	

B. Distribution of the Holding Land According to its Utilization

14. Name of Local Area Unit		
15. Equivalent in Square Meters	106	
16. Total Local Units (Total Holding Area) 17 + 18 + 20	107	
17. Number of Local Units Owned	108	
18. Number of Local Units Rented (19 + 20 + 21 + 22 + 23)	109	
19. Number of Local Units Rented in Cash	110	
20. Number of Local Units Rented in Kind	111	
21. Number of Local Units Rented in Cash and Kind	112	
22. Number of Local Units Rented by Share	113	
23. Number of Local Units Rented by Other Type of Rent	114	
24. Number of Local Units Under Other Legal System	115	
25. Number of Parcels of Land in the Holding Within One Village	116	

26. Main Purpose of Holding Production	Sale	1	117	Family Consumption	2	117	Sale & Family Consump	3	117
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27. Is There a Specialised Agricultural Project in the Holding	Yes	1	118	No	2	118		
28. Did you Obtain Loan from the Agricultural Bank	For Proj.	Yes	1	119	Non-Prod.	Yes	1	120
		No	2			No	2	

29. Date Provider			32. Enumerator			001
30. Relation to Holder			33. Supervisor			002
31. Date of Visit			34. Editor			003



Section Three: Fertilizers and Pesticides for both the Winter and Summer Seasons for the Census Year 1981/82

35. Do you use in the Holding A-Organic Fertilizer

Yes	1	131	No	2	131
-----	---	-----	----	---	-----

B-Anything to improve the Soil, like sand.

Yes	1	132	No	2	132
-----	---	-----	----	---	-----

C-Chemical fertilizer

Yes	1	133	No	2	133
-----	---	-----	----	---	-----

	Where did you get the chemical fertilizers?	Quantity of Chemical fertilizers used in the Holding			
		Unit	Weight in Kilos	Number of Units	
36.	From the Holder		134		135
37.	From others		136		137

38. Are pesticides used in the holding (insects, bacteria, nematodes and others)?

Yes				138	No	138
By the Holder	1	By others	2	By holder & others	3	4

Section Four: Labor

Type of Worker	Saudi				Non-Saudi			
	Male		Female		Male		Female	
	Unpaid	Paid	Unpaid	Paid				
39. Permanent (more than 6 months)	139	140	141	142	143		144	
40. Temporary for summer (3-6 months)	145	146	147	148	149		150	
41. Occasional for the Summer (less than 3 months)	151	152	153	154	155		156	

Section Five: Livestock and Poultry

Type of Animal	Permanent animals in the Farm		Animals that live & are fed in farm also on public past.		Animals that don't live on the farm but are fed farm		Animals that neither live or are fed from farm	
	Male	Female	Male	Female	No	No	No	No
	No	No	No	No	No	No	No	No
42. Camels-total number of camels	157	158	159	160	161		162	
43. Camels 3 years or more	163	164	165	166	167		168	
44. Female milking camels		169		170	171		172	
45. Sheep- Total number of sheep	173	174	175	176	177		178	
46. Sheep 1 year or more	179	180	181	182	183		184	
47. Female milking sheep		185		186	187		188	
48. Goat - Total number of goats	189	190	191	192	193		194	
49. Goats 1 year or more	195	196	197	198	199		200	
50. Female milking goats		201		202	203		204	
51. Cattle-total number of Cattle	205	206	207	208	209		210	
52. Cattle two years or more	211	212	213	214	215		216	
53. Female milking cattle		217		218	219		220	
54. Horses-total number of horses	221	222	223	224	225		226	
55. Poultry-total number of Poultry	227							

56. Sources of irrigation water in the holding (Write total area irrigated by each of the following four sources).

Bunded Rain	Unbunded Rain
235	236
Spring	Other Sources
237	238

(Existing wells in the holding)

Type	Number used	Number unused
Tube well	228	229
Artesian well	230	231
Regular Well	232	233
Shared Well	Yes 1 234	No 2 234



Section Six: A-Seasonal Summer Crop

Crop	Number of area local units harvested			Production		
	Irrigated Area		Rainfed	Production Unit	Production unit in Kilogram	Number of units produced
	By wells, springs, others	Bundled Rain	Unbundled Rain			
57. Pearl Millet	296	297	298		299	300
58. Sorghum	301	302	303		304	305
59. Maize	306	307	308		309	310
60. Peanut	311	312	313		314	315
61. Sesame	316	317	318		319	320
62. Tobacco	321	322	323		324	325
63. Eggplant	326	327	328		329	330
64. Pumpkin	331	332	333		334	335
65. Squash	336	337	338		339	340
66. Watermelon	341	342	343		344	345
67. Muskmelon	346	347	348		349	350
68. Potato	351	352	353		354	355
69. Onion	356	357	358		359	360
70. Cucumber	361	362	363		364	365
71. Pepper	366	367	368		369	370
72. Other vegetables	371	372	373			
73. Mixed crop (grain and fodder)	374	375	376			
74. Seasonal alfalfa	377	378	379			
75. Other fodder	380	381	382			
76. Other crops	383	384	385			
77. Number of area local units left fallow					386	

B. Crops Grown Under Permanent Crops (Trees).

78. Grain crop	387	388	389
79. Vegetables	390	391	392
80. Alfalfa	393	394	395
81. Other fodder	396	397	398

Section Seven: Permanent Trees

Crop	Clustered Trees				Number of Scattered Trees	Production		
	Area	Number of Trees		Production Unit		Production unit in kilogram	Number of Units	
		Producing	Non-Producing					
82. Dates	399	400	401	402		403	404	
83. Oranges	405	406	407	408		409	410	
84. Tangerine	411	412	413	414		415	416	
85. Lemon	417	418	419	420		421	422	
86. Grapes	423	424	425	426		427	428	
87. Pomegranate	429	430	431	432		433	434	
88. Peach	435	436	437	438		439	440	
89. Apricots	441	442	443	444		445	446	
90. Fig	447	448	449	450		451	452	
91. India Fig	453	454	455	456		457	458	
92. Bananas	459	460	461	462		463	464	
93. Apples	465	466	467	468		469	470	
94. Coffee	471	472	473	474		475	476	
95. Bums	477	478	479	480		481	482	
96. Others	483	484	485	486				

97. If there is any green fence as a windbreak in your farm, what is its length in meters?

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Section Eight: Agricultural Machinery and Transportation Means		Machine Types	Total Machines Owned by the holder alone during the visit	Machines Used for This Season									
				Sole ownership by holder	Joint ownership with others	Offered to the holder by							
						Landlord	Rent	Cooperative	Govt. Agency				
										No	No	No	No
96	Engines up to 10 h.p.		501	502	503	504	505	506	507				
99	Engines 11 to 30 h.p.		508	509	510	511	512	513	514				
100	Engines 31 to 100 h.p.		515	516	517	518	519	520	521				
101	Engines 101 h.p. and more		522	523	524	525	526	527	528				
102	Water pumps		529	530	531	532	533	534	535				
103	Deep bore pumps		536	537	538	539	540	541	542				
104	Submersible pumps (Elect.)		543	544	545	546	547	548	549				
105	High pressure pumps		550	551	552	553	554	555	556				
106	Propeller pumps		557	558	559	560	561	562	563				
107	Water pump unit (Engine)		564	565	566	567	568	569	570				
108	Electric water pump unit		571	572	573	574	575	576	577				
109	Electric generators		578	579	580	581	582	583	584				
110	Crawler Tractor		585	586	587	588	589	590	591				
111	Wheel Tractor		592	593	594	595	596	597	598				
112	Self-powered Shovel		599	600	601	602	603	604	605				
113	Backhoe		606	607	608	609	610	611	612				
114	Threshers		613	614	615	616	617	618	619				
115	Combine harvesters		620	621	622	623	624	625	626				
116	Disc Harrows		627	628	629	630	631	632	633				
117	Disc plow		634	635	636	637	638	639	640				
118	Mouldboard plow		641	642	643	644	645	646	647				
119	Chisel plow		648	649	650	651	652	653	654				
120	Land plane		655	656	657	658	659	660	661				
121	Levelling blades		662	663	664	665	666	667	668				
122	Ditchers		669	670	671	672	673	674	675				
123	Border ridger		676	677	678	679	680	681	682				
124	Planters		683	684	685	686	687	688	689				
125	Fertilizer distributors		690	691	692	693	694	695	696				
126	Seed drill with fertilizer box		697	698	699	700	701	702	703				
127	Sprayers (engine)		704	705	706	707	708	709	710				
128	Sprayers (knapsack)		711	712	713	714	715	716	717				
129	Potato planters		718	719	720	721	722	723	724				
130	Baler		725	726	727	728	729	730	731				
131	Fodder harvester		732	733	734	735	736	737	738				
132	Trucks and Cars		739	740	741	742	743	744	745				
133	Trailers		746	747	748	749	750	751	752				
134	Draft Animals		753										
Notes													





بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

المملكة العربية السعودية
وزارة الزراعة والري
إدارة الدراسات الاقتصادية والإحصاء

استبيان القطاع الزراعي والسائل لعامي ١٤٠١ / ١٤٠٢ هـ الموسم الصيفي

القسم الأول: البيانات التفرعية:

1	اسم الإمارة الرئيسية	
2	اسم الإمارة الفرعية	
3	اسم القرية	
4	اسم الحاش	
5	سن الحاش	
7	هل تزاول مهنة أخرى غير الزراعة	
8	عنوان الحاش	
9	اسم المالك	
10	عنوان المالك	
11	اسم الحيازة (المزرعة) إن وجد	

القسم الثاني:

٢ - الوضع النظامي للحاش وأسلوب إدارة الحيازة.

12	صنع علامة ✓	شخص عادي	هئية او مؤسسة حكومية	عشيرة أو قبيلة	مشاركة او شركة	فادنة	نظام آخر
	أمام الوضع النظامي للمأزر	١	٢	٣	٤	٥	٦
13	أسلوب إدارة الحيازة	برابطة الحاش	١	١٠٥	برابطة مدير بآجر	غير سعودي	٣

ب - توزيع مساحة الحيازة حسب نظام الاستغلال:

14	اسم الوحدة المحلية للمساحة	
15	ما تساويه بالأمتار المربعة	
16	العدد الاجمالي للوحدات المحلية للمساحة (اجمالي مساحة الحيازة) ١٧ + ١٨ + ٢٤	
17	عدد الوحدات المحلية للمساحة المملوكة	
18	عدد الوحدات المحلية للمساحة المستأجرة (١٩ + ٢٠ + ٢١ + ٢٢ + ٢٣)	
19	عدد الوحدات المحلية للمساحة المستأجرة نقدًا	
20	عدد الوحدات المحلية للمساحة المستأجرة عيني (حصّة من الإنتاج)	
21	عدد الوحدات المحلية للمساحة المستأجرة نقدي + عيني	
22	عدد الوحدات المحلية للمساحة المستأجرة مشاركة	
23	عدد الوحدات المحلية للمساحة المستأجرة بنوع آخر من الإيجار	
24	عدد الوحدات المحلية للمساحة التي تخضع لنظام آخر	
25	عدد القطع المكونة لهذه الحيازة وتقع في قرية واحدة	

26	الفرع الأساسي من إنتاج الحيازة	البيع	١	١١٧	استهلاك الأسرة	٢	١١٧	استهلاك الأسرة	٣	١١٧
27	هل يوجد بالحيازة مشروع زراعي متخصص	نعم	١	١١٨	لا	٢	١١٨			
28	هل حصلت على قرض من البنك الزراعي	نعم	١	١١٩	لا	٢	١١٩			
29	معلّي البيانات	٢٤	باسم إبياد	٠٠١						
30	مبلّته بالحاش	٢٣	بشد زبير بللة	٠٠٢						
31	تاريخ الزيارة	٢٤	١٤٠٢ / ١٤٠٢ هـ	٠٠٣						



القيم الثالث: الاسمدة والبذلات للموسمين الشتوي والصيفي من عام التقاد ١٤٠١ / ١٤٠٢ هـ

نعم	١	١٣١	٥	٢	١٣١
نعم	١	١٣٢	٥	٢	١٣٢
نعم	١	١٣٣	٥	٢	١٣٣
كمية الاسمدة الكيماوية المستخدمة بالحيازة					
من أي مصدر حصلت على الاسمدة الكيماوية	الوحدة	الوزن بالكيلو	عدد الوحدات		
بواسطة الحائز		١٣٤		١٣٥	
بواسطة آخرون		١٣٦		١٣٧	

٣٨ - هل يستخدم بالحيازة مبيدات آفات زراعية (حشرية فطرية - بكتيرية، نيماتودا الخ)

نعم					
بواسطة الحائز	١	بواسطة آخرون	٢	بواسطة الحائز وآخرون	٣
				٤	

القسم الرابع: العمالة

نوع العمال	سعودي				غير سعودي	
	بدون أجر	بأجر	بدون أجر	بأجر	عدد الذكور	عدد الإناث
عمال دائمين (أكثر من ستة شهور)	١٣٩	١٤٠	١٤١	١٤٢	١٤٣	١٤٤
عمال مؤقتون للصيفي (٣ - ٦ شهر)	١٤٥	١٤٦	١٤٧	١٤٨	١٤٩	١٥٠
عمال عابرون للصيفي (أقل من ٣ شهر)	١٥١	١٥٢	١٥٣	١٥٤	١٥٥	١٥٦

القسم الخامس: الحيوانات والدواجن

نوع الحيوانات	حيوانات داجنة في الزراعة		حيوانات ميسرة وتربى في المزرعة وتزود المزارع بالمنتجات		حيوانات لا تبيت في المزرعة وتعيش من المزرعة		حيوانات لا تبيت في المزرعة ولا تعيش من المزرعة	
	ذكور	إناث	ذكور	إناث	العدد	العدد	العدد	العدد
٤٢ - الأبل :- إجمالي عدد الأبل	١٥٧	١٥٨	١٥٩	١٦٠	١٦١	١٦٢		
٤٣ - ابل عمر (٣ سنوات فأكثر)	١٦٣	١٦٤	١٦٥	١٦٦	١٦٧	١٦٨		
٤٤ - الإناث الحلوب		١٦٩		١٧٠	١٧١	١٧٢		
٤٥ - الضأن :- إجمالي عدد الضأن	١٧٣	١٧٤	١٧٥	١٧٦	١٧٧	١٧٨		
٤٦ - ضأن عمر عام فأكثر	١٧٩	١٨٠	١٨١	١٨٢	١٨٣	١٨٤		
٤٧ - الإناث الحلوب		١٨٥		١٨٦	١٨٧	١٨٨		
٤٨ - الماعز :- إجمالي عدد الماعز	١٨٩	١٩٠	١٩١	١٩٢	١٩٣	١٩٤		
٤٩ - ماعز عمر عام فأكثر	١٩٥	١٩٦	١٩٧	١٩٨	١٩٩	٢٠٠		
٥٠ - الإناث الحلوب		٢٠١		٢٠٢	٢٠٣	٢٠٤		
٥١ - الأبقار :- إجمالي عدد الأبقار	٢٠٥	٢٠٦	٢٠٧	٢٠٨	٢٠٩	٢١٠		
٥٢ - إبقار عمر سنتين فأكثر	٢١١	٢١٢	٢١٣	٢١٤	٢١٥	٢١٦		
٥٣ - الإناث الحلوب		٢١٧		٢١٨	٢١٩	٢٢٠		
٥٤ - الغنم :- إجمالي عدد الغنم	٢٢١	٢٢٢	٢٢٣	٢٢٤	٢٢٥	٢٢٦		
٥٥ - الدواجن :- إجمالي عدد الدواجن	٢٢٧							

٥٦ - مصادر مياه الري بالحيازة (اكتب الساحة التي

تروي عن طريق المصادر الأربع التالية)

(الأبار الموجودة بالحيازة)

النوع	عدد السطوح	عدد الغير مستعمل
آبار ارتوازية	٢٢٨	٢٢٩
آبار فوارة	٢٣٠	٢٣١
آبار عادية	٢٣٢	٢٣٣
يستخدم بئر مشترك	نعم ١	لا ٢

مطار يقوم	٢٣٥	مطار بدون يقوم	٢٣٦
عيون	٢٣٧	مصدر آخر	٢٣٨

القسم السادس ٢ - المحاصيل الوقتية الصيفية

المحاصيل	عدد الوحدات الحقلية للوحدات المحسودة				الاستنتاج	
	ملاحظة مزرعية	ساعات مزرعية	اسم الوحدة	وزن الوحدة بالكيلو	عدد الوحدات المحسودة	عدد المحاصيل
دخن	٢٩٦	٢٩٧	٢٩٨	٢٩٩	٣٠٠	٥٧
ذرة ريفية	٣٠١	٣٠٢	٣٠٣	٣٠٤	٣٠٥	٥٨
ذرة شامية	٣٠٦	٣٠٧	٣٠٨	٣٠٩	٣١٠	٥٩
فول سوداني	٣١١	٣١٢	٣١٣	٣١٤	٣١٥	٦٠
فول	٣١٦	٣١٧	٣١٨	٣١٩	٣٢٠	٦١
طماطم	٣٢١	٣٢٢	٣٢٣	٣٢٤	٣٢٥	٦٢
بادنجان	٣٢٦	٣٢٧	٣٢٨	٣٢٩	٣٣٠	٦٣
قرع غلي	٣٣١	٣٣٢	٣٣٣	٣٣٤	٣٣٥	٦٤
كوسا	٣٣٦	٣٣٧	٣٣٨	٣٣٩	٣٤٠	٦٥
بطيخ	٣٤١	٣٤٢	٣٤٣	٣٤٤	٣٤٥	٦٦
شمام	٣٤٦	٣٤٧	٣٤٨	٣٤٩	٣٥٠	٦٧
بطاطس	٣٥١	٣٥٢	٣٥٣	٣٥٤	٣٥٥	٦٨
ياميا	٣٥٦	٣٥٧	٣٥٨	٣٥٩	٣٦٠	٦٩
حسار	٣٦١	٣٦٢	٣٦٣	٣٦٤	٣٦٥	٧٠
بصل	٣٦٦	٣٦٧	٣٦٨	٣٦٩	٣٧٠	٧١
فصل وأمث أخرى	٣٧١	٣٧٢	٣٧٣	٣٧٤	٣٧٥	٧٢
محاصيل مختلطة (زيتون)	٣٧٦	٣٧٧	٣٧٨	٣٧٩	٣٨٠	٧٣
برسيم	٣٧٦	٣٧٧	٣٧٨	٣٧٩	٣٨٠	٧٤
اعلاف أخرى	٣٨١	٣٨٢	٣٨٣	٣٨٤	٣٨٥	٧٥
محاصيل أخرى لم تدرك	٣٨٣	٣٨٤	٣٨٥	٣٨٦	٣٨٧	٧٦
عدد الوحدات الحقلية للمحاصيل المزروعة للزراعة وقت الربيع	٣٨٧	٣٨٨	٣٨٩	٣٩٠	٣٩١	٧٧

ب - المحاصيل المزروعة تحت محاصيل دائمة (اشجار)

محاصيل حقلية	٣٨٧	٣٨٨	٣٨٩	٣٩٠	٣٩١	٧٨
محاصيل خضراوات	٣٩١	٣٩٢	٣٩٣	٣٩٤	٣٩٥	٧٩
برسيم	٣٩٣	٣٩٤	٣٩٥	٣٩٦	٣٩٧	٨٠
اعلاف أخرى	٣٩٦	٣٩٧	٣٩٨	٣٩٩	٤٠٠	٨١

القسم السابع : محاصيل الاشجار الدائمة

التفاصيل	الاشجار الخفيفة		عدد الاشجار		الاستنتاج	
	الاحاد	عدد الاشجار	البيعة	وزن الوحدة بالكيلو	عدد الوحدات المحسودة	عدد المحاصيل
التوت	٣٩٩	٤٠٠	٤٠١	٤٠٢	٤٠٣	٨٢
البرتقال	٤٠٥	٤٠٦	٤٠٧	٤٠٨	٤٠٩	٨٣
الليمون	٤١١	٤١٢	٤١٣	٤١٤	٤١٥	٨٤
ليمون	٤١٧	٤١٨	٤١٩	٤٢٠	٤٢١	٨٥
كروم	٤٢٣	٤٢٤	٤٢٥	٤٢٦	٤٢٧	٨٦
زيتون	٤٢٩	٤٣٠	٤٣١	٤٣٢	٤٣٣	٨٧
خوخ	٤٣٥	٤٣٦	٤٣٧	٤٣٨	٤٣٩	٨٨
مشمش	٤٤١	٤٤٢	٤٤٣	٤٤٤	٤٤٥	٨٩
تين (رحطاط)	٤٤٧	٤٤٨	٤٤٩	٤٥٠	٤٥١	٩٠
تين شوكي (برشوت)	٤٥٣	٤٥٤	٤٥٥	٤٥٦	٤٥٧	٩١
موز	٤٥٩	٤٦٠	٤٦١	٤٦٢	٤٦٣	٩٢
تفاح	٤٦٥	٤٦٦	٤٦٧	٤٦٨	٤٦٩	٩٣
قهوه (زن)	٤٧١	٤٧٢	٤٧٣	٤٧٤	٤٧٥	٩٤
جوز	٤٧٧	٤٧٨	٤٧٩	٤٨٠	٤٨١	٩٥
أخرى	٤٨٣	٤٨٤	٤٨٥	٤٨٦	٤٨٧	٩٦

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٩٧ عنه ويوجد سياج اخضر كمسند للرياح في مزرعتكم طوله بالقر ؟



الآلات المستخدمة هذا الموسم بالحيازة										ماكينة الحارث		أنواع الآلات		
المقدمة للحارث						يمكك الحارث		يمكك الحارث بمفرده		كلية (و بمفرده) هذا الزيادة				
من هينيت		من هينيت		من الهينيت بالإيجار		مع أخريه		مفرده						
عدد	عدد	عدد	عدد	عدد	عدد	عدد	عدد	عدد	عدد	عدد	عدد			
٥٠٧		٥٠٦		٥٠٥		٥٠٤		٥٠٣		٥٠٢		٥٠١	ماكينات قوتها تصل إلى ١٠ حصان	٩٨
٥١٤		٥١٣		٥١٢		٥١١		٥١٠		٥٠٩		٥٠٨	» من ١١ - ٣٠ حصان	٩٩
٥٢١		٥٢٠		٥١٩		٥١٨		٥١٧		٥١٦		٥١٥	» » ٣١ - ١٠٠ حصان	١٠٠
٥٢٨		٥٢٧		٥٢٦		٥٢٥		٥٢٤		٥٢٣		٥٢٢	» ١٠١ حصان فأكثر	١٠١
٥٣٥		٥٣٤		٥٣٣		٥٣٢		٥٣١		٥٣٠		٥٢٩	مخناط سطحية عمودية	١٠٢
٥٤٢		٥٤١		٥٤٠		٥٣٩		٥٣٨		٥٣٧		٥٣٦	» أعماق عمودية	١٠٣
٥٤٩		٥٤٨		٥٤٧		٥٤٦		٥٤٥		٥٤٤		٥٤٣	» غطاس كهربائية	١٠٤
٥٥٦		٥٥٥		٥٥٤		٥٥٣		٥٥٢		٥٥١		٥٥٠	» دفاعة	١٠٥
٥٦٣		٥٦٢		٥٦١		٥٦٠		٥٥٩		٥٥٨		٥٥٧	» عمادية	١٠٦
٥٧٠		٥٦٩		٥٦٨		٥٦٧		٥٦٦		٥٦٥		٥٦٤	وحدات ضخ مياه	١٠٧
٥٧٧		٥٧٦		٥٧٥		٥٧٤		٥٧٣		٥٧٢		٥٧١	ماكينات مشبوبة بمولد كهرباء	١٠٨
٥٨٤		٥٨٣		٥٨٢		٥٨١		٥٨٠		٥٧٩		٥٧٨	مولد كهرباء منفصل	١٠٩
٥٩١		٥٩٠		٥٨٩		٥٨٨		٥٨٧		٥٨٦		٥٨٥	جرارات بمجنيز (تراكتورات)	١١٠
٥٩٨		٥٩٧		٥٩٦		٥٩٥		٥٩٤		٥٩٣		٥٩٢	» بالمحارات (مراكبات)	١١١
٦٠٥		٦٠٤		٦٠٣		٦٠٢		٦٠١		٦٠٠		٥٩٩	غراف ذات الحركة (شوك)	١١٢
٦١٢		٦١١		٦١٠		٦٠٩		٦٠٨		٦٠٧		٦٠٦	» غير ذات الحركة	١١٣
٦١٩		٦١٨		٦١٧		٦١٦		٦١٥		٦١٤		٦١٣	حصادات	١١٤
٦٢٦		٦٢٥		٦٢٤		٦٢٣		٦٢٢		٦٢١		٦٢٠	حصادات ذرايات (كوبالين)	١١٥
٦٣٣		٦٣٢		٦٣١		٦٣٠		٦٢٩		٦٢٨		٦٢٧	محراث قديمي منقذ للتربة	١١٦
٦٤٠		٦٣٩		٦٣٨		٦٣٧		٦٣٦		٦٣٥		٦٣٤	محارث قرصية (للرثة)	١١٧
٦٤٧		٦٤٦		٦٤٥		٦٤٤		٦٤٣		٦٤٢		٦٤١	محارث مطرحة (قلاية)	١١٨
٦٥٤		٦٥٣		٦٥٢		٦٥١		٦٥٠		٦٤٩		٦٤٨	محارث مشطية	١١٩
٦٦١		٦٦٠		٦٥٩		٦٥٨		٦٥٧		٦٥٦		٦٥٥	آلة تسوية	١٢٠
٦٦٨		٦٦٧		٦٦٦		٦٦٥		٦٦٤		٦٦٣		٦٦٢	سكين تسوية	١٢١
٦٧٥		٦٧٤		٦٧٣		٦٧٢		٦٧١		٦٧٠		٦٦٩	آلة عمد سواق	١٢٢
٦٨٢		٦٨١		٦٨٠		٦٧٩		٦٧٨		٦٧٧		٦٧٦	آلة عمل بون (بنانه)	١٢٣
٦٨٩		٦٨٨		٦٨٧		٦٨٦		٦٨٥		٦٨٤		٦٨٣	آلة بذار	١٢٤
٦٩٦		٦٩٥		٦٩٤		٦٩٣		٦٩٢		٦٩١		٦٩٠	آلة تسميد	١٢٥
٧٠٣		٧٠٢		٧٠١		٧٠٠		٦٩٩		٦٩٨		٦٩٧	آلة بذار وتسميد	١٢٦
٧١٠		٧٠٩		٧٠٨		٧٠٧		٧٠٦		٧٠٥		٧٠٤	مانور رش	١٢٧
٧١٧		٧١٦		٧١٥		٧١٤		٧١٣		٧١٢		٧١١	آلة رش وتغيريدوية	١٢٨
٧٢٤		٧٢٣		٧٢٢		٧٢١		٧٢٠		٧١٩		٧١٨	آلة زراعة بطاطس	١٢٩
٧٣١		٧٣٠		٧٢٩		٧٢٨		٧٢٧		٧٢٦		٧٢٥	لبانة (بنانة)	١٣٠
٧٣٨		٧٣٧		٧٣٦		٧٣٥		٧٣٤		٧٣٣		٧٣٢	آلة حصاد علف	١٣١
٧٤٥		٧٤٤		٧٤٣		٧٤٢		٧٤١		٧٤٠		٧٣٩	وسائل نقل: سيارات	١٣٢
٧٥٢		٧٥١		٧٥٠		٧٤٩		٧٤٨		٧٤٧		٧٤٦	مفطورات	١٣٣
												٧٥٢	حيوانات	١٣٤
												ملاحظات		



APPENDIX C

LINEAR PROGRAMMING TABLE FORMATS

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TABLE C.1.--Total Resource Inventory for the Representative Farm

Resource/Time	Land	Labor	Capital	Water
January				
February				
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.				
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.				
.				
December				
Total				



TABLE C.2.--Land Resource

Number	Field Name	Field Size In Dunom	Land Use				
			Irrigated Land	Rainfed Land	Range Land	Buildings, Roads, etc.	Unused Land
	1	2	3	4	5	6	7
1							
2							
3							
.							
.							
.							
.							
.							
N							
Total Land							
Irrigated Land							
Rainfed Land							
Range Land							
Building, Road, etc.							
Unused Land							



TABLE C.3.--Labor Resource

Time	Total Man Hours	Source		
		Operator	Family	Hired
Jan.				
Feb.				
Mar.				
Apr.				
May.				
June				
July				
Aug.				
Sept.				
Oct.				
Nov.				
Dec.				
Total Man Hours Per Year				
Total Operator's Man Hours Available per Year				
Total Family's Man Hours Available per Year				
Total Hired Labor Per Year in Man Hours				



TABLE C.4.--Capital Resource

Time	Total Income (SR)	Source		
		Farm Income	Off-Farm Income	Loans
Jan.				
Feb.				
Mar.				
.				
.				
.				
.				
.				
.				
Dec.				
Total Income per Year (SR)				
Total Farm Income Per Year				
Total Off-Farm Income Per Year				
Total Loans Per Year				



TABLE C.5.--Water Resource

Month	Total Water Available (Cubic Meter)	Source		
		Wells	Irrigation Project	Rainfall
Jan.				
Feb.				
.				
.				
.				
.				
.				
.				
.				
Dec.				
Grand Total Per Year				
Total Per Year from Wells				
Total Per Year From Project				
Total Per Year from Rainfall				



TABLE C.6.--Input-output Coefficients per Donum

Resource/Time	Labor	Capital	Water	Machine's Hours
January	**		**	
February		**	**	**
.				
.				
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.				
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.				
.				
.				
December	**	**		**

1861

1862

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1904

1905

APPENDIX D

CALCULATION OF BENEFIT/COST RATIO AND NET PRESENT VALUE TABLE FORMAT



TABLE D.1.--Calculation of Benefit/Cost Ratio and Net Present Value

Year	Investment Cost I	Operation & Maintenance Costs (O + M)	Production Costs (P)	Gross Cost (I+O+M+P)	Gross Benefit (B)	Discount Factor at i Percent	Present Worth of Gross Costs at i Percent (PWC)	Present Worth of Gross Bene- fits at i Percent (PWB)
1								
2								
3								
4								
.								
.								
.								
.								
.								
.								
N								

$$B/C \text{ at } i \text{ percent} = PWB/PWC$$

$$\text{Net Present value at } i \text{ percent} = PWB - PWC$$



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