IRRIGATION AND IRRIGATED AGRICULTURE IN JORDAN: AN ECONOMIC GEOGRAPHIC APPRAISAL

Dissertation for the Degree of Ph. D.

MICHIGAN STATE UNIVERSITY
FOUZI EID SAHAWNEH

1970

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ABSTRACT

IRRIGATION AND IRRIGATED AGRICULTURE IN JORDAN: AN ECONOMIC GEOGRAPHIC APPRAISAL

By

Fouzi Eid Sahawneh

Economic progress in many of the countries of the Middle East has been closely tied to the development of an efficient irrigation system. Jordan in particular, with limited land resources and a predominantly agricultural population, is faced with considerable problems in attempting to expand its areas of irrigated land to meet present and future demands for agricultural products.

Several irrigation schemes have been developed, utilizing water obtained mainly from the side-wadis of the River Jordan. In particular the construction of the East Ghor Canal has brought benefits not only in terms of increased agricultural production and income for the local farmers, but has also aided greatly in the economic and social development of the whole country.

The bringing of water to the land is, however, not enough. Not only have drainage systems, new settlements, roads and other facilities to be constructed, but the social conditions of the area have to be considered. In particular,

the traditional system of land tenure has to be changed in order to ensure the efficient operation of new irrigation schemes.

Unfortunately the successful implementation of new irrigation schemes in Jordan are hampered by several factors, physical and human. Apart from the problem of obtaining sufficient water from the river systems of the East Bank of the Jordan the most serious problem is the continuing military action in the area which has prevented the full implementation of the East Ghor Canal project among others. However, other human factors also cause considerable problems. Although the technical and administrative aspects of the management of the East Ghor Canal scheme are good, a lack of legal enforcement of new land tenure regulations, lack of experience on the part of local officials and many social problems, may cause difficulties in the practical implementation of the scheme.

It is difficult to foresee the eventual efficacy of the irrigation schemes which are at present being developed, especially if Arab-Israeli hostilities continue over a long period. Even if hostilities cease, however, much remains to be done. Nevertheless, the results of the implementation of new irrigation schemes during the last five years can be observed in the form of increased agricultural production and higher incomes in the study area.

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By

Fouzi Eid Sahawneh

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Several interviews were held with many officials in the Irrigation Department of the Natural Resources Authority in Amman, Jordan. For this I am grateful. Many thanks go to the staff of the Library of the Natural Resources Authority for their assistance in the search for materials.

The trip to the United States for the defense of this dissertation was made possible by a Travel Grant from the United States Cultural Attache in Amman, Jordan.

The patience and encouragement of my family and fiance made the task a little more pleasanter.

I am appreciative to my colleagues in the Department of Geography at the University of Jordan for their incessant encouragement.

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INTRODUCTION

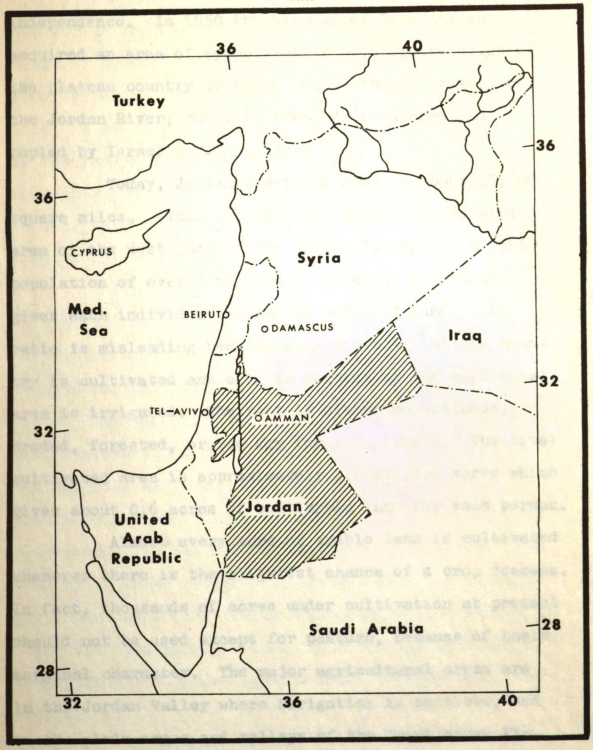
From time immemorial the peoples of the Middle East have supported themselves in a difficult environment, with the aid of irrigation. The rise and fall of cities and civilizations have in many cases been linked to the efficiency of their irrigation systems. Today, no less than in the past the economic welfare of many of the peoples of the Middle East depends on the efficient organization of their water resources and the development of new areas of irrigated agriculture to feed increasing populations.

One Middle Eastern country which faces considerable problems in expanding agricultural production to meet the requirements of a rapidly increasing population is Jordan.

The Hashemite Kingdom of Jordan incorporates the area of former Transjordan and that part of Palestine which remained in Arab hands at the conclusion of hostilities with Israel in 1948. (Map 1)

The British established Transjordan as a principality in 1921 under the rule of Prince Abdullah

MAP 1



Scale

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LOCATION MAP OF THE H.K OF JORDAN

(grandfather of the present king.) It remained under British mandate until 1946 when it gained its independence. In 1950 the Kingdom of Transjordan acquired an area of approximately 5000 square miles of the plateau country of former Palestine lying west of the Jordan River, but this area was conquered and occupied by Israel in June, 1967.

Today, Jordan covers an area of about 37,500 square miles. (This includes the presently occupied area of the West Bank of the Jordan River) with a 1965 population of over 2 million. Although this area gives each individual around 16 acres of land, this ratio is misleading because only 5 percent of the country is cultivated and only 10 percent of the cultivated area is irrigated. The rest is either mountainous, eroded, forested, or too dry for crop growth. The total cultivated area is approximately 1.2 million acres which gives about 0.6 acres of cultivable land for each person.

Almost every acre of arable land is cultivated whenever there is the slightest chance of a crop success. In fact, thousands of acres under cultivation at present should not be used except for pasture, because of their marginal character. The major agricultural areas are in the Jordan Valley where irrigation is possible, and on the plain areas and valleys of the Transjordan Plateau to the east. In both these areas both irrigated

and rain-fed agriculture are carried out.

Agriculture is the most important sector of the Jordan economy. "In recent years it has contributed about 17 percent of gross domestic product, 12 percent from crops and 5 percent from livestock. On the other hand, it provides main employment to about 35 percent of the labor force. Imports of agricultural products have averaged about 25 percent of all imports during recent years and exports of such products about 40 percent of all exports."[1]

A major problem exists whenever the extension of agriculture into new lands is attempted. Every acre of rainfed cultivable land is already being used, and extension can only take place in areas that can be irrigated. The judicious exploitation of the water resources, therefore, is very important to Jordan's social and economic welfare. A number of irrigation schemes have been and are being developed in order to increase food production and for the settling of refugees. Financing of these projects is being undertaken by the government of Jordan (funds appropriated from sale of water and from general funds) with foreign assistance. It is these irrigation schemes that form the basis for this study.

---

[1]Department of Statistics, Report on Agriculture Census, 1965, Department of Statistics Press, Amman, 1967, p.1.

The area selected for this study covers all the irrigated lands found in the Jordan Valley and along certain streams and tributaries of the Jordan River that originate in the Transjordan Plateau and which empty into the Jordan. (Tributaries originating in the Palestine Hills are excluded because of Israel's occupation of the area at the present time.) The area extends from the borders of Syria on the north to the Wadi Zerqa on the south, and from the River Jordan on the west to a distance of no more than 40 miles to the east; to the edges of the desert. (Map 2)

The purposes of this study can be summarized as follows:

1. To evaluate the role and impact of the irrigation schemes in the study area and on the economy of the country.
2. To study field patterns, patterns of land use, and settlement, under conditions of irrigation.
3. To examine problems of management of irrigation schemes, fragmentation of property, land tenure, salinity of soils and all other factors that may hinder agricultural development, and to suggest or recommend better courses of action.
4. To examine the feasibility and prospects of bringing more land under irrigation, and

MAP 2

STUDY AREA

to recommend possible future courses of action or approaches to developing new irrigation schemes.

The reasons for undertaking this study are both personal and academic. The former stems from the fact that I was born and riased in a farming family in Jordan, that I know the language, that I am familiar not only with the physical terrain but also with the people and, finally, my sincere desire to do something that may benefit someone even in a small way. The academic reasons stem from my interest in geography of agriculture and rural settlement and my desire to continue teaching and research work in this area.

The methods used to fulfill the stated purposes of this study fall into two categories:

1. Intensive library research before and after the field work, both in the United States and Jordan. Use was made of maps, statistics, and reports. Aerial photography was not available for security reasons.
2. Limited field work was carried out in the study area in 1969. Due to the military and political situation in the area and due to the dangerous conditions in the Jordan Valley, field work was of necessity, limited. All irrigated areas were within reach of Israeli guns and planes and were marked as military

zones. This in addition to the bitter fact that over 90 percent of the farmers in the Jordan Valley had left their farms. Many of the irrigation schemes have been bombed several times especially the East Ghor Canal which lies in the study area in this dissertation.

Much of the material used in writing thus came from written reports and interviews with many officials involved directly and indirectly with agriculture and irrigation. Because of the problems associated with the collection and interpretation of statistical material in developing countries, along with the difficulty of obtaining data in the field, much of the statistical information presented in this dissertation comes from studies made by various agencies and groups, government and otherwise.

CHAPTER I

THE NATURAL ENVIRONMENT OF JORDANIAN AGRICULTURE

Before considering the nature of agriculture in Jordan we must first look at the natural conditions under which agriculture takes place. Land forms, climate and soil types vary considerably from one part of the country to the other, causing notable variations in conditions for agriculture.

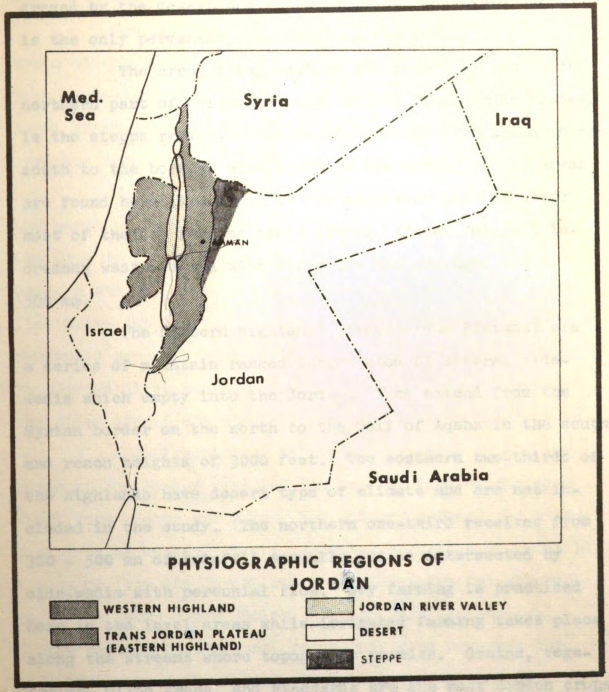
Physiographic Regions

Jordan can be divided into four main physiographic regions which are distinguished by their topography and climate. The four regions are:

1. The Uplands
    a. Western Uplands
    b. Eastern Uplands (Transjordan Plateau)
2. The Steppe region
3. The Rift Valley of the Jordan River
4. The Desert region (Map 3)

The desert region is an extension of the Arabian Desert and rises gradually westward and becomes the Eastern Highlands or the Transjordan Plateau. This region occupies more than two-thirds of Jordan and it is for the most part

MAP 3


Med. Sea
Syria
Iraq
AMMAN
Israel
Jordan
Saudi Arabia
PHYSIOGRAPHIC REGIONS OF JORDAN
WESTERN HIGHLAND
TRANS JORDAN PLATEAU (EASTERN HIGHLAND)
JORDAN RIVER VALLEY
DESERT
STEPPE

Flint-strewn desert. The area is characterized by a short and cold winter, and a long hot summer with rather cool nights. The yearly rainfall average is below 3 inches (76 millimeters). Some grasses grow in spring and are grazed by the desert nomads (Bedouins.) The Azraq Oasis is the only permanent settlement in the area.

The areas lying west of the desert region in the northern part of Jordan and east of the Transjordan Plateau is the steppe region. This region extends from Amman in the south to the borders with Syria to the north. Level areas are found here especially in the northwest quarter where most of the dry farming takes place. Annual rainfall increases westward and with elevation and averages 200 - 500 mm.

The Eastern highlands (Transjordan Plateau) are a series of mountain ranges intersected by several side-wadis which empty into the Jordan. They extend from the Syrian border on the north to the Gulf of Aqaba in the south and reach heights of 3000 feet. The southern two-thirds of the highlands have desert type of climate and are not included in the study. The northern one-third receives from 300 - 500 mm of rainfall annually and is intersected by side-wadis with perennial flow. Dry farming is practiced here in the level areas while irrigated farming takes place along the streams where topography permits. Grains, vegetables, Olive trees, and vineyards are the most common crops grown in these areas.

The Western highlands resemble the northern third of the eastern highlands in topography and climate with a little more rainfall and averaging 600 mm annually. The only difference is the fact that the western highlands have steeper slopes towards the Jordan Valley.

Grains, fruits, and vegetables are the most common types of crops grown in the western highlands, with special emphasis on Olive trees. These trees are planted in level areas and hill slopes. Intensive types of agriculture are found in areas where water is available.

The Jordan Depression begins from Lake Tiberias on the north to the Gulf of Aqaba in the south. Halfway lies the Dead Sea. The Jordan River runs in a trench from the Lake to the Dead Sea, known as the Ghor. Most of the area lies below sea level. The width of the valley increases Southward where it reaches about 15 Km. near Jericho where the Jordan River empties into the Dead Sea. Areas west of the river itself are narrower than those to the east of it.

A different type of climate prevails in the lowlands of the Jordan area and can be described as having a short warm winter and a long hot and dry summer. An intensive type of agriculture is practiced here most of which is irrigated from the Jordan and from side-wadis and streams as in the Zerka River Valley. In the northern section of the valley, agricultural lands have been expanded due to better use of the Yarmouk River and the establishment of the East Ghor Canal which will be discussed in detail in later parts of this study.

Climate

Two types of climate prevail in Jordan: First, Mediterranean in the west and northwest, characterized by a rainy winter season with mild temperatures, and a hot dry summer with plenty of sunshine. To the east lies the second type of climate; low latitude desert.

Another approach to the climate of East Jordan was suggested by G. A. long.[1] According to him, most of the area falls within the Mediterranean Bioclimatic region with a concentration of rainfall in the cool winter season and a very marked summer-drought (Map 4).

He developed the following sub-divisions.

1. Mediterranean Sub-humid bioclimate stage

   Average rainfall more than 600 mm. Average Minimum Temperature in the coldest month (Jan.) 3° c. Average Maximum Temperature in the hottest month (August) between 27 and 33° c.

2. Mediterranean arid bioclimate stage

   Average rainfall 300 - 600 mm, Average Minimum temperature in the coldest month (Jan.) 3 - 7c°.

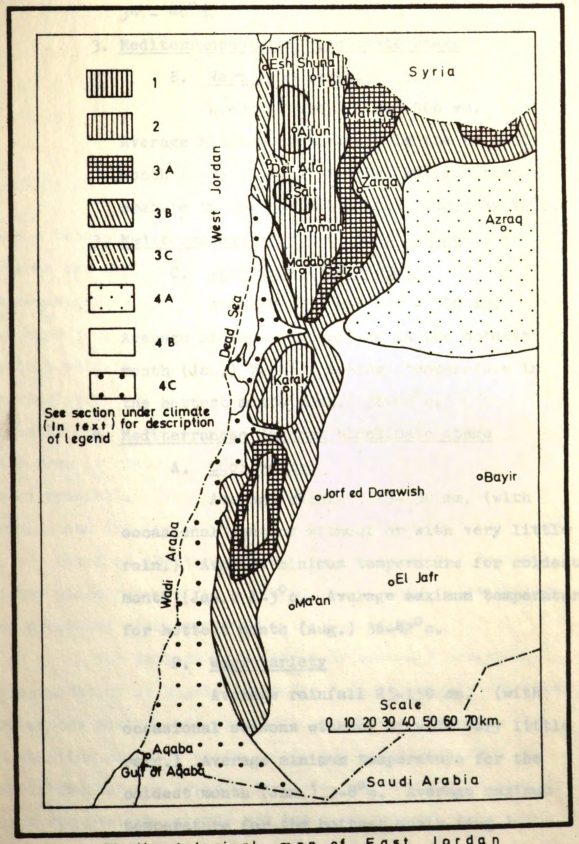
3. Mediterranean arid bioclimate stage

   A. Cool type variety

   Average rainfall 150 - 300 mm. Average Minimum temperature in the coldest month (Jan.) 1-3°c. Average Maximum

[1] Long, G.A., "Bioclimatology and Vegetation of East Jordan," FAO working paper, 1957.

MAP 4



Bioclimatological map of East Jordan

Source: Bioclimatology of East Jordan

temperature in the hottest month (August) 34 - 40°c.

3. Mediterranean arid bioclimate stage

B. Warm type variety

Average rainfall 200-300 mm. Average minimum temperature in the coldest month (Jan.) 3-7°c. Average maximum temperature in the hottest months (Aug.) 34-40°c.

3. Mediterranean arid bioclimate stage

C. Very warm type variety

Average rainfall 200 - 300 mm. Average minimum temperature in the coldest month (Jan.) 7-10°. Average temperature in the hottest month (Aug.) 38-42°c.

4. Mediterranean Saharan bioclimate stage

A. Cool variety

Average rainfall 25-150 mm. (with occasional seasons without or with very little rain.) Average minimum temperature for coldest month (Jan.) 1-3°c. Average maximum temperature for hottest month (Aug.) 36-42°c.

B. Warm variety

Average rainfall 25-150 mm. (with occasional seasons without or with very little rain.) Average minimum temperature for the coldest month (Jan.) 3-8°c. Average maximum temperature for the hottest month (Aug.) 36-42°c.

C. Very warm variety

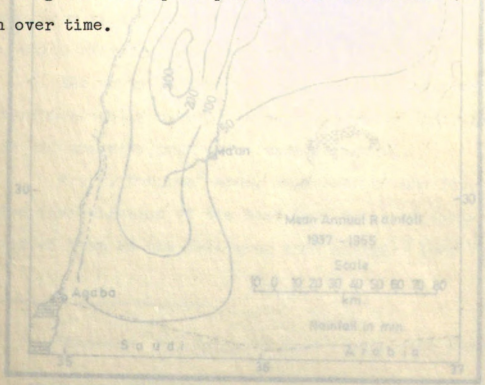
Average rainfall 24-150mm. (with occasional seasons without or with very little rain.) Average minimum temperature in the coldest month (Jan.) 8-12°c. Average maximum temperatures in the hottest month (July) 38-44°c.

No agriculture is practiced in types 4-a, b, and c because of their desert nature. Vegetation is sparse and some grasses grow only in a few areas such as depressions. Most of the irrigated agriculture takes place in type 3-c; the area being the Jordan River Valley. Very little rain-fed agriculture is practiced here. From an agricultural point of view, type 3-b may be regarded as a transitional zone between the desert and the steppe region. The area is grazed by the Bedouins especially in years of good rainfall. Type 3-a may be considered as a steppe region and dry farming is practiced. Climatic types 1 and 2 are found on the Transjordan Plateau where dry farming takes place especially in the northern areas. Irrigation is practiced along side-wadis in this area.

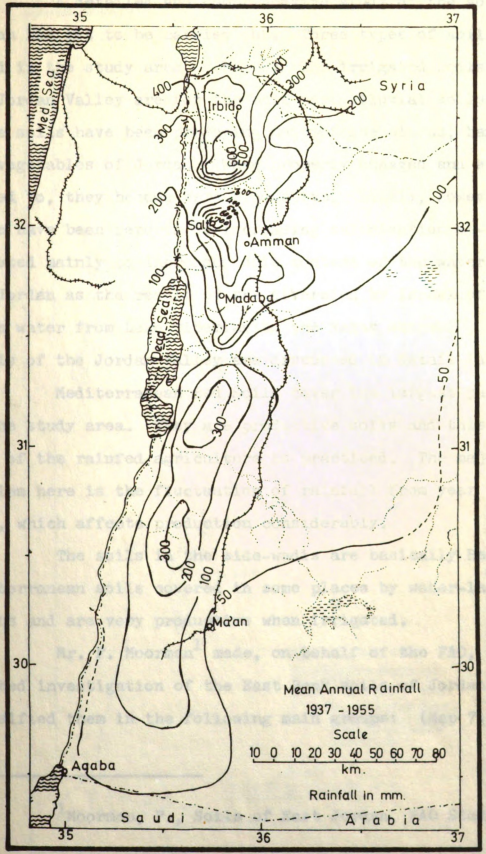
The pattern of rainfall is markedly orogenic. Precipitation is highly seasonal, being virtually confined to winter months, and extremely variable in amount. The prevailing westerly winds obtain their moisture from the Mediterranean and deposit it where they are forced upwards over the western uplands and the highlands of north eastern

Jordan. The prevailing winds which reach the south come from across north Africa and carry little moisture. Consequently, the south-eastern highlands, though higher than those of the north, receive a more scanty and unreliable rainfall. (Map 5).

Average precipitation totals vary considerably from one part of the country to another; ranging from less than 10 mm in the desert to 600 mm in the West bank of the Jordan. It is estimated that only about 12 percent of the country's area receives an annual average rainfall exceeding 200 mm, and that only about 6 percent receives over 300 mm. While changes in the volume of rainfall has a direct and proportionally amplified effect on yields of dry-farmed crops, the distribution of rainfall over the season may offset or accentuate the effect of the volume of rainfall depending on the crop in question and the intensity of the rain over time.



MAP 5



SOURCE: RAINFALL ATLAS OF JORDON

Soils

A detailed and comprehensive study of the soils of Jordan has yet to be carried out. Three types of soils are found in the study area (Map 6). The irrigated soils of the Jordan Valley are for the main part alluvial soils. These soils have been producing most of the citrus, banana, and vegetables of Jordan. When properly managed and attended to, they become very productive. Lately, however, there have been reports of increasing salinization attributed mainly to increased salt content of the waters of the Jordan as the result of the diversion by Israel of fresh water from Lake Tiberias to the Negev desert. (Soils of the Jordan Valley are discussed in detail later.)

Mediterranean Red Soils cover the largest part of the study area. They are productive soils and this where most of the rainfed agriculture is practiced. The major problem here is the fluctuation of rainfall from year to year, which affects production considerably.

The soils in the side-wadis are basically Red Mediterranean soils covered in some places by water-laid deposits and are very productive when irrigated.

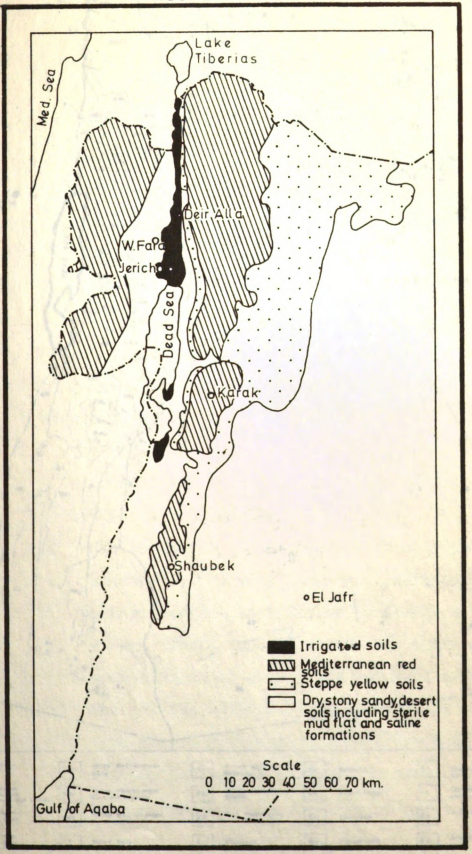
Mr. F. Moorman[1] made, on behalf of the FAO, a limited investigation of the East Bank soils of Jordan, and classified them in the following main groups: (Map 7)

---

[1]Moorman, F., Soils of East Jordan, FAO Studies, 1962.

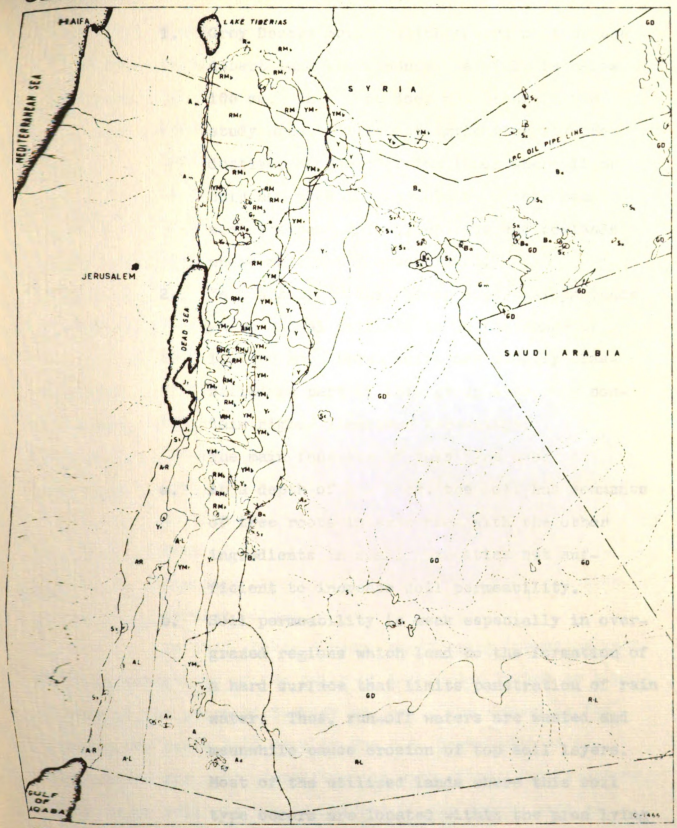
MAP 6

Soils of Jordan



SOURSE: JORDON COUNTRY REPORT

GENERAL SOIL MAP OF EASTERN JORDAN (To be considered as tentative)



Source: Soils of East Jordan

1. Grey Desert Soil: which covers most of the desert land where annual rainfall is below 100 mm. This type does not occur in the study area. It is not agriculturally productive, and most of the lands where it occurs are used for pasture on a very small scale, except for valley beds and lowlands where rain water accumulates.

2. Yellow soils: This group covers slope lands where annual rainfall is in the range of 100-200 mm. Brown soils are usually classified as part of this group also, but contain higher limestone percentage.

The main features of this type are:

a. At a depth of $\frac{1}{2}$ - 2 cm. the soil has remnants of tree roots interspersed with the other ingredients in small quantities but sufficient to increase soil permeability.

b. Soil permeability is weak especially in overgrazed regions which lead to the formation of a hard surface that limits penetration of rain water. Thus, run-off waters are wasted and meanwhile cause erosion of top soil layers. Most of the utilized lands where this soil type occurs are located within the area lying between Mafrag and Giza, especially in valleys. Most of the land in this region has a salt-free

class one soil, and with the presence of adequate rain, could be well utilized.

3. Yellow Mediterranean Soil: This group includes lands located between mountainous regions and steep lands with an annual rainfall of 200-300mm. It is somewhat similar in physical characteristics to the yellow soil, but differs in having a sub-layer with high limestone content.

4. Red Mediterranean Soil: This group includes soils of the mountainous regions where annual rainfall is over 350 mm., and is characterized by presence of humus in small quantities in surface layers with a color different from the sub-layers. The soil has relatively high pure limestone content, and its water retention capacity makes it cultivable in the same way that alluvial soils are. Most of the Ghor soils which are with alluvial deposits carried over by the R. Jordan and side-streams belong to this type.

In 1955, Baker & Harza Engineering Companies made an investigation of the soils of the Jordan Valley as a prelude to the proposed Yarmouk project. The companies followed the basis laid down by the U.S. Department of Agriculture for soil classification with slight modifications. The major soil classes identified in the report were as follows:

1. Class one soils which cover a total area of 143,090 dunums. These lands have deep soil layers of good permeability, the soil being fertile and fit for most kinds of vegetation with a high yield per dunum.

2. Class two soils which cover a total area of 138,473 dunums. The main factor that limits soil fertility is the relatively heavy soil texture which also decreases its permeability and little amounts of salts and alkalines in varying proportions, in addition of course, to the simple problems of topography.

3. Class three soils which cover a total area of 65,972 dunums. The main factor that limits its fertility is the presence of moderate quantities of salt and alkalies. Soil texture is very light in addition to problems of topography.

4. Class four soils cover a total area of 172310 dunums most of which located on the river banks. 14 percent of this total area may be reclaimed as class one and two after leaching.

5. Class six soils cover a total area of 423000 dunums, 890 dunums of which are cultivable if irrigated, but cannot be reached at the present time due to its isolation from and elevation to the irrigated area.

Most of the land in this group have light soil and located in the area between the Ghor and the Zor*, and includes likewise the extensively eroded lands between the stream banks and arid lands.

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* Zor lands are those which lie in the flood area of the river.

In summary, as far as the soils of the study area are concerned, we can say that the major criterion for the further development of irrigation in the study area is the availability of areas of flat land. Within these areas soil types vary but on the whole they are mainly alluvial. Soil classes also vary but for the most part, they are class one soils when irrigated.

CHAPTER II

AGRICULTURE AND THE JORDANIAN ECONOMY

The important role of agriculture in the economy of Jordan is more easily appreciated if one first considers several aspects of the rate of growth and composition of the population of the country.

The population of Transjordan in 1947 was about 375,000 but this grew rapidly as a result of the forced migration of persons from areas occupied by Israel, and in less than eighteen months, an additional 460,000 were added for a total of 835, 000 persons. "In a single year, 1948, about 350,000 persons left the rest of Palestine and entered the area that became Jordan. Thus, when the kingdom of Jordan was created, its population was more than three times as large as the population of Transjordan has been...[1] This tremendous influx of refugees put a heavy strain on the economy, forcing

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[1] International Bank for Reconstruction and Development of Jordan, The Economic Development of Jordan, the John Hopkins Press, Baltimore, 1957.

Jordan to depend heavily upon foreign aid. The estimated population of Jordan as of December 31, 1965 was 2,016,618[2] which indicates a rate of increase of over 3 percent per year; one of the highest in the world. This population figure includes an unspecified number of refugees who enter Jordan almost every day.

The population is about equally divided between the two banks of the Jordan River, the West Bank being more densely populated (about 170 per square Kilometer, compared with 12 in the East Bank) but not as densely populated as the area around Amman and Irbid. About nine-tenths of the population are concentrated in one-tenth of the area of the country, i.e., in the West Bank and in the four East Bank districts of Amman, Zarqa, Irbid and Balga.

Not only does the high rate of annual increase of population call for a constant expansion in agricultural production, but the fact that the population is concentrated in agricultural areas which are already densely populated further increases the pressure on Jordan's agricultural resources. (Map 8)

The 1961 census showed that 45.4 percent of the total population was under 14 years of age which is below the work age, most being in schools. About 10 percent of the remaining population are unable or unwilling to work. Those

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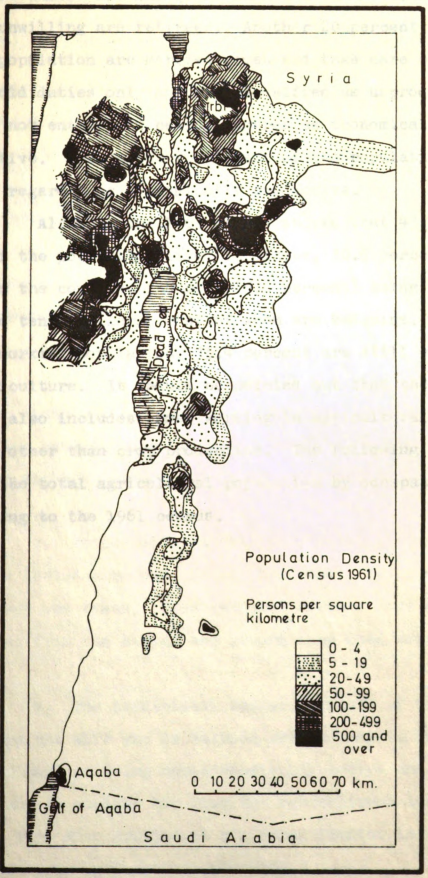
[2]Department of Statistics, Statistical Guide to Jordan, 1965, No. 3, Department of Statistics Press - Amman.

MAP 8



SOURCE: JORDAN COUNTRY REPORT

that are unable are not qualified to hold most jobs while those unwilling are retirees. Another 20 percent of the total population are married women and take care of household duties only and are classified as unproductive or are not entered in census figures as economically productive. Thus about 25 percent of the population can be regarded as economically productive.

Although the 1961 census showed that 43.7 percent of the population lives in cities, 50.6 percent still live in the country, the rest (5.6 percent) being classified as tent dwellers, most of whom are Bedouins. Of the total working population, 35.4 percent are still engaged in agriculture. It should be pointed out that the above figure also includes those working in agricultural activities other than crop production. The following table shows the total agricultural population by occupation according to the 1961 census.

TABLE 1

Agricultural Labor Force by Main Occupation (1961)

Main Occupation	Male	Female	Total
1. Farmers	73,701	480	74,181
2. Agriculture Farmers	43,260	6,499	47,959
3. Agri-Machine Operators	973	____	973
4. Poultry	3599	9	3608
5. Shepherds	9036	90	9126
6. Fishermen	110	____	110
Total	130,679	7,076	137,757

The above are the offical figures of the 1961 population census. The actual number of the total agricultural workers exceeds this number for the following reasons:

1. It is believed that many seasonal workers were not included because of the time (Nov. 1961) when the census was taken. Some seasonal workers came at harvest time from the cities and return then when work is completed.

2. The traditional social attitude of the people considers the wife who is helping her husband in his agricultural work as being non-economically active and leads, therefore, to exclude her from the agricultural labor force. This also applies to all other females in the family helping in agricultural pursuits.

The social and Economic Survey of the East Jordan Valley, (published in 1961) indicated that the number of females involved in agriculture total 25 percent of all persons working in agriculture in the region, 71 percent of them being family workers.

Thus, it is certain that well over half of the total population is involved in agricultural activities and that the official statistics do not reflect the true situation.

Underemployment and concealed unemployment in rural areas further complicates the accurate assessment of the numbers of people effectively employed in agriculture.

Agricultural resources

As we have already noted agriculture is the most important sector of the Jordan economy. In spite of its importance, however, physical conditions for the development of agriculture are clearly limited. Most of the area of Jordan is desert and only relatively small area of the country is cultivated. The rest is either mountainous, eroded, forested, or too dry for crop growth. The following table shows the area and percentages of land according to usage.

TABLE 2

Land classification according to type of use:

Type of land	Area (Dunum)* (1000's)	Percentage
Deserts	75,709	79.9%
Agricultural land	13,000	13.1%
Forest land	1,250	1.3%
Meadow	1,000	1.1%
Public land	1,525	1.6%
Government land	1,500	1.6%
Water bodies	756	0.8%

It can be seen from this table that almost 80 percent of the total area is desert and only 13.7 percent can be considered as agricultural land and all other uses of the land make up about 6.5 percent.

*Dunum is an area measurement equalling one fourth of an acre.

TABLE 3

Land Distribution according to type of agriculture

Type of agriculture	Area (000 Dunums)	Percentage
Irrigated and Potentially irrigable	759	5.8%
Non-irrigated or rain-fed	5,616	43.2%
Fallow land	3,909	30.1%
Unused because of the lack of water	2,716	20.9%

The table above shows that the total agricultural land is only 13,000,000 Dunums, 43.2% of which is rain fed and only 5.8% is irrigated. The rest is either fallow or unused because of the lack of water.

Most of the agricultural land is used for the growing of grain, vegetables, and fruits. About 65.3% of the agricultural land is planted in grain, 7.1% in fruit trees, 4.7% in vegetables, 2% in young tree plantations, and the rest being unused as of this time as is shown in the following table:

TABLE 4

Agricultural Land Distribution according to type of use:

Type of Use	Area (000 Dunums)	Percentage
Grains	8,500	65.3%
Vegetables	610	4.7%
Fruit trees	918	7.1%
Young tree plantations	256	2%

TABLE 4 Cont'd

Unused land because of lack of water	2,716	20.9%
	13,000	100%

Land Use

About 6,000,000 dunums or (6%) of Jordan's land area receives an average annual rainfall of more than 300 mm, the minimum required for permanent and reliable dry farming. A part of this zone, which covers the Western and Eastern highlands, is either too steep for cultivation or has poor soil. Dry farming is extended to the 200-300 mm zone during years of good rainfall. On the other hand, small patches of land outside the 200 mm rainfall zone are irrigated from springs or wadis or by pumped water.

The estimates of the cultivated area in 1953, which have not changed much since that date, and that of the cropped area in 1965 are summarized in Table 5 below. They indicate that out of a possible cultivable area of some 9,000,000 to 10,000,000 dunums, only 6,330,000 were cropped in 1965 (against 6,690,000 dunums in 1964), the rest being presumably left fallow. Out of 760,000 dunums of land possessing water rights, about 300,000 dunums were actually irrigated.[1]

The statistical information on land use given in the agricultural census of 1953 and by the estimates of the Ministry of Agriculture suffers from many weaknesses.

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[1]Jordan, Department of Statistics, 1953 Census of Agriculture.

The area of agricultural holding estimated in the 1965 agricultural census turned out to be unreliable.

The 1953 census results cover only holdings of more than 10 dunums in area and includes overlapping classifications. It also seems to have applied a loose definition of irrigated land to probably any land having some water rights. The estimates of the Ministry of Agriculture, on the other hand, refer to the cropped area only and are collected by regional extension agents and statistics inspectors from information supplied by the village heads or leading farmers. Hence, they are subject to a high degree of error, particularly concerning estimation for yields.

No land use map of Jordan is available and none has been attempted... Map 9 is a generalized one and was based on the topographical sheets of Jordan and the patterns indicated are approximates. It was made with the help of some officials in the Natural Resources Authority. It should be considered as tentative and general.

MAP 9

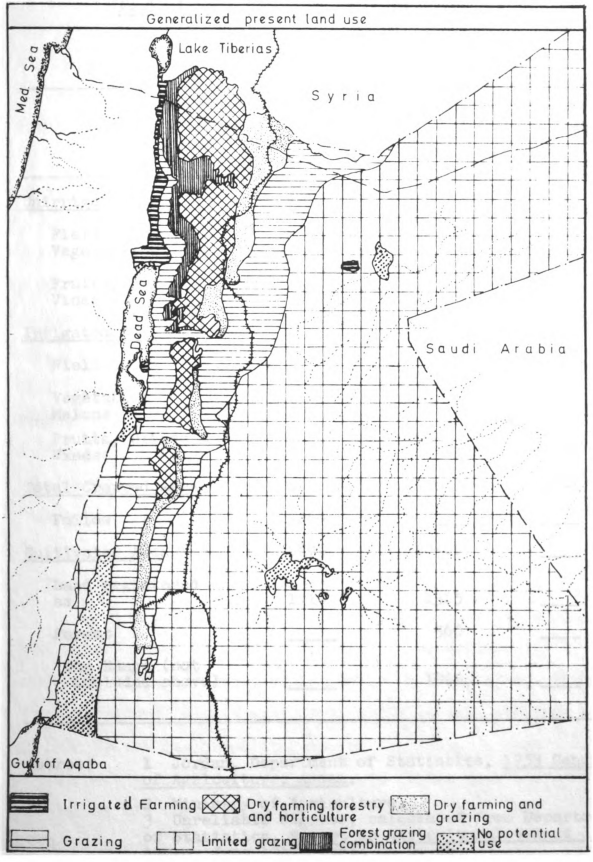
Generalized present land use
Med. Sea
Lake Tiberias
Syria
Dead Sea
Saudi Arabia
Gulf of Aqaba
Irrigated Farming
Dry farming forestry and horticulture
Dry farming and grazing
Grazing
Limited grazing
Forest grazing combination
No potential use

TABLE 5

Agricultural Land Use 1953 and 1965

('000 dunums)

	1953 Census 1)	1965 estimate 2)	1965 Census 3)
Unirrigated crops	5051	6009	4962
Field Crops Vegetable & Melons	4367	537	188
Fruits, Olives & Vines	684	1260	666
Irrigated Crops	759	323	443
Field Crops	—	195	132
Vegetables & Melons	—	75	234
Fruits, Olives & Vines	—	51	76
Total Cropped Area	5810	6332	5404
Fallow	3064	—	—
Cultivated Area	8874	10400	—
Land registered as	1114	1315	—
Forest	—	360	—
The Range (not included above)	—	1000	—

Source: 1 Jordan, Department of Statistics, 1953 Census of Agriculture, Amman.

2 Ministry of Agriculture.

3 Unreliable Figures, calculated from Department of Statistics, Report on Agricultural Census 1965, Amman, June 1967, table on p. 18.

Agricultural Crops and Production

Before assessing the importance of agriculture in the Jordanian economy we should also look briefly at the types of crops grown and the amounts produced both under conditions of irrigation and dry-farming, as well as the major agricultural regions of the country.

An overall picture of the pattern and growth of agricultural production can best be seen in the estimates of the value of agricultural output in the years 1954-1966 (Table 6) Since the values are given in current prices, their changes do not exactly reflect changes in physical output but the picture is not seriously distorted by the relatively small changes in prices from year to year. It will be noted that while total agricultural output roughly doubled during the period 1954 and 1966, its growth has been unsteady and it has fluctuated violently from year to year. It can be seen that the major sources of instability have been the changing output of cereals and olives. On the other hand, income from vegetables and fruits has shown the greatest degree of steady growth.

The relative importance of the various agricultural products can be seen in (Table 7), which gives the estimates of their output and value in the year 1966. Since the agricultural season was a relatively normal one, the pattern is not distorted in favor of particular groups of products. In that year field crops represented 55.7 percent of the total value of agricultural output, and

animal and poultry contributed 43.6 percent. The remaining 0.7 percent was contributed by forestry, fish and honey. Within the group of field crops, fruits, vines and olives are the most valuable crops followed closely by vegetables; grains and legumes in a year of normal rainfall have thus been surpassed in importance by more intensive types of cultivation.

The cropped area as a whole expanded with the influx of refugees in 1948 and with the shift of population to the E. Bank, and reached its maximum in 1956, when the total cropped area was estimated at 6,330,000 dunums. Since then it has remained below that level, contracting in years of late or poor rainfall and expanding when early rains suggest that the rainy season may be promising (Table 8). Since the area under field crops, particularly wheat and barley, represented about three-quarters of the total cropped area, its variation tended therefore to determine the overall changes in the total area under crops each year (Table 9).

The allocation of the cropped area among the various crops changed significantly during the period 1954-1966. While the area under field crops tended to contract, the area under fruit trees, particularly olives, showed a continuous and steady expansion. The area under vegetables also increased considerably with the expansion of irrigation, but the area under unirrigated vegetables, like cereals, fluctuated with rainfall. The shift in the crop pattern

can be illustrated by the change in the proportions of the area under various crops in the four best agricultural years (Table 9). Within the group of field crops, the area under wheat and barley remained predominant, covering over 80 percent of the total. The area under lentils, beans and tobacco tended to expand, probably due to the high prices they fetch, while maize, sesame declined in the area, probably to allow greater cultivation of summer vegetables, other legumes followed the fluctuation in the area of winter wheat and barley. Within the group of vegetables the major crops are tomatoes, watermelons, and cucumbers, which have shown the fastest expansion in response to the demand of the export markets in neighboring Arab countries. However, a slowdown in the growth of production occured in recent years due, mainly, to marketing problems. In 1966 there was a substantial decline in the area under tomatoes and watermelons owing to the poor rainfall season. The area of fruit trees, vines and olive trees has steadily expanded as more land was terraced and planted, particularly in the W. Bank. Olives, almonds and citrus have expanded most and in the same order. The cultivation of both citrus and bananas has been stimulated by the opening of irrigated lands in the Ghor and by high returns, but the area under bananas failed to expand much as a result of various production problems and the shortage of irrigation water. Marketable fruits such as plums, peaches, apples, and pears

TABLE 6

Value of Agricultural Production at Farm Prices (1954-1966)

(Millions of Jordanian Dinars)

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
Grain & Legumes	7.0	2.9	7.7	6.4	2.5	3.1	2.1	5.6	4.5	3.1	10.8	10.1	4.2
Vegetables	3.2	2.4	3.3	4.0	5.2	5.2	7.5	7.9	6.9	7.4	8.6	9.0	5.7
Tobacco	0.2	0.2	0.4	0.4	0.3	0.4	0.1	0.4	0.3	0.1	0.4	0.4	0.3
Fruits & Vines	0.9	0.8	0.9	1.1	2.0	2.7	9.0	3.4	5.3	5.3	7.9	5.6	4.7
Olives	1.4	0.3	2.4	0.5	1.8	0.4							1.6
Total	12.7	6.6	14.7	12.4	11.8	11.2	12.4	22.9	15.1	15.9	27.7	25.1	16.5
Less Cost of Production	1.4	1.1	1.6	1.6	1.6	2.5	2.5	3.0	3.2	3.3	3.7	4.3	5.0
Net Farm Income	11.3	5.5	13.1	10.8	10.2	8.7	9.9	19.9	11.9	12.6	24.0	20.8	11.5
Index (1954-56 = 100)	108	48	145	98	98	114	111	192	158	167	258	258	205

First Series 1954-1958: R.S. Porter "Economic trends in Jordan 1954-1959", Beirut, July 1961 (Mimco).
Second Series, 1959-1965: Jordan, Dept. of Statistics, The National Accounts, 1959-1965. Amman. Estimates for 1966 from the Dept. of Statistics.

The two series 1954-1958 and 1959-1960 are not strictly comparable although following essentially the same estimation methods.

Figures may not add up exactly to total because of rounding.

TABLE 7

Output and value at Farm prices of Agricultural products (1966)

Product	Output (1000 tons)	Value (JD million)	Percent of Total value	
Grains & Legumes				
Wheat	101.1	2.97	70	
Barley	28.8	0.43		
Lentils	11.0	0.39	10	
Vetch (Karsanneh)	6.9	0.16	9	
Others	7.8	0.29	7	
	155.6	4.24	100	14.2%
Tobacco				
Virginia	1.27	0.25	83	
Local (Hishi)	0.34	0.05	17	
	1.61	0.30	100	1.0%
Vegetables				
Tomatoes	144.6	1.87	33	
Eggplant	50.4	0.58	10	
Cucumbers	15.4	0.47	8	
Watermelons	41.0	0.44	8	
Green beans	10.7	0.43	7	
Potatoes	22.3	0.33	6	
Squash	15.9	0.30	5	
Others	82.3	1.31	23	
	382.6	5.73	100	19.2%
Fruits, Olives and Vines				
Olives	32.7	1.64	26	
Citrus	52.7	1.70	27	
Grapes	61.9	1.28	20	
Bananas	16.8	0.67	10	
Apples & Pears	6.8	0.36	6	
Figs	16.4	0.31	5	
Almonds	3.5	0.13	2	
Plums & Peaches	6.7	0.10	2	
Others	6.7	0.15	2	
	206.4	6.34	100	21.3%
Total Crops	746.2	16.61		55.7%

Dept. of Statistics:

The total differs from total agricultural output given in Table 29, due to the exclusion of value added by construction on the farm (JD 0.54 million)

TABLE 8

Indices of Area of Crops and of Total cropped Area
(Av. 1954-1956 = 100)

Year	Field crops	Vegetables	Olives [a]	other fruits and vines	all crops
1954	98.3	115.1	96.7	101.2	99.1
1955	92.3	85.3	99.6	99.3	92.5
1956	109.3	99.5	103.5	99.4	107.6
1957	93.9	132.5	109.6	103.6	97.2
1958	98.3	114.6	116.0	111.1	100.7
1959	83.8	145.0	122.8	117.6	91.0
1960	77.9	131.0	130.8	119.8	85.9
1961	87.6	177.7	138.4	130.4	97.5
1962	93.6	187.4	144.2	132.4	103.5
1963	68.2	175.7	151.4	129.3	81.9
1964	93.5	209.2	157.3	133.0	105.4
1965	91.2	211.8	163.2	138.1	104.3
1966	67.7	142.4	169.4	138.5	81.3

Derived from the estimates of the Ministry of Agriculture given in the statistical Yearbook 1954 to 1966.

[a] Index number of trees; after 1957 the number was arrived at by adding the number of new seedlings planted during the previous year. The area included in the total was arrived at by applying the index to the estimate of area planted with olives in 1966.

also expanded in area but a slowdown in new planting of apples and pears has occured in recent years, probably due to lack of irrigation water in suitable highlands.

TABLE 9

Changes in the Crop Pattern (Percent of Total Area)

	1956	1961	1964	1965
Field Crops	84.7	74.9	74.0	72.9
Vegetables	5.1	10.1	11.0	11.3
Fruit Trees and Vines	4.4	6.4	6.0	6.4
Olive Trees	5.8	8.6	9.0	9.4
All Crops	100.0	100.0	100.0	100.0

Yields

Yields of most of Jordan's crops fluctuate widely from year to year, dry farmed crops show the most violent variation in yields, a variation which is nearly always in the same direction as the changes in the average volume of rainfall but which tends to be of greater amplitude (Table 10). Yields of irrigated crops, and of fruit trees other than olives, show narrower annual variations and are influenced by other factors such as extreme weather conditions, cultivation practices, disease and pests. Yields have also tended to rise substantially over the period 1954 to 1966, partly as a result of improved cultivation practices but also, in the case of citrus and other trees, because of the rising proportion of mature trees. The yields of olives are subject to even more violent changes than dry farmed field crops.

TABLE 10

Index of Average Rainfall and Indices of yields of Major Crops

(Av. 1954-1956 = 100)

Year	Index of Rainfall 1)	Index of Rainfall 2)	Wheat	Barley	Lentils	Tomatoes	Watermelons and Cucumbers	Olives	Grapes	Citrus	Bananas
1954	116		135	141	130	103	127	132	130	84	81
1955	66		47	35	33	98	86	25	81	90	118
1956	118		118	124	138	99	86	143	89	125	101
1957	112		124	120	75	113	88	21	112	94	56
1958	85		35	23	27	140	85	94	95	84	91
1959	79		63	46	32	159	104	19	116	105	94
1960	51	47	28	25	20	216	109	26	91	76	68
1961	96	89	80	92	58	215	124	171	154	107	112
1962	93	95	62	48	94	155	125	11	157	125	132
1963	56	64	59	43	39	201	133	53	119	234	94
1964		128	157	150	146	183	135	128	155	213	102
1965		132	158	140	152	177	122	48	157	214	104
1966		81	56	50	91	166	94	40	121	247	111

Derived from the detailed tables of crop areas, output and yields given in the Statistical Yearbook. The rainfall index is derived from Table 27.

1) Average 1953/54 to 1955/56 seasons = 100. The average seasonal rainfall is for all reading stations.

2) Average for 17 main stations. The index is linked to the first series by using the ratio of 1959/60-1962/63 averages in the two series as a factor for inflacting the second series.

Dry Farming

The dry farming areas are restricted to the western and eastern highlands but include also some land in the steppe region which is considered marginal. Part of this marginal land yields a crop twice in ten years and is planted only in years of favorable early rains, while other areas yield a crop perhaps once in three or four years and are more regularly planted. The extent of this marginal land, which lies in the steppe and northeastern mountain escarpments, is not known with any certainly but may reach 1,000,000 dunums. However, the Ministry of Agriculture has initiated Laws in 1967 which prohibit the cultivation of these marginal and submarginal lands for cereal production.[1] Rainfall, upon which the success of dry farming depends, is traditionally classified by farmers as early, seasonal or late. The early rains are expected to fall at the end of October and early November when wheat, the major crop in Jordan, is sown as Afir.* The seasonal rains are expected to fall in January and early February, but when they are delayed or when they fail to come, the Afir crops perish from the lack of sufficient reserve of moisture in the soil. The late rains occur in late February and March and are as important as the early rains. Their failure endangers the spring as well as the summer crops. Best harvests are normally obtained when abundant rain occurs over extended periods early and late in the season.

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[1] Regulation No. 21 of 1967 based on Agricultural Law 11:92 of 1966.

* Afir, refers to the early sowing of cereals in late September and early October.

In dry farming regions only one crop can be produced in a year. Winter crops are planted with early rainfall in December-January. Summer crops are planted in March and not later than April, since no rainfall is expected thereafter. This is in contrast to the Jordan Valley where irrigation and the warm climate result in quicker plant growth and, therefore, can allow three crops to be planted in one year. The most common dry farming crop rotations are based on a winter crop, particularly wheat or barley. In marginal zones, no summer crop is included. Here a two-year rotation is usually followed, based on alternating winter crops (mainly wheat or barley) with fallows. On the other hand, increases of relatively high rainfall, summer crops are included, replacing fallow partially or completely. A two year rotation is used or a modified three-year rotation in which wheat or barley is planted in the first year, followed by a summer crop (vegetables, Sorghum or sesame) then followed by pulses or grain legumes in the third year. It should be also mentioned that any rotation which includes a summer crop does not mean a permanent substitution to fallow but occurs only in good rainfall seasons.

Soil tilling is mainly done with the native wooden plough which carries a metalic tip and is pulled by a mule or team of oxen. Mechanized tilling is common, however, in the highland plains (Irbid, Salt and Madaba), but is impractical on steep slopes or in rocky areas. Mould boards and disc ploughs are used but few harrows or rollers.

The field which is prepared for wheat is ploughed once before sowing and then ploughed again after sowing in the opposite direction to cover the seeds. In some cases, seeds are broadcast then the land is ploughed twice cross-ways. After harvesting wheat in July, the land is ploughed and, if left fallow, is ploughed again in March to remove the weeds. Cultivation of land after sowing is very rare (it is only practiced for vegetables). The only means for removing weeds is by hand, but due to the high cost of labor, many crops suffer from severe weed infestations, where weeds are left to go to seed before being removed.

The standard method of sowing cereals and grain legumes is by hand broadcasting. Yellow corn and sorghum are sometimes drilled, but no great attention is given to proper spacing or uniform population. Seed drills are not used except on Government farms. Mechanized harvesting is common only for wheat and barley where the terrain permits, but all other crops are harvested with sickles or by hand. Mechanical threshing is spreading but is still largely done in the classical manner. No fertilizers are used in dry farming areas except in some very high rainfall regions and on a very limited scale. Both the means and the experience in the use of pest control on field crops are nearly absent.

Farming under Irrigation

As a result of the population pressure and of the unreliable output of dry farming, a great deal of attention

has been directed in Jordan in the last two decades to the expansion of irrigated lands. In 1953, the Agricultural census report estimated the irrigated land at 760,000 dunums. This figure is a gross over-estimation since it included all land registered as having any water rights rather than land which was actually irrigated. Table 11 represents an estimate of the present fully irrigated areas, which is collected from various sources and checked by the Irrigation Department in the Central Water Authority.

TABLE 11

Estimate of Irrigated Areas by source of Water (dunums)

Area	Ground water	Springs	Side Wadis	Yarmouk & Jordan rivers	Total Irrigated	Total Fully Irrigated
Jordan valley for area	———	———	———	49000	49000	49000
East Ghor						
Below Canal	———	———	———	117000	117000	117000
Other	27000	———	59000	9000	95000	71000
West Ghor	8000	10000	28000	———	46000	27000
Sub Total	35000	100000	87000	175000	307000	264000
Southern Rift Valley	———	———	26000	———	26000	26000
West Bank (Coast)	15000	———	———	———	15000	15000
Eastern Plateau	7000	5000	———	———	12000	5000
Total	57000	15000	113000	175000	360000	310000

The total fully irrigated area is estimated at present at about 310,000 dunums and an additional 55000 dunums, largely in side wadis, are only partly irrigated. More than 85 percent of the irrigated area is in the Jordan Valley, which is also the major potential area for expansion of irrigated farming. Another 8 percent is found in the Southern Rift Valley near the Dead Sea, and less than 7 percent is located in the uplands. The major sources of water utilized at present are the Yarmouk and Jordan rivers and the side wadis that carry water into the Jordan Valley. Underground water is of considerable importance in the southern Ghor area and the coastal area of the West Bank, and efforts are being made to develop such sources in the Eastern Plateau. Apart from pumping of ground water and limited pumping from the Jordan river to irrigate the Zor lands, irrigation in Jordan is effected by gravity. It is estimated that about 70-75 million m^3 of water are drilled annually from underground sources in the Jordan Valley and irrigate some 35000 dunums of land which is largely found on Wadi Shueib-Karameh area and wadi Kafrein-Hisban area in the East Ghor. Overpumping in these areas has resulted in considerable lowering of the level of ground water and has raised fears that it may cause an intrusion of the Dead Sea water into the Kafrein-Hisban aquifer. To guard against such a possibility, the government has prevented any further ground water development in these areas. Underground water

in the East Bank is being actively explored, particularly from the sandstone aquifer in the area between the southern highlands and AlJafr depression. The main available sources of irrigation water for the future remains the Yarmouk river and the side wadis, exploration of which for irrigation purposes (1964-1970), is included in Jordan's 7 year development program. The Jordan river water which is pumped to irrigate part of the Zor area has tended to become more saline in recent years due to increasing pumping upstream. The Northeast part of the Zor (19000 dunums) has moved to the use of East Ghor Canal water, supplied by gravity, but the remaining areas (49000 dunums) must await the completion of the Yarmouk irrigation project for further supplies of water.

Another general problem related to irrigated cultivation is the inefficient use of irrigation water. Wasteful overirrigation by pumping in the Zore is practiced. No measurement of the actual water application efficiency has been attempted yet in any area in Jordan. The improvement of yields and saving of water could follow from scientific studies of application efficiency and helping the farmer in adopting the more suitable regime for his crops under the scientific soil and climate conditions.

Major Irrigated Areas

A brief description is here presented of the main agricultural characteristics of the irrigated areas concerned in this study.

The Zor Area is the flood plain of the Jordan river covering 49000 dunums, of which 15000 are in the West Bank. Before the completion of the East Ghor Canal project all the area was irrigated from the Jordan river water by means of mechanical pumping but, at present, the Eastern Bank depends largely on gravity irrigation from the canal. The development of this zone was started on a large scale after 1948 as a result of the refugee movement from Palestine. At present, all the area is developed and used (as all land in the valley) mainly for growing vegetables, citrus and bananas. Since most of the recent alluvial soils of the Zor have a medium to light texture (sandy loam), it is suitable for all crops, including root crops such as potatoes, in addition to citrus and bananas. The lower calcium carbonate content of this land has made it more suitable for citrus production as compared to the Ghor area where the more calcareous soil material causes a deficiency of trace elements.

The North East Ghor region consists of those lands which extend from the Yarmouk river in the north to the Zarqa river and those which lie east of the river Jordan. This area of 117000 dunums is irrigated from the first section of the East Ghor canal project and another 42000 dunums above the canal are irrigated from side-wadis. Precipitation in this area is high (300-500 M.M.), soil profiles are more developed and textures are generally heavier

than in other parts of the valley. A series of alluvial fans provides topography which is generally favorable for irrigation practices and adequate surface drainage. Approximately 7 percent of the arable area presents subsurface alkalinity and salinity problems are relatively few and are confined to a few depression areas. This area is the best developed irrigation district of Jordan. It is provided with a modern, lined irrigation canal. Farm units measure about 30 dunums each. Water is delivered to the farmer on request against a charge of 1 fils/cubic meter. The major crops grown in this area are bananas, citrus fruits and tomatoes. Before the completion of the East Ghor canal project in 1961, only 14.9 percent of the project area was fully irrigated, while 58.5 percent was partially irrigated, 18.4 percent dry farmed, 6.7 percent left fallow and 1.5 percent was uncultivable. At present, all irrigated land is cultivated for winter crops. However, only 26-30 percent is under cultivation during summer because of insuffieient water supplies. The crop pattern in the project area, before and after the completion of the project is shown in table (12) below. It is observed that there was a big increase in the proportion of area under fruit trees (bananas and citrus) and vegetables at the expense of cereals and fodder crops. The Government has lately prohibited any further banana plantation until investigations are made to determine the maximum area of bananas which could be allowed

in the area without risking a water shortage. The decline in the area under fodder crops is largely apparent because the 1961 area included unirrigated grazing land and only a limited area of irrigated alfalfa.

TABLE 12

Crop pattern in East Ghor Canal project Area 1961 and 1963 (Percent of total area)

Crops	Before the Project 1961 (1)	After the Project 1963 (2)
Wheat and Cereals	48.4	38.2
Vegetables	40.7	45.0
Fruit Trees and (Citrus & Bananas)	3.7	16.0
Feed and Fodder	4.6	
Miscellaneaus	2.6	0.8
	100.0	100.0

1) Jordan, Department of Statistics, East Jordan Valley Social and Economic Survey. 1961.

2) Natural Resources Authority, Department of Irrigation.

The South-East Ghor extends from the Zarqa river in the north to the Dead Sea in the south. This area which is earmarked for development in the second stage of the Yarmouk Jordan irrigation project, covers approximately 334000 dunums, of which 189000 dunums or 57 percent are arable.

At present, only about 20000 dunums are under irrigation largely from underground water of uneven quality. The southern part is irrigated from side wadis such as Shueib, Hisban and Kafrein. The main crops are vegetables, wheat, citrus and bananas. Precipitation decreases rapidly from north to south and soil textures likewise become lighter in the southern sections. A gently sloping gradient characterises the majority of the area. Drainage problems are created primarily by the caving in of ancient water development works (known as fuquaras) and by the presence of localized artesian aquifers.

The Eastern Plateau has no more than 5000 dunums of irrigated lands, scattered in small plots over the whole area. Small areas irrigated from springs or surface water are found near Zarqa, Salt and Jerash. The utilization of ground water for irrigation has been under thorough investigation, and exploration for underground water has been under way. At present, only a few farms and small pilot projects are operating the Wadi Dhuleil and in the Azraq and Al Jafr depressions.

Problems of Irrigated Farming

The problems of irrigated farming differ considerably from those of dryland farming in Jordan. They include insufficiency of water for intensive cultivation, particularly in the summer, salinity and drainage problems, soil fertility problems, and high incidence of diseases and pests.

The insufficiency of irrigation water in the Jordan Valley in the summer has dictated a crop pattern which is not the best that can be obtained. Cereal growing under irrigation occupies a considerable part of the cropped area because it requires no water in the summer; banana and citrus plantations cannot expand, due to the scarcity of summer water. The completion of side-wadi storage dams and the increase in the capacity of the East Ghor canal should help to ease this problem in the immediate future until the construction of Khaled Storage dam on the Yarmouk river is completed, hopefully in 1969 (work on this dam have stopped since the 1967 June war).

The need to economize on water is partly reflected in the charges for the use of water in the East Ghor canal area. The present water charges are one fils (0.28 cent) per m^3 up to an application rate of 1500 m^3/dunum and 2 fils per m^3 for additional amounts. These rates have not been effective in restricting the demand for water; water charges represent an extremely small part of the cost of production and are no burden to the local farmer. While they may be barely adequate to cover the operational cost of the scheme they allow no return on the invested capital. In these conditions, there is a good case for raising the rates (e.g. doubling them) and making 7500 m^3 the dividing line between the lower and the higher rate, at least in the summer season. This would promote greater economy in the use of water. The increase in funds thus collected (which

could reach JD 100,000 or more/year) could be put in a fund to finance development of regional value in the valley, e.g. planting trees along canals, developing municipal services, etc.

As a means of saving water the case for sprinkler irrigation calls for consideration. Sprinkler irrigation involves high initial investment, possibly amounting to JD 30 per dunum, but this may be offset to a large degree by 26 percent saving of water and by reduced land development costs, since land-levelling and field channels would be unnecessary. The frequency and duration of high wind velocities must, however, be taken into account and this may be a limiting factor, at least in parts of the valley. Wind velocities of 10 km per hour reduce the efficiency of sprinkler irrigation considerably and at velocities exceeding 16 km per hour it becomes impracticable.

There is no agreement on the optimum crop pattern in the irrigated areas of the Jordan Valley although there is general agreement that greater emphasis should be placed on forage crops and industrial crops, as compared with vegetables and fruits which have been developed spontaneously in the newly irrigated lands. The great variations in the proposed crop patterns and the actual pattern in 1963 can be seen in Table 13 following. It will be noted from the table below that the anticipated crop pattern of irrigated land in 1970 reflects more or less the existing pattern except

that irrigation of cereals is not expected to continue and a beginning is expected to be made in expanding the area under forage and industrial crops (safflower). While such a crop pattern with its great emphasis on vegetable growing is not an ideal one, it would seem to be realistic in view of past developments and the experience of farmers in the Jordan Valley where most of the expansion will take place. Even so, some extra efforts would probably have to be made in order to achieve the small expansion which the plan anticipates will take place in the area under forage and industrial crops.

TABLE 13

Proposed and actual crop patterns in the Jordan Valley (percent of total area)

Crop	A1	A2	B	C	Actual 1963 East Ghor	Planned 1970
Winter Cereals	46	28	60	15	38	----
Feed and Forage	18	20	30	35	1	4.5
Vegetables	37	34	8	60	45	78.0
Fruit Trees	15	18	6	25	16	13.0
Industrial Crops	24	24	16	8	--	4.5
Total	143	124	120	143	100	100.0

IBRD Report, p. 104; 7-year program, derived from table on p. 160; Natural Resource Authority.

[A]Baker and Harza Report, patterns 1 and 2; percent of net irrigated area.

[B]International Bank Mission, 1955; percent of net irrigated area.

[C]East Ghor Canal Authority; percent of net irrigated area.

In the hothouse conditions of the valley the creation of uncontrollable pest and disease situations by continuous cultivation of tomatoes and other vegetables is an ever-present danger. Such situations have already risen in parts of the valley and significant areas of land have been abandoned because of the concentration of nematodes and soil borne disease organisms. A rotation which will check the incidence of pests and diseases and allow an effective field hygiene is, therefore, a necessity.

A practice which partly helps to maintain land productivity and reduce nematodes is the summer fallowing of extensive areas (perhaps two thirds of the Jordan Valley.) This practice seems to have been accidently adopted by farmers due to the absence of any valuable summer crop that could be grown profitably during summer. To be effective in reducing nemotides fallow land has to be deeply ploughed thus subjecting the surface soil to hot dry conditions during the summer.

Government efforts to encourage the growing of alfalfa and other legumes to improve rotations in the Jordan Valley have not been very successful so far. Its promotion derives from economic considerations as well as considerations of soil fertility.

It would seem that its spread in the Jordan Valley would require much greater incentives. Since no organized market exists for such a crop the preference for growing other

cash crops is understandable. It is reasonable to expect that alfalfa cultivation follow rather than preceed the expansion of dairy cattle farming in the valley and elsewhere. It is therefore recommended that preference be given to loan request by farmers to the ACC (Agricultural Credit Corporation) for the purchase of milk cows in the Jordan Valley on condition that an appropriate area in the farm would be devoted to alfalfa growing. Industrial crops have similarly found a place in all recommended crop rotations. The 7-year program promotes safflower but sunflower is now encouraged for commercial considerations. Research is continuing on various oil seeds the production of which might help meet part of demand for vegetable oils both for food and for industrial purposes. Cotton has been excluded due to relative cost disadvantages compared with neighboring countries, and through fear of high pest incidence. Beetroot production as a winter crop in the valley is being seriously considered, due weight being given to its usefulness as a rotation crop and as a source of cheap foodstuff.

Salinity and drainage problems are encountered in irrigated areas, mainly in the Dead Sea basin but also in the southern part of the Jordan Valley. The presence of marls, which have low permeability and saline deposits, leads to the formation of hard pan-like layers which result in a high

water table in these areas and cause drainage problems. Where the soil is shallow the very dry and hot climatic conditions encourage the movement of salts by evaporation to the surface and thus create salinity problems.[1] In anticipation of expanding the irrigation in these areas special attention will have to be given to meeting these problems simultaneously with the construction of the irrigation system.

An important characteristic of all soils in the Jordan Valley is their very low content of organic matter. This is due to the poor vegetation and the very dry and hot climate that prevails in the area, resulting in the very rapid decomposition of organic matter. As a result of the low organic matter content, total nitrogen is generally low and experience has indicated that most crops respond remarkably well to the application of nitrogen fertilizers.

The lack of organic matter has also created other soil problems. Poor soil structure is evident in many areas, especially in heavy soils whose compact clays cause physical limitation to plant growth. In light or sandy soil the absence of organic matter makes it difficult to improve the low water holding capacity of those soils and to raise their poor fertility potentials. These and other problems related to soil fertility in irrigated areas should be studied by

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[1]See F. Gruenberg, The Soils of Deir Alla Area, German Geological Mission in Jordan, 1965.

the new Soil and Irrigation Division with a view to finding practical ways of aleviating them.

Although the use of fertilizers is now common in irrigated lands, a reliable evaluation of plant response to various fertilizers has not yet been made in Jordan. Many fertilizer trials were conducted by the Agricultural Research Department and other agencies but failed to establish any basic and consistent information. The absence of reliable basic information on these matters in irrigated and rainfed lands does not enable the Extension Department to help farmers properly in the fields of soil management and fertilizer use. Wasteful use of fertilizers by farmers is therefore common. For example, large quantities of phosphorus fertilizers (in some cases more than 100 Kg. per dunum of single superphosphates) are used for a short period crop. This material is broadcast on the surface after land is prepared and planted without recognizing that the mobility of superphosphate renders it unbeneficial unless it is applied in the root zone. Many farmers use complete fertilizers containing a high percentage of potassium from which farmers get little or no economic response.

Farmers recognize the importance of organic manures but this material is not available in the valley. The number of farm animals in the valley is very small, and most animal manure in the valley and in the rest of Jordan is of low quality. This is mainly because farmers are not familiar with methods of composting and conserving animal manure. Some of

the farm manure is mixed with straw without the addition of inorganic nitrogen or phosphorus which results in very high calcium/nitrogen and calcium/phosphorus ratio. The practice of green manure is not known nor practiced by Jordan farmers.

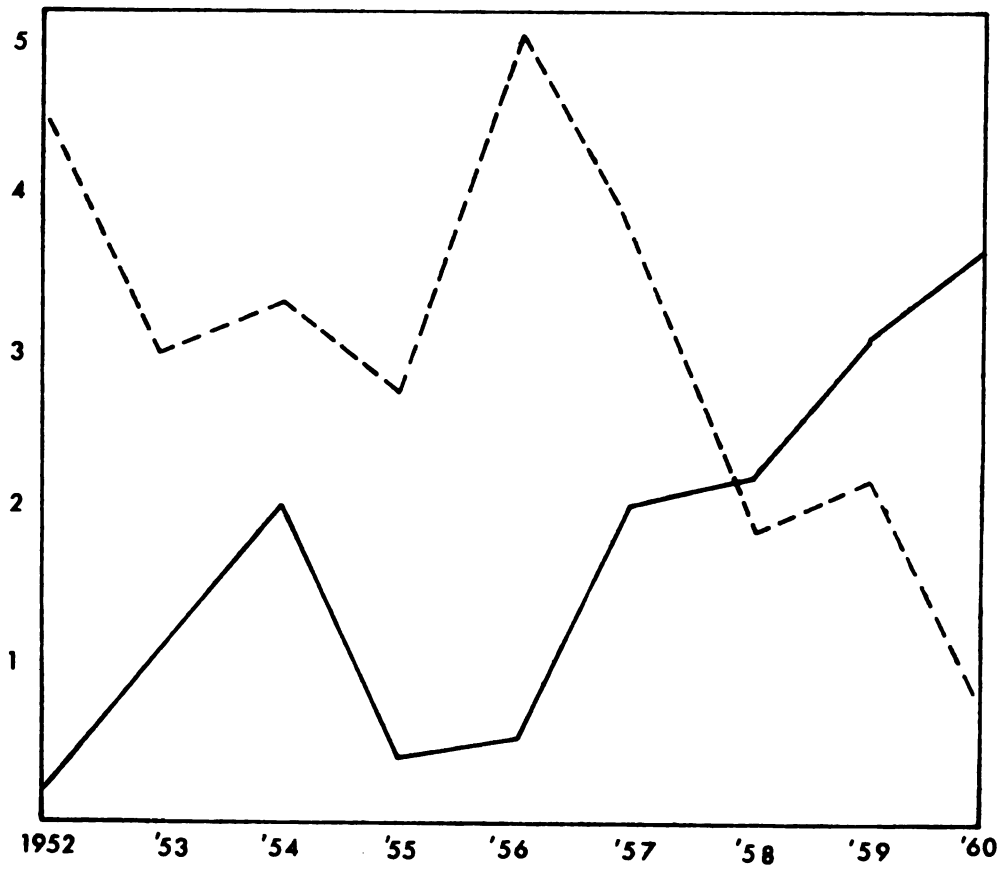
The Role of Irrigation in Agricultural Production

The foregoing discussion of agricultural production in Jordan has shown the importance of irrigation in the total picture of Jordanian farming. It is no exaggeration to say that the key to improved agriculture is further investment in irrigation.

In order to demonstrate the impact of water availability on the production of certain agricultural crops, agricultural data has been compiled from the statistical yearbooks published by the Department of Statistics of the Government of Jordan.

The impact of irrigation on Jordan's agricultural production is illustrated in Charts I to VIII. It should be noted that wheat, sesame, fruits and tobacco are non-irrigated crops, tomatoes, citrus and banas are irrigated, while olives, grapes and figs being drought resistant rely less on rainfall than most other non-irrigated crops.

CHART I



RECENT GROWTH OF TOTAL OUTPUT OF MAJOR IRRIGATED AND NON-IRRIGATED PRODUCTS

——— IRRIGATION (Growth Per Year Av.+ 16.5%)

– – – – – NON-IRRIGATED (Growth Per Year Av.–15%)

CHART II

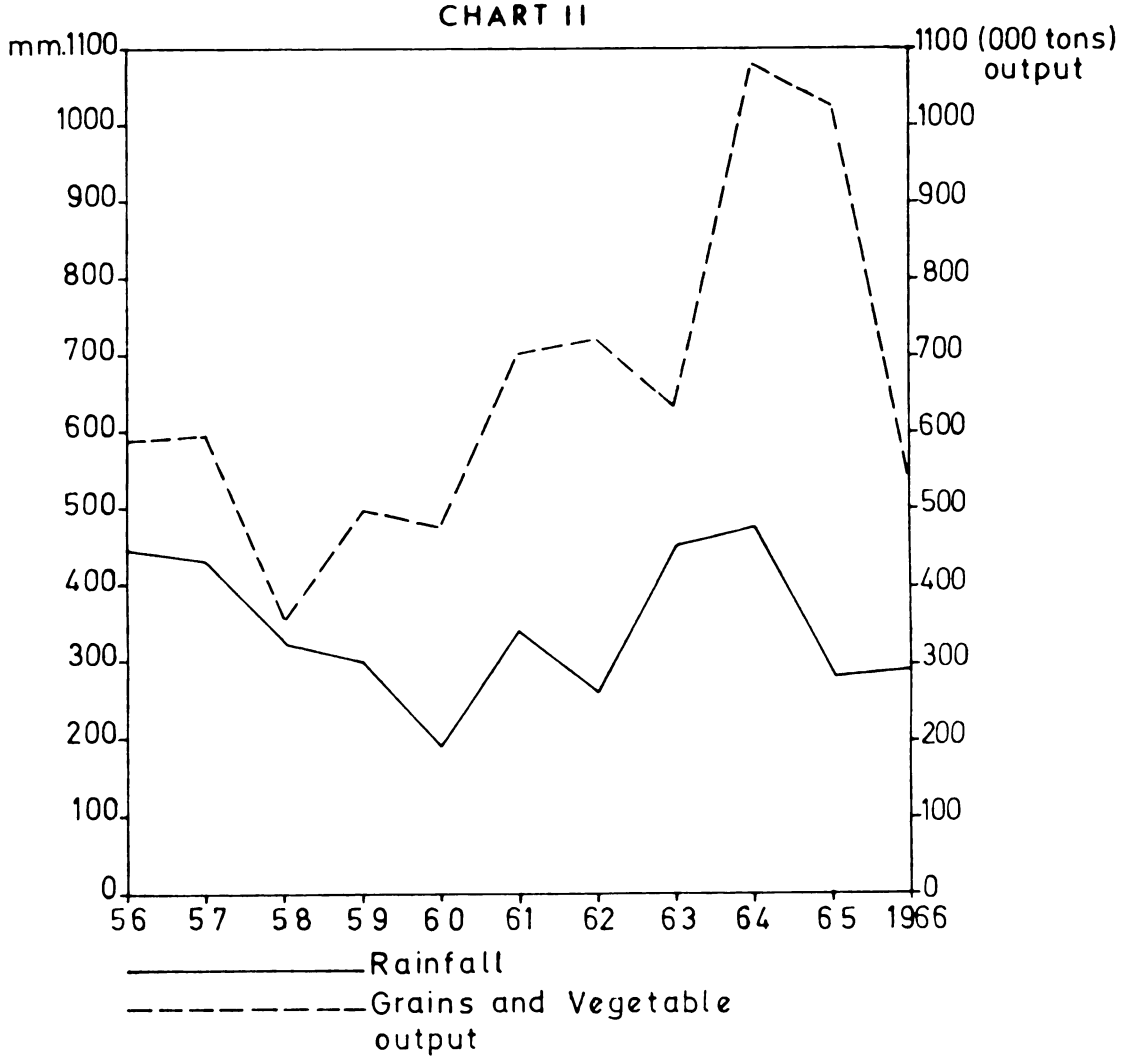


CHART III

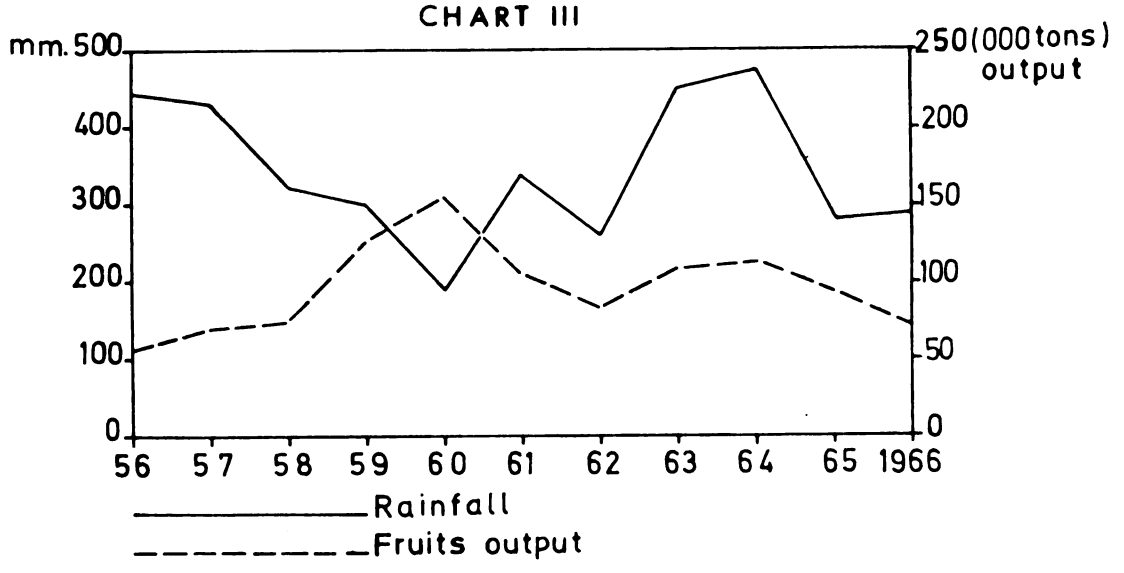


CHART IV

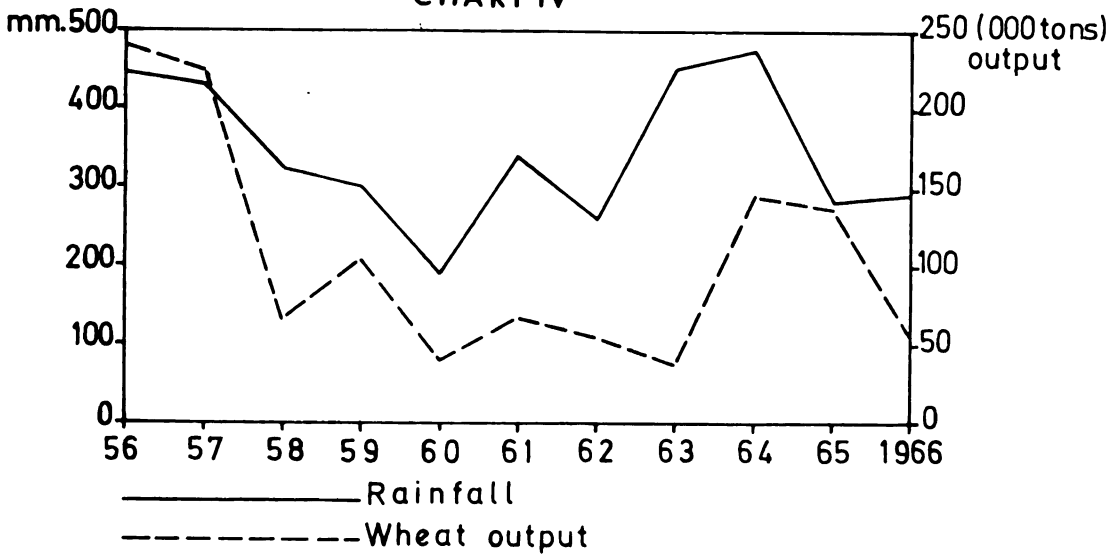


CHART V

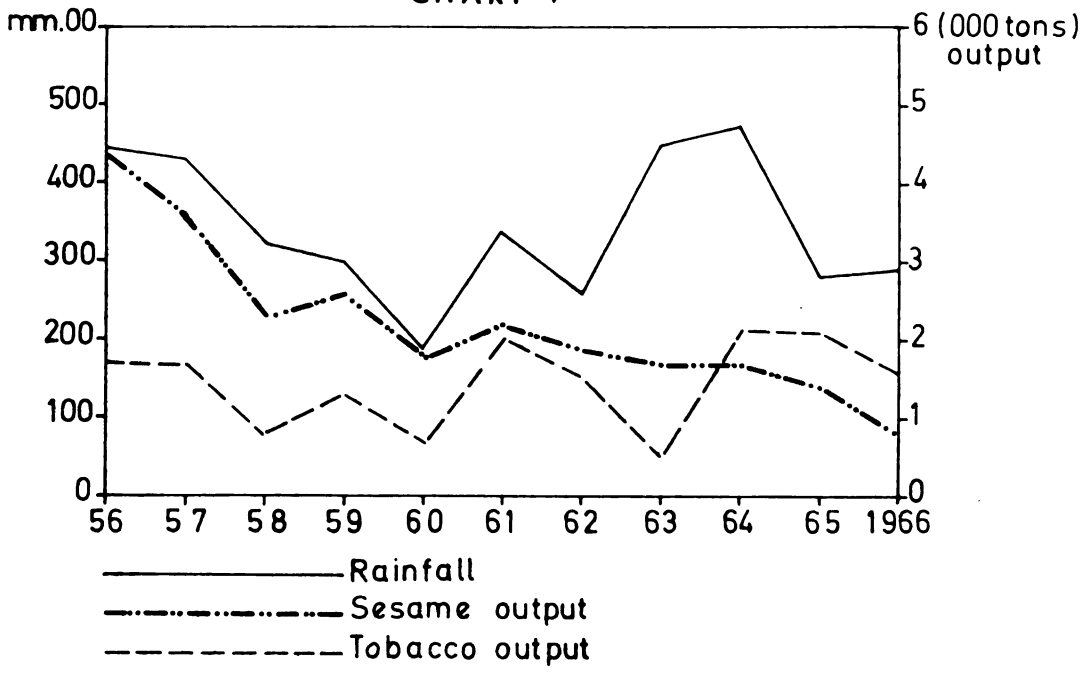


CHART VI

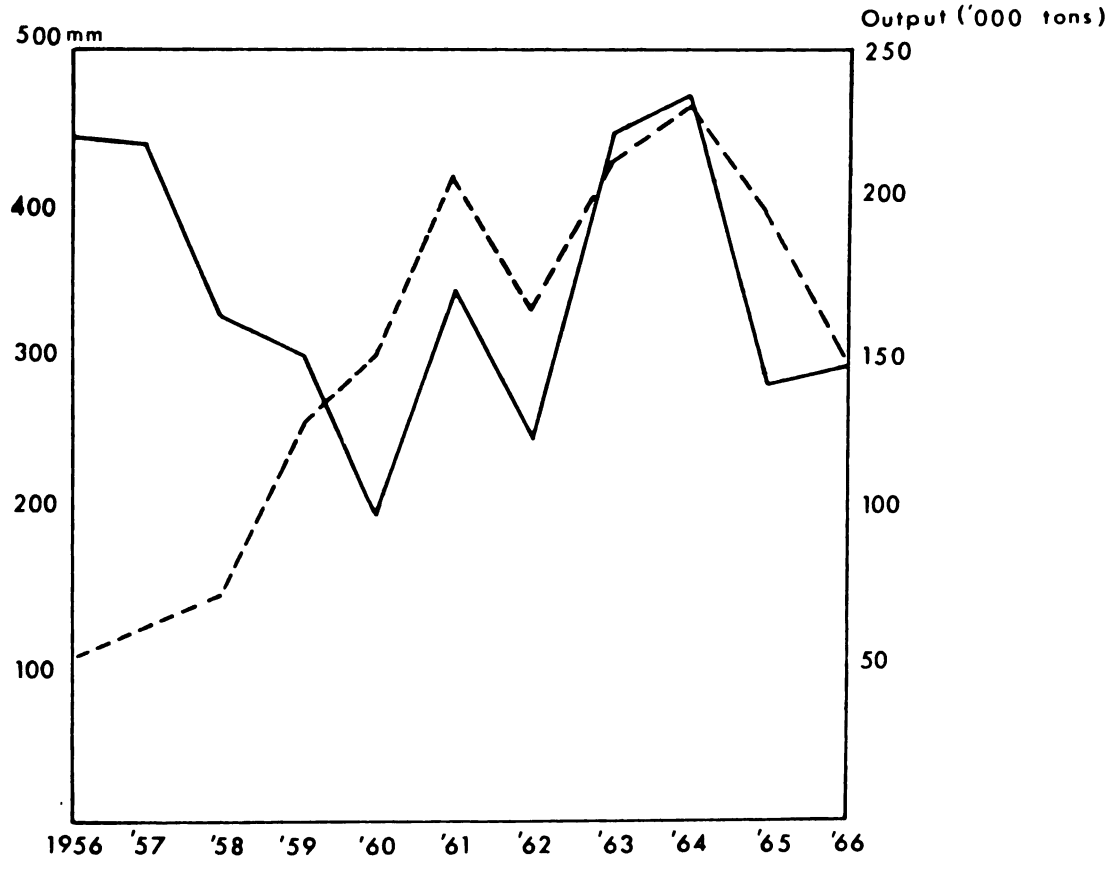
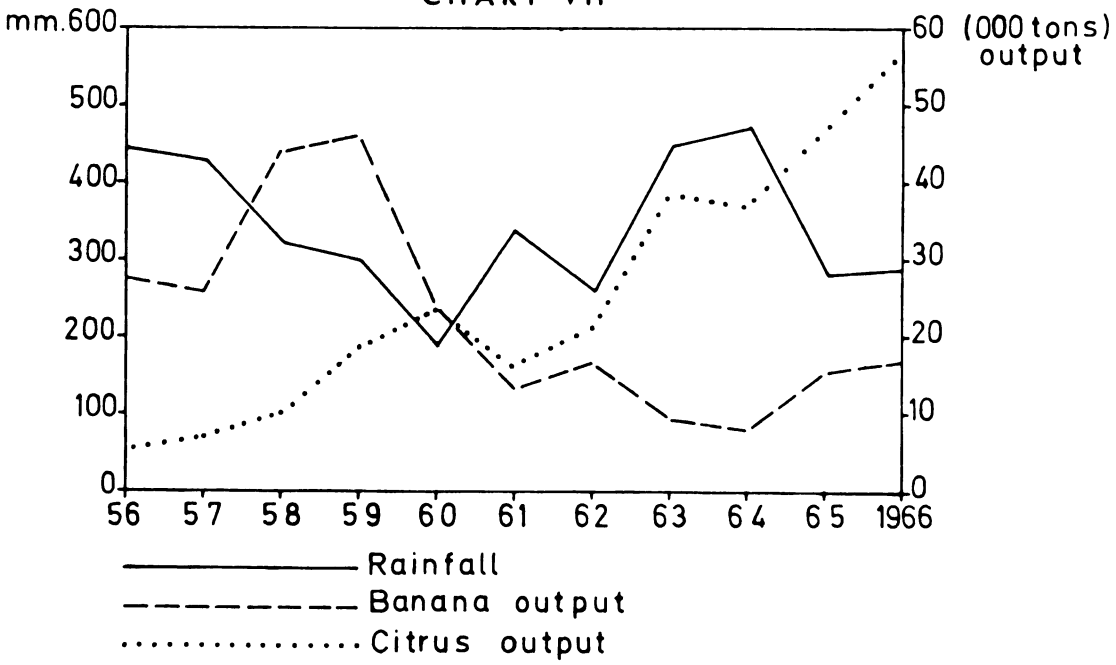


CHART VII



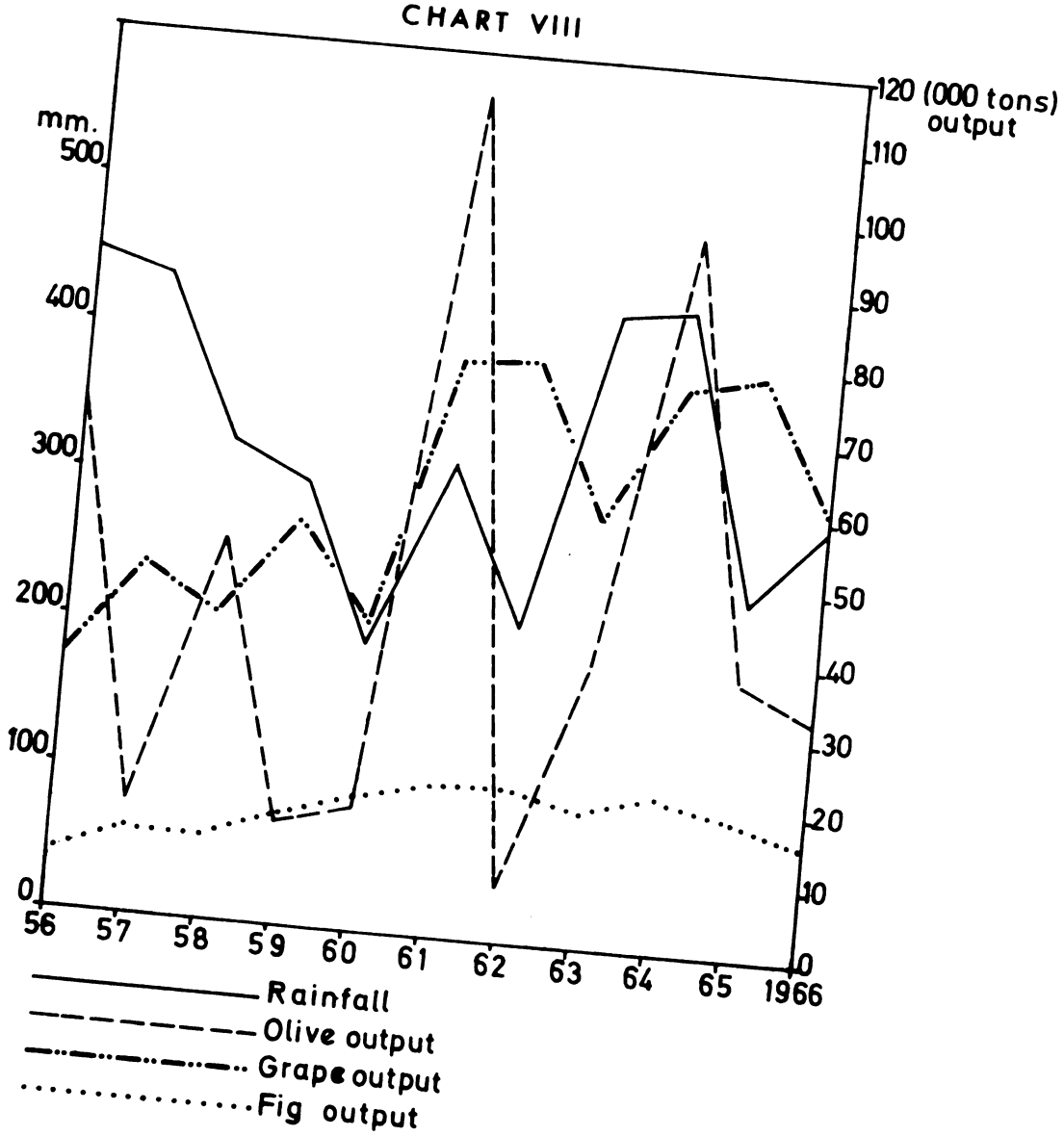


CHART VIII
mm.
500
400
300
200
100
0
120 (000 tons)
output
110
100
90
80
70
60
50
40
30
20
10
0
56 57 58 59 60 61 62 63 64 65 1966
Rainfall
Olive output
Grape output
Fig output

Chart I shows the relative stability and growth of irrigated products as compared to the relative instability and decline in trend of non-irrigated products. Chart II shows the predominant influence of Jordan's erratic rainfall upon grain and vegetable output which represent approximately 76 percent of Jordan's total agricultural crop output. Fruit output correlates positively with rainfall. The increased output of fruits in 1960, a year of lowest rainfall (Chart III) is attributed to the maturing of trees planted in the middle fifties.

The production of rainfed products wheat, sesame and tobacco as depicted in Charts IV and V illustrates the heavy dependence of these crops upon rainfall. The wide fluctuations in rainfall from one year to the next result in corresponding fluctuations in output of these crops and hence in income to the farmers. Since wheat is a major crop in Jordan, the government must import wheat in years of low rainfall.

Irrigated products such as tomato, citrus and bananas (Charts VI and VII) do not fluctuate with fluctuations in rainfall. The wide fluctuations in rainfall from one year to the next did not result in a corresponding fluctuation in tomato and citrus output. On the contrary, tomato and citrus output increased over the period which resulted in increased income and in exports. The banana is another irrigated product which is not affected by the fluctuation of rainfall. However, the next fluctuation in the banana

output from one year to the next, as seen in Chart VII, is due not to the rainfall fluctuation but is dependent upon the planting cycle applied to banana trees. Peak output of bananas therefore, occurs about every four years. The decline in banana output from 1960 onward as compared to the previous period is due to the fact that the area planted with banana during the latter period was about 52 percent of the area planted before 1960. In order to stabilize banana output a better rotation method should be followed. In any case, it is clear from the chart that the fluctuation in banana output is not due basically to rainfall, but to other causes.

Output of non-irrigated drought-resistant crops (Chart VIII) is not too much dependent upon rainfall. Olive yields during some of the low average rainfall years was better than yields in some of the good rainfall years. High and low outputs reflect the 3-4 year crop cycle. Fig output showed a slow but steady increase despite a sharp decline in rainfall fluctuations in certain years. Although grape output at times corresponds to rainfall fluctuations it is not wholly dependent on this factor. This is seen in drought years, 1959-1960, when output remained at the level of or exceeded that of good average rainfall years.

Study of agricultural data on these selected products, as depicted in Charts I-VIII, and the tables in the Statistical Yearbooks concerning these products lead to the following conclusions:

1. The total area cultivated with principal grains and vegetables varied considerably from year to year, but over the period has actually declined. Output of farm crops also fluctuated widely, and in 1960 total farm crops output was actually only about 72 percent of 1954 production, and about 79 percent of 1957 production. In most expanding countries output rises while agricultural acreage declines. Jordan's agricultural problem is therefore not being resolved in terms of aggregate performance.

2. The output of rain-fed products fluctuated considerably from year to year depending upon weather conditions, but over the period has seriously declined. In 1960 wheat output was only about 19 percent of 1954 production, and tobacco output was about 42 percent of 1956 production. This severe decline in output is due to the fact that average rainfall of 1960 was a little less than half of 1954 and 1956 average rainfall.

3. The output of irrigated agricultural products varied widely from year to year, but over the period sharply increased. During the worst 1960 drought year tomato output was actually 299 percent of 1954 production, citrus output was 1014percent of 1954 production, and banana output was 175 percent of 1954 production. This tremendous increase in output resulted from putting more lands to full production through irrigation and clearly demonstrated that the growth in output of irrigated products is little if at all affected by drought years. The growth in output of irrigated products

offsets the decrease experienced on the rain-fed lands during the drought years. The significant impact of irrigated output in Jordan relative to non-irrigated is revealed in the data in Table 14.

4. The output of products of the non-irrgated drought-resistant three types also fluctuated from year to year depending upon weather conditions, but not as much as had the output of rain-fed crops. Over the period, output of certain types of drought-resestant tree and vine crops slightly declined, while other types maintained about the same level of production. In 1960, for example, olive output was about 112 percent of 1954 production, the output of grapes was about 92 percent of 1954 production. This clearly indicates that the drought resistant tree type products are not nearly as seriously affected during the drought years as are non-irriagated cereals and other non-irrigated, non-drought resistant crops. This argues for more of such crops in areas of otherwise good farm potential, but where irrigation is not feasible.[1]

Clearly further investment in and development of irrigation in Jordan will have a positive effect on agricultural production, and thus on the total economy.

Mr. N. Simansky[2], past managing Director of the East Ghor Canal Authority, has emphasized the economic impact of

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[1] Prioritics in Jordan Agriculture....

[2] Simansky, N., "Economic Impact of Irrigations" in A Series of Seminars on Jordanian Agriculture , mimeographed, Jordan Development Board, Aman, 1962.

irrigation on the economy of Jordan. He pointed out that imports of agricultural products and other foodstuffs will decrease with the increase in irrigated lands, in addition to stabilization of crop production due to less crop failure and damage from droughts. Newly irrigated lands will create opportunities for employment not only for the new owners and their laborers, but also for those working in secondary and tertiary activities. All this leads to more prosperous communities and to an increase in the national income. Land reform and conditions of land tenure are usually associated with new irrigation schemes. These reforms will limit the fragmentation of property. Irrigation schemes may necessitate better conservation of land and water resources and serve as recreation areas.

Choice of crops

The identification above of certain irrigated crops raises the problem facing Jordan when establishing irrigation schemes of what crops to produce in these irrigated areas and whether Jordan is producing the right types. Should more food crops be raised for local consumption or should products be grown especially for export?

In determining what are the right products to produce in Jordan, it may not be sufficient to expect that Jordanian farmers are capable of deciding this for themselves. While this may be true under the conditions of soil and climate with which the farmers have to work, it is very often beyond the capacity of the farmers to decide whether the circumstances themselves should be or can be

changed. For example, dry farming techniques may be forced upon the farmer as the only means for achieving the maximum results with the given rainfall pattern and the soil structure imposed by nature.

However, it may not be within the power of the farmer to change the dry farming tradition through irrigation. An irrigation system may have to be established by the Jordan government, as in the case of the East Ghor, before the farmer can learn to produce those products which will maximize the gains for himself and for the country. Similarly, a farmer may go on producing the same products even after an irrigation system has been installed simply out of habits of farming which cannot be changed without instruction and provision of security against the chance of failure when he tries the new crops.

The most suitable agricultural products cannot, therefore, always be determined, in transitional phases of improvement, by the farmers themselves.

What criteria then, will determine the correct choice of farm products? A review of the historical pattern of farm production is necessary to gain insights into this problem. Rainfall is very erratic in Jordan from one year to the next and as we have seen, production of those crops which depend on this rainfall also show an erratic pattern. If we return to chart IV, which shows the historical pattern of wheat production as related to rainfall we notice that the record is very erratic, in common with other crops in Jordan

which depend on rainfall. Thus, total agricultural production suffers from considerable fluctuations because of the predominance of such non-irrigated crops. Such fluctuations are, of course, reflected in erratic incomes to farmers and in the loss to other sectors of spending which farmers must forego in bad years.

From this brief picture, one criterion for determining at least what not to produce may be gained. The erratic behavior of wheat production is chronically disturbing to farmers and to the country as a whole. Some flexible cropping patterns should be developed which will mitigate the effects of this erratic wheat production, Jordan's largest crop in terms of tonnage.

On the other hand, chart VI shows the same relationship between tomato output and rainfall. The evidence indicates that for various reasons the growth of tomato output has escaped the dependency upon an erratic rainfall. To a significant extent, this may be attributed to irrigation. A similar pattern can be shown for other irrigated crops.

This evidence seems to suggest that those products which can be liberated from the effects of an erratic rainfall would be the best to produce in Jordan. This would be the simplest, but by no means necessarily always the only conclusion to be drawn from the simplified examples given. It would mean greater emphasis on promoting and developing to the maximum the irrigation potential of the country. Production statistics of irrigated and non-irrigated crops support this conclusion, as shown in table 14. The change in the

output pattern between 1952-1960 is particularly dramatic, as the latter years experienced serious drought. The 1961 rainfall was better and rain-fed products showed a sharp improvement. The role of irrigation in stabilizing the growth in output in many cases is clear.

Given an irrigation system, the farm products which should be produced are not necessarily the same as would be produced without such a system. The farmers in such cases must be trained to produce those products which will utilize the irrigation system to the optimum. This may require that farmers be taught to produce crops they do not like to produce, or do not want to produce, or do not know how to produce. They may have to learn to market in an entirely different way from the product marketing practice that they had been using, prior to the installation of an irrigation system.

TABLE 14

Production of Major Non-Irrigated and Irrigated Products in Jordan 1952-1961

	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Rainfall	———	404.9	439.3	252.8	4481	427.3	321.6	300.3	192.5	350.0
Total Production (000 tons)	658.4	538.5	651.1	351.2	725.9	698.7	675.5	617.3	571.2	810.0
Non-Irrigated										
Wheat	225.2	99.7	233.3	79.4	242.5	219.8	65.6	103.5	43.6	130.0
Barley	92.5	42.9	104.2	25.4	96.2	80.6	16.8	62.0	13.3	62.0
Sesame	4.4	3.6	4.3	3.5	4.4	3.6	2.3	2.6	1.8	2.2
Olives	62.4	49.2	———	12.0	71.5	14.9	52.4	11.2	16.7	21.7
Grapes	48.8	41.0	———	31.6	37.0	47.0	42.6	54.1	43.3	78.4
Figs	17.9	61.2	———	7.6	12.7	14.7	14.3	14.7	17.7	20.9
Total	451.2	297.6	341.7	159.5	464.3	380.6	794.0	212.1	136.4	315.3
Irrigated										
Tomato	27.8	40.4	52.1	48.0	52.2	65.4	74.4	126.1	155.6	214.0
Cucumber	58.2	77.1	125.8	48.2	68.1	109.4	77.3	105.0	90.0	41.0
Eggplant	7.4	9.6	12.9	11.3	12.2	13.1	22.1	34.3	51.5	52.0
Other Vegetables	5.9	7.3	12.7	8.6	6.9	8.6	10.2	21.2	20.3	30.0
Citrus	0.7	1.9	———	1.0	1.5	2.0	3.1	5.8	7.1	16.3
Banana	6.5	7.4	———	13.5	8.2	7.7	13.1	13.7	7.2	13.8
Total	106.5	143.7	203.5	130.6	149.1	206.2	200.2	306.1	332.4	367.1

Total production of all cereals, fruits & vegetables. Products included in Table includes on the average approximately 85 percent of total output.

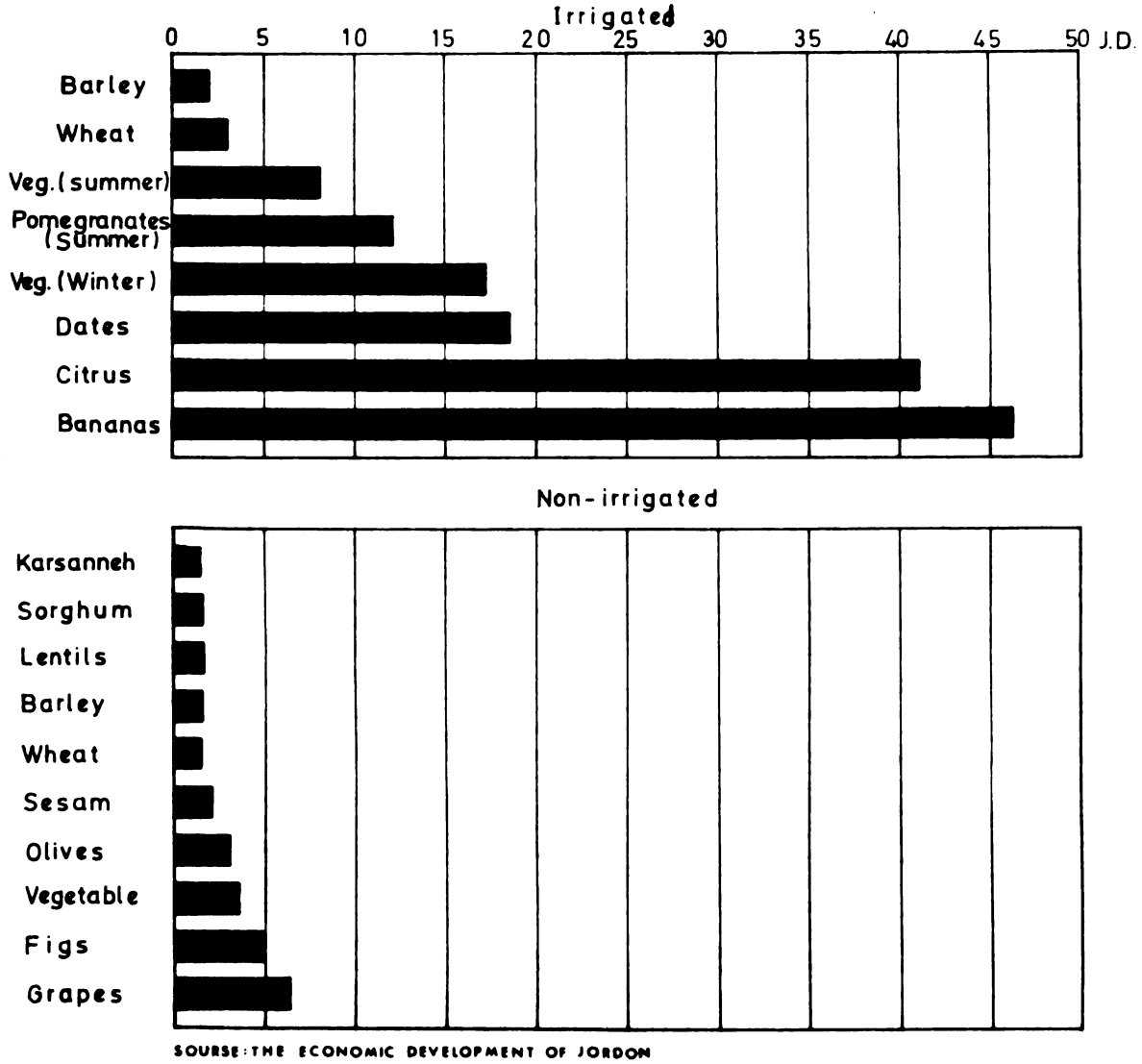
Statistical Yearbooks, different years.

Imports offer another guide as to what to produce. The question arises whether the country should try to promote import substitution. For example, Jordan imports substantial amounts of vegetables and citrus fruits which it produces itself. The decision must be made on the basis of objective studies whether more is to be gained on the principle of comparative advantage from producing high yield per dunum products and selling them abroad, while importing those products which bring only a low yield per dunum at home. The role of irrigation in Jordan and the role of import substitution as a guide in determining what to produce will probably be closely related.

A further insight into these issues is seen in chart IX which shows the value per dunum of certain major irrigated and non-irrigated crops in Jordan. Given the maintenance of a costly irrigation system, it is imperative that crops be chosen which will pay for the system and also bring the maximum returns from a combination of domestic and export sales. Once these determinations are made, farmers, especially those newly attracted to irrigated lands, should be assisted in learning the techniques in promoting such crops.

CHART IX

Value per Dunum of major irrigated and non-irrigated crops in Jordan.



SOURSE: THE ECONOMIC DEVELOPMENT OF JORDON

CHAPTER III

PRESENT IRRIGATION SCHEMES

We have seen the undoubted benefits that irrigation will bring not only for the future development of Jordanian agriculture along but also for the economy of the country as a whole. We shall now consider the existing irrigation schemes both for their importance to the economy and as a guide for the development of future areas.

By far the most important new irrigation scheme in the whole country both in terms of present irrigated area and future expansion is the East Ghor Canal. Before examining this scheme we shall have to look first at the water resources available for present and future use in the forms of the Jordan River and several of the side-wadis of the Jordan, extending from the Wadi Yarmouk on the north to the West Zerqa on the south.

The Jordan River

Next to the East Ghor Canal the most important area of irrigation at present is the Jordan River Basin. The Jordan River Basin is unusual in that the Jordan Valley was originally formed by the down faulting of a long strip of land about 20 kilometers wide and not by the erosive process of natural drainage. Natural drainage systems have of course

developed on the flanking escarpments forming what are referred to as the 'side-wadi'. On the eastern side of the Jordan Valley the two side-wadis, the Yarmouk and Zerqa, have cut back far enough to capture parts of the internal drainage systems of the eastern plateau, and as a result have much larger catchment areas than the other side-wadis.

The Jordan River Basin whose catchment area amounts to about 17000 square kilometers, can be conveniently divided into two parts. The upper Jordan River flows into Lake Tiberias and its catchment, comprising 16 percent of the total catchment area of the Jordan River Basin, lies entirely outside Jordan territory. The lower Jordan River flows from Lake Tiberias to the Dead Sea and collects the important flow contributions of the Yarmouk and Zerqa on the way. It lies mostly within Jordan (9300 square kilometers) but partly in Syria (5000 square kilometers).

The average annual precipitation in the Jordan River Basin is about 450 mm., The average precipitation varies from more than 1500 mm, on the slopes of Jebel Sheikh (Mount Hermen) to about 100 mm. on the north shore of the Dead Sea.

South of Lake Tiberias the Jordan River follows a meandering course across the silts and gravels of the Rift Valley floor, an area known to the Arabs as the "Ghor". In these deposits the river has cut a minor valley, known as the "Zor", up to a kilometer in width. The main channel of the lower Jordan is between 20 and 30 meters wide, but during the

larger floods it overflows its banks and may inundate the Zor completely. The distance between Lake Tiberias and the Dead Sea is 105 km. but because of meanders the river length is 320 km.

The major tributaries of the lower Jordan are the Yarmouk and the Zerqa both of which have a substantial perennial base flow. In winter most of the flood flow in the lower Jordan comes from these two tributaries. A number of the other side-wadis also have perennial base flows, notably wadis Arab, Ziglab, Yabis, Kufrinja, Rajib, Shueib, Kafrein and Hisban on the East Bank and Wadis Faria, Auja and Qilt on the West Bank.

The discharge of all the side-wadis, including the Yarmouk and Zerqa, consists of two main components which are sharply defined.

The main component is the base flow which is derived from ground water discharge mainly through springs. Typically this is fairly constant with relatively small annual and seasonal pluctuations.

The second component is the flood flow derived from storm rainfall. These flood flows are of typical flash type, rising in a few hours or even in less than an hour, and receding in a few hours or at the most, days.

In the case of the East Bank side-wadis the flood hydrographs are typically multi-peaked because the main storms always move up the catchments, and consequently there is a marked tendency for the flood flows of the tributaries to move down the main channel in succession rather than to compound

themselves into one single-peaked flood. Another curious feature of the flood runoff in the side-wadis is not because the down stream parts of the catchment lie in the high rainfall zone the flood flows from the lower tributaries tend to be greater than from the upper tributaries. This effect is further compounded by the fact that catchment and channel slopes in the downstream parts of the catchment are generally steeper than in the upper parts which once formed part of the eastern plateau so that runoff from the lower tributaries tends to be more intense.

This typical sequence is particularly noticeable in the case of the Yarmouk where flood flow from one of its tributaries (Wadi Ragaed) preceeds, and exceeds, flow from the upper Yarmouk. The irregularity and varied intensity of these floods (which occur only during the winter season) create problems of water control. Small diversionary dams and structures built by the farmers may be destroyed during a particularly violent flood. The construction of new large dams will effectively control much of this flooding and by storing the excess water will help to regulate the flow of the wadis.

Present water use and irrigation practices in the Jordan Valley

Irrigation has been a feature in the development of agriculture in the Jordan Valley since the earliest times of which there is any record. Evidence of old works indicates that at one time this area was much more highly developed and more intensively cultivated than today, supporting a population considerably larger than the present, and permitting export of agricultural products to surrounding areas. Some of these early developments, principally among those constructed during the time of the Roman occupation, continue in use even now. Earlier prosperity, resulting chiefly from the nearby overland trade routes, created a demand for the produce of the Valley. However, because of changes in the trade routes and movement of population centers, this demand diminished and irrigation works were neglected to the point where most of them became inoperative.

At the present time, to varying degrees of intensity, water for irrigation is supplied by gravity flow from the Yarmouk and Zerqa Rivers, by pumping from the Jordan River, by gravity flow from perennial wadis, by springs, by wells, and by ancient fuquaras constructed for development of ground water. There have been only minor attempts to coordinate these

sources of water, and no plan integrating all water supplies into one system providing optimum development of the Jordan Valley has ever been put into effect.

Irrigation from springs and wells

On the East Ghor 1960 dunums lying in the Wadi Arab area are registered as irrigated from Duga Spring, located about 4 km. above the mouth of the wadi. In the wadi Jurum area 2660 dunums within the irrigated area about 2 km. west of the diversion dam, and certain minor areas, particularly in the vicinity of Wadi Shueib, wadi Kafrein, and Wadi Hisban, receive either a full or supplemental supply of irrigation water from wells.

Few of the wells used for irrigation have been in useful intensive production long enough to establish the recharge rate. Furthermore, in many of the wells the quality of the water is questionable except for the production of highly salt tolerant crops. Particularly in shallow wells the quality may be expected to deteriorate as intensive irrigated agriculture is developed in surrounding areas.

Irrigation from ancient works

Evidence of 22 Fuquaras, constructed during the Roman occupation for development of ground water, has been discovered in the Jordan valley. Two minor areas continue to receive irrigation water from these ancient sources. The flow from one fuquara is used to irrigate an area on the East Ghor north of Wadi Shueib, and the flows from these fuquaras have

been conbined to irrigate an area on the west Ghor north of Wadi Fari'a. It is also probable that many of the springs within the Jordan Valley are the only remaining outward manifestations of other historical developments which have become blocked through lack of maintenance.

Sub-surface Drainage

Presently very little use is made of subsurface drainage waters. There are some instances where shallow open ditches have been constructed for draining high water table areas and such water has sometimes been used for irrigation purposes, but as a whole, facilities for subsurface drainage of such areas are inadequate. These are certain locations in the northern part of the East Ghor where subsurface waters find their way to the Zor below and these waters are reused for irrigation and for livestock and domestic water. In some instances drainage water has percolated through soils of a saline nature and the use of such water has done much to lower production on the Zor lands.

Irrigation Methods

Irrigation methods are influenced to a major degree by the source of the water supply. In many cases water is available in relatively large quantity for a short period of time. The tendency is to use a large head of water with no regard for the water intake rate of the soil or topographic features of the land. In such instances, as most field head ditches are unlined, a degree of erosion takes place which eventually eliminates their usefulness and new ones must be

constructed. Such practices also tend to spread a given amount of water over a large area with inadequate penetration at any one place. Cereals which are generally irrigated with a semiwild flooding technique, seldom receive full benefit from water applied in this manner.

Vegetables and fruits are usually irrigated by the basin methods. Good distribution of water is generally obtained with a minimum of waste.

Irrigation methods used for certain crops

At present mainly the zig-zag system is applied in irrigating vegetables. The advantage of the zig-zag system is that less levelling is required than e.g. in furrow-irrigation. Disadvantages are the labor-intensive digging required for the zig-zag system and the impossibility of mechanized intercultivation. As labor will become expensive over time these disadvantages will count more heavily in the future. Therefore it is likely that a change to furrow-irrigation will be made in the future.

Irrigation of one dunum by the zig-zag system takes about 0.1 man-day at present. The labor requirements for this type of irrigation in vegetable growing in the U.S.A., where syphons and canvas dams are used, show that some reduction will be possible. For this reason it has been estimated that labor requirements for irrigation of one dunum will have been reduced by 25 percent by the year 2000.

The number of applications of irrigation water depends mainly on the season. For tomatoes, eggplant,

squashes and potatoes the calculations are based on one irrigation in Dec. and Jan. and 2-3 irrigations in Nov. and Feb. In the other months irrigation water is applied once a week. For cabbage, cauliflower and beans 2 irrigations are assumed in Dec. and Jan. and weekly irrigation in the other months.

Irrigation of Wheat

At present wheat is usually irrigated by means of wild flooding. Under the assumed higher standard of wheat-growing in the future a transition to basin irrigation will be imperative. The number of applications of irrigation water, at present being no more than 2 or 3 during the growing season, will increase to about 7 in 1990 and 2000. There is hardly any difference between the labor requirements for the irrigation of cereals and that of vegetables.

Irrigation of fruit

Both basin and furrow irrigation may be applied in fruit tree cultivation. Bananas are irrigated with weekly intervals under present conditions, except in December and January when 1 or 2 irrigations per month are common. Also citrus is irrigated with weekly intervals at present, except in November and February when 2 irrigations per month are normal practice, and in December and January when the trees are usually not irrigated at all.

Present Yields

Yields are considered to be low although they are reasonable compared with those in other developing countries particularly for vegetable and fruit crops. The wide

range in yields which was found for individual crops is an indication that there is much scope for improvement. Certain factors responsible for these variations cannot be controlled such as climate and soil; others such as drainage, irrigation, farm management, fertilizer applications and pest control may, however, be improved over time.

Cold winters have a harmful effect on the yields of tomatoes and bananas. The tomato crop is sometimes a total loss locally and the yields and quality of bananas are substantially reduced. Hot and dry wind in spring damage the flowers and young fruits of citrus trees.

Soil textures and soil structures do not seem to be responsible for the variations in yield. Exceptions are the low-productive heavy soils in the north which require drainage. Low yields owing to salinity are reported, but this is rather a matter of quality of the irrigation water and of irrigation techniques than of soils.

Present variations in yields are especially due to differences in water supply, fertilizer application, insect control and farm management.

The present yields are shown in the Table below; they are given as an average of bad, reasonable and good years.

TABLE 15

Present Yields[1]

Type	Kilogram per Dunum
Wheat	150
Maize	200
Tomatoes	1200
Eggplant	2000
Peppers	700
Cabbage and Cauliflower	1500
Broad Beans	600
Cucumber and Squash	750
Potatoes	900
Onions	750
Citrus	700
Bananas	1500

[1]Department of Statistics, Statistical Yearbook, 1966.

The Yarmouk River

The Yarmouk River is the largest tributary of the Jordan, its catchment area being about 6800 square kilometer or 40 percent of the whole Jordan River Basin. About 1800 square kilometer of the Yarmouk catchment lie within Jordan, the remaining 5000 square kilometer lie within Syria.

The Yarmouk River originates at the confluence of three tributary streams, the Wadi Shallalah which rises in north Jordan between Irbid and Mafraq, the Wadi Zeizoun which rises near Muzeirib in south Syria and the Wadi Allane which rises near Nawa, also in south Syria. These tributaries join just upstream of Maqarin; a town located south east of Lake Tiberias.

These three wadis drain the rolling plateau country of the east Yarmouk catchment, but downstream of the points at which their perennial base flows rise they begin to enter deep canyon-like valleys which join at Magarin to form a gorge several hundred meters deep. Several proposals have been made for building a dam in this gorge.

From Maqarin the Yarmouk flows westward to join the lower Jordan about 7 km. south of Lake Tiberias. In this lower reach there is a minor addition to the base flow from springs at ElHemmeh, about 8 km. from the confluence with the Jordan, and the Wadi Raggad, whose catchment is the main source of flood runoff in the Yarmouk, joins the Yarmouk from the north.

The Yarmouk is the major supplier of water for the East Ghor Canal which will be discussed later. The purpose of

the Khalid-Bin-AlWalid dam on the Yarmouk is to store water to supply the canal during the summer months, when the base flow of the river is low and when the demand for water is greatest. Work on this dam was stopped during the 1967 Arab-Israeli War and has not been renewed yet. Another purpose of the dam is the irrigation of lands below the dam.

Irrigation

Nine thousand dunums of land in the Jordanian section of the Yarmouk basin, mostly at Adassiya and Baqura, are being irrigated by simple diversion of water. Few hundred more dunums are irrigated from the Yarmouk and scattered all along its course.

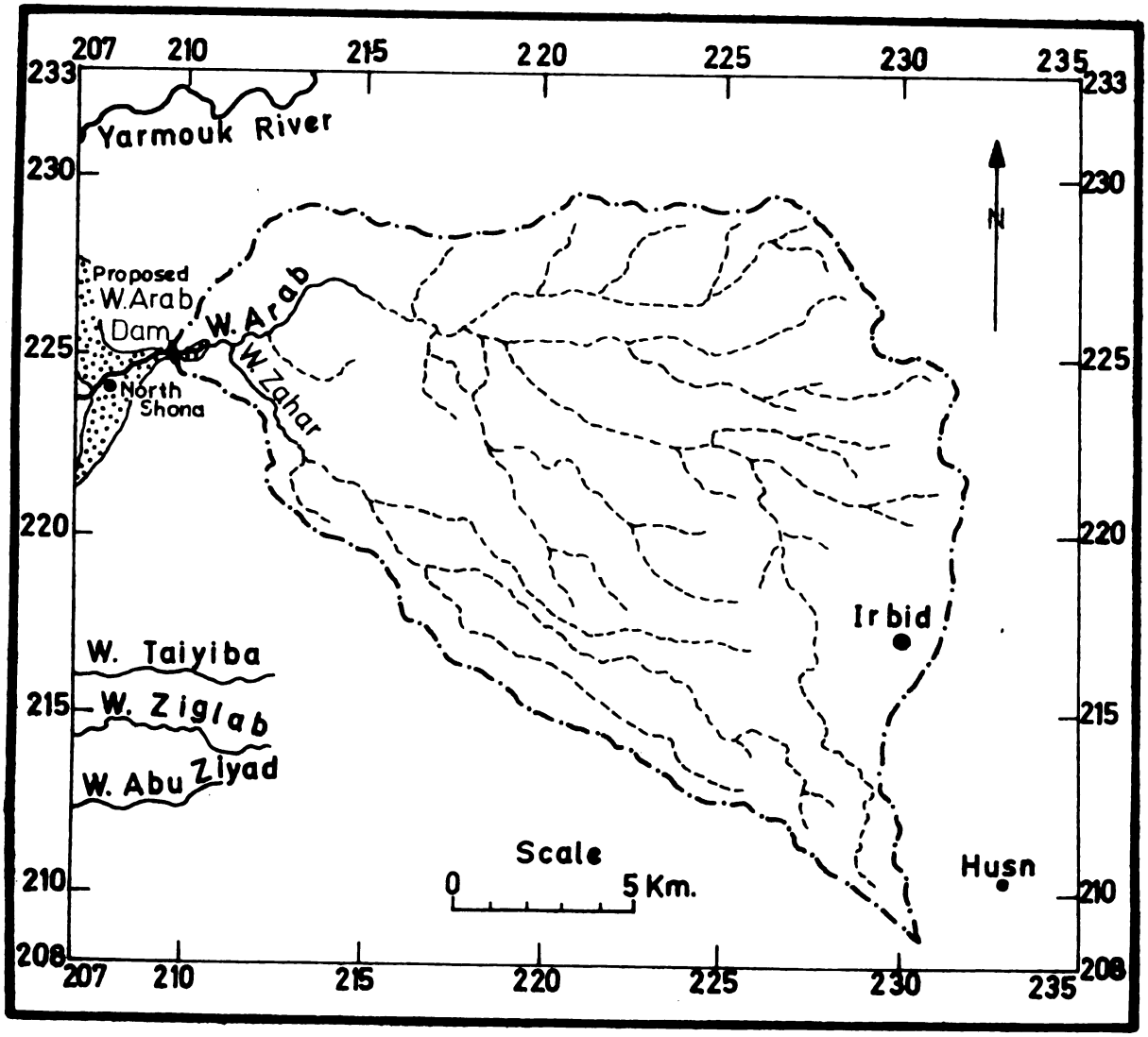
Vegetables, bananas and citrus are intensively cultivated. At present, most of these areas are not fully utilized because of the military situation in the area.

Wadi Arab

The most northerly of the side-wadis is the Wadi Arab. Its catchment area is about 265 square kilometers and ranges in height from 850 meters above sea level just south of Irbid to 140 meters below sea level where it enters the Ghor. (Map 10)

The source of the base flow in the Wadi Arab is from springs in the Wadi itself and from springs in its tributary Wadi Zahar. Because of the abundance of this base flow a proposal has been made to build a conservation dam. A proposal has also been made to build a dam on this Wadi as a part of the total utilization of the water resources of the Yarmouk Jordan plans, according to which it would receive directed Yarmouk water. Just upstream of the Wadi's entrance into the Ghor, near the town of North Shouat, a concrete diversion weir and canal system have been built which divert and utilize the base flow. Prior to the construction of the East Ghor Canal, this irrigation scheme irrigated about 16 thousand dunums. The East Ghor Canal Authority has now acquired most of the Arab water shares of the areas commanded by the canal, except for 3775 dunums which are still served from the Arab irrigation scheme. At one place, the East Ghor Canal is taken underneath the Arab irrigation canal by means of a siphon, and in two other places the Arab water is carried over the East Ghor Canal by means of pipes. The main purpose of the proposed Wadi Arab reservoir is to store excess discharge in the Wadi

MAP 10



Wadi Arab Catchment

Irrigated area

Arab during the winter months, when there are adequate supplies in the Yarmouk for the East Ghor Canal system and releases water during the summer months when the Yarmouk is deficient.[1]

The average rainfall in the catchment area varies from 550 millimeters near Irbid down to 400 millimeters at the Ghor. This amount of rainfall provides for good rainfed agriculture in the area.

Irrigation

There is intensive cultivation through irrigation along the wadi wherever there is sufficient local widening of the wadi floor. Most of these areas are planted with bananas. On the areas served by the Wadi Arab irrigation scheme, bananas also are the principal crop, particularly south of the town of North Shouat and along the south bank of the Wadi. To the north and west of North Shouat the irrigated land is under vegetables, with some maize, and in the vicinity of Baqura citrus groves and nursery plantations predominate.

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1) Sir M. Macdonald and Partners, East Bank Jordan Water Resources, Vol 2., Eash Ghor Side Wadis, Lion House London, 1965. (The study was prepared for the Jordanian Central Water Authority)

Wadi Ziglab

The next significant side wadi to the south of Wadi Arab is the Wadi Ziglab, with a catchment area of about 100 square kilometers. (Map 11)

The Ziglab catchment mainly consists of steep hill sides with the drainage channels in deep valleys. Much of the upper catchment, which has a maximum elevation of 1050 meters above sea level, has low natural forest cover but is partially cultivated. Part of the lower catchment, particularly around Deir Abu-Said is rich loamy soil on which fruit, vegetables and grain crops are cultivated without need of irrigation.

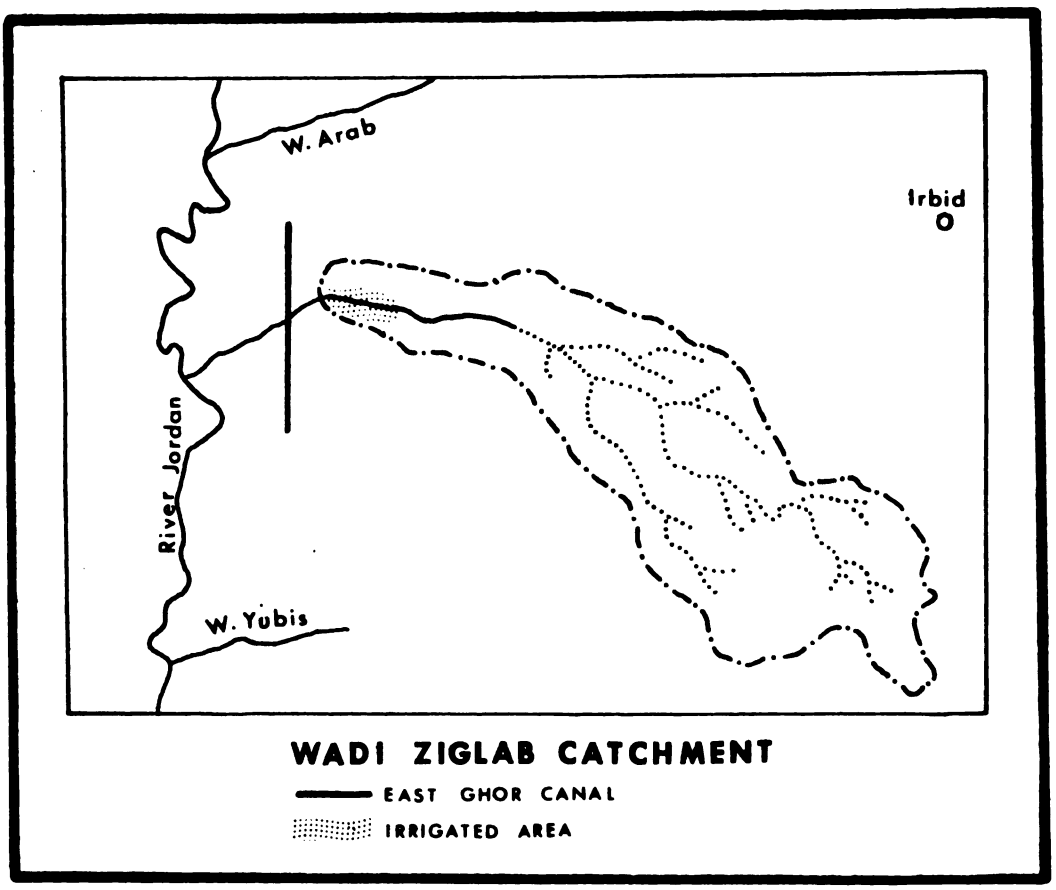
The average rainfall again varies from about 550 mm in the headwater area down to about 400 mm at the Ghor. The base flow comes from a single spring about 6 km. from the entrance to the Ghor.

To conserve this base flow a small dam has been built close to the point where the wadi enters the Ghor. The dam, called Sharhabil Ibn Hasneh, is 44 meters high and the total live storage is 4.2 million cubic meters. The purpose of this dam is to control flood water and store water to supplement East Ghor Canal supplies in times of shortage. Irrigation releases are also given to lands above the East Ghor Canal.

Irrigation

The existing gravity system irrigates an area of about four thousand dunums scattered along the course of

MAP 11.


W. Arab
Irbid
River Jordan
W. Yubis
WADI ZIGLAB CATCHMENT
EAST GHOR CANAL
IRRIGATED AREA

the Wadi. To the west the system is bounded by the Jordan River Valley and the supply is supplemented by some pumping both from the river and from wells. This area is however, part of the larger area now supplied by the East Ghor Canal.

Vegetables, bananas and fruit trees are intensively cultivated with the irrigated area in both summer and winter seasons. Grain crops, especially wheat, barley, maize and lentils are cultivated in late winter months and they are partially irrigated. There is some vine cultivation on the steeper hillsides where they are supplied by the canals.[1]

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[1]Ibid. Part II, p. 4

Wadi Yabis, Wadi Kufrinja, Wadi Rajib

The catchment of the Wadi Yabis (125 square kilometers), Kufrinja (110 square kilometers), and Rajib (84 square kilometers) provide the principle western surface drainage for Ajlun mountains. The elevation rises from an average of 200 meters below sea level in the East Ghor to a height of 1250 meters near Ajlun in a distance of about 20 km. The rainfall is equally varied. At the Wadi Kufrinja in the Ghor the annual average rainfall is 270 mm whereas at Ajlun it is 560 mm. The area is deeply dissected by the three main valleys and those of the main tributaries. The higher part is forested with low scrub much of which is under control of the Forestry Department. Outside the forest all suitable land is intensively cultivated and some terracing to reduce run-off and erosion is evident. However, towards the west the valleys become deeper and the rainfall decreases so that cultivation is limited to the valley bottom and to the sides where they are gentle enough to be cultivated and commanded from the main streams.[1] (Map 12)

Studies indicate that there are no suitable dam sites in Wadis Kufrinja and Rajib. They also indicate that such schemes are unfavorable economically.

Irrigation in Wadi Yabis

During the summer months all the water originating from Ain El-Beitha and Ain Tannour, which are the main springheads from the Yabis, is utilized by irrigating lands

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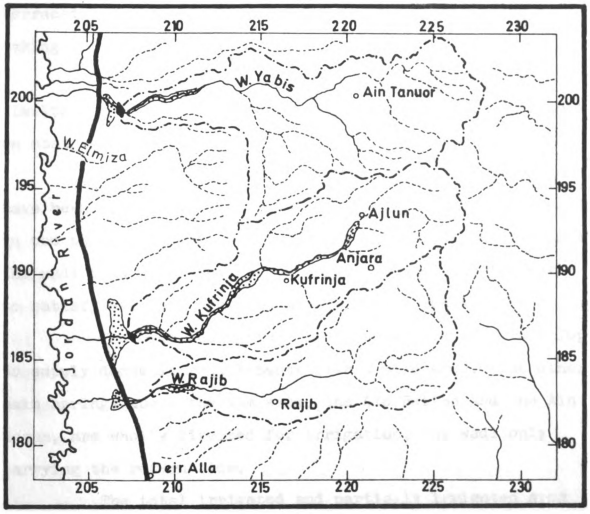
[1] Ibid., part IV, pp. 1, 2.

MAP 12



Scale
5 0 5 Km.

Wadis **Yabis and Kufrinja and Rajib Catchment Areas**

East Ghor Canal

Irrigation area

Boundaries

immediately downstream.

The intensive cultivation is devoted mainly to fruit trees, figs, apricots and apples, supplied from offtakes continuously along the wadi. Even where the side slopes are particularly steep, the land has been terraced and planted with vines, fed from small laterals taking off at suitable points in the wadi.

Although the existing off-takes are seldom used simultaneously it is apparant that availability is dependent on abstractions upstream.

Some extensive canals to irrigate additional land have been constructed in few places. They are however rarely in use as in dry seasons and throughout the late summer months, the wadi flow in these reaches appears to be insufficient to satisfy even the meager domestic requirements.

The main headspring, Ain Tannour, is being developed to supply domestic requirements over a wide area. The other main springs above the dam site, the Ain Beitha and the Ain Rasun, are wholly diverted for irrigation, the wadi only carrying the return flow.

The total irrigated and partially irrigated area in the upper catchment is about 5000 dunums of which a small portion was irrigated directly from small springs which did not contribute to the base flow.

Irrigation in Wadi Kufrinja

There are very few diversions from the base flow

in the wadi between its main summer source Ain Quantara near Ajluh until it reaches the East Ghor. In winter, the head-spring is Ain Ajluh which rises in the town of Ajluh. During summer the water from this spring is almost entirely utilized as the domestic water supply for Ajluh.

The irrigated and partially irrigated areas are about 4000 dunums planted mainly in olive trees and vine yards. Such irrigation that is done on the hillside terraces along the wadi is derived from small local springs.

Irrigation in Wadi Rajib

Although the summer head spring rises at Ain Sakkina east of the town of Rajib, no water is taken off here from the wadi for irrigation. However, two earth-channels are found further down (5 kilometers) both of which traverse very rough country and are in a poor state of repair. After a further drop in height of approximately 60 meters, a series of channels are led to irrigate the plateau land below Rajib. The area which has a traditional share of this water is about 2000 dunums. The existing cultivation is for pomegranates, olives, figs, some citrus fruits, vegetables and wheat. There is a marked lack of terracing which prevents the best use of the available land.

Wadi Zerqa

The Wadi Zerqa carries the largest perennial base flow of all the rivers wholly in Jordan. It is second only to the Jordan in respect of total annual discharge. On this account the Zerqa has been the subject of several previous investigations for possible storage and hydroelectric works. UNRWA, the Clap Mission, the U.S. Bureau of Reclamation, Sir M. Macdonald and Partners, Harza-Baker and Jordan Government Departments have all made preliminary investigations of various sites.[1]

The catchment area of the Wadi Zerqa is 3500 square kilometers. It is roughly triangular in shape, with its apex at the confluence with the Jordan. The southern boundary runs along the high plateau lands a few kms. south of Amman. To the east there is an ill-defined boundary with the internal drainage area which is centered roughly on Azraq. On the north it joins the Yarmouk catchment and extends on the foothills of Jebel Druze. (Map 13). The character of the catchment is unusual in that the head waters drain the low rainfall high plateau lands in the east and mountainous regions with high rainfall are traversed in the lower reaches. The river emerges on to the East Ghor near Dier Alla, and flows in wide pebbly flood plain for 12 kilometers southwest to join the River Jordan near the village of Damiya.

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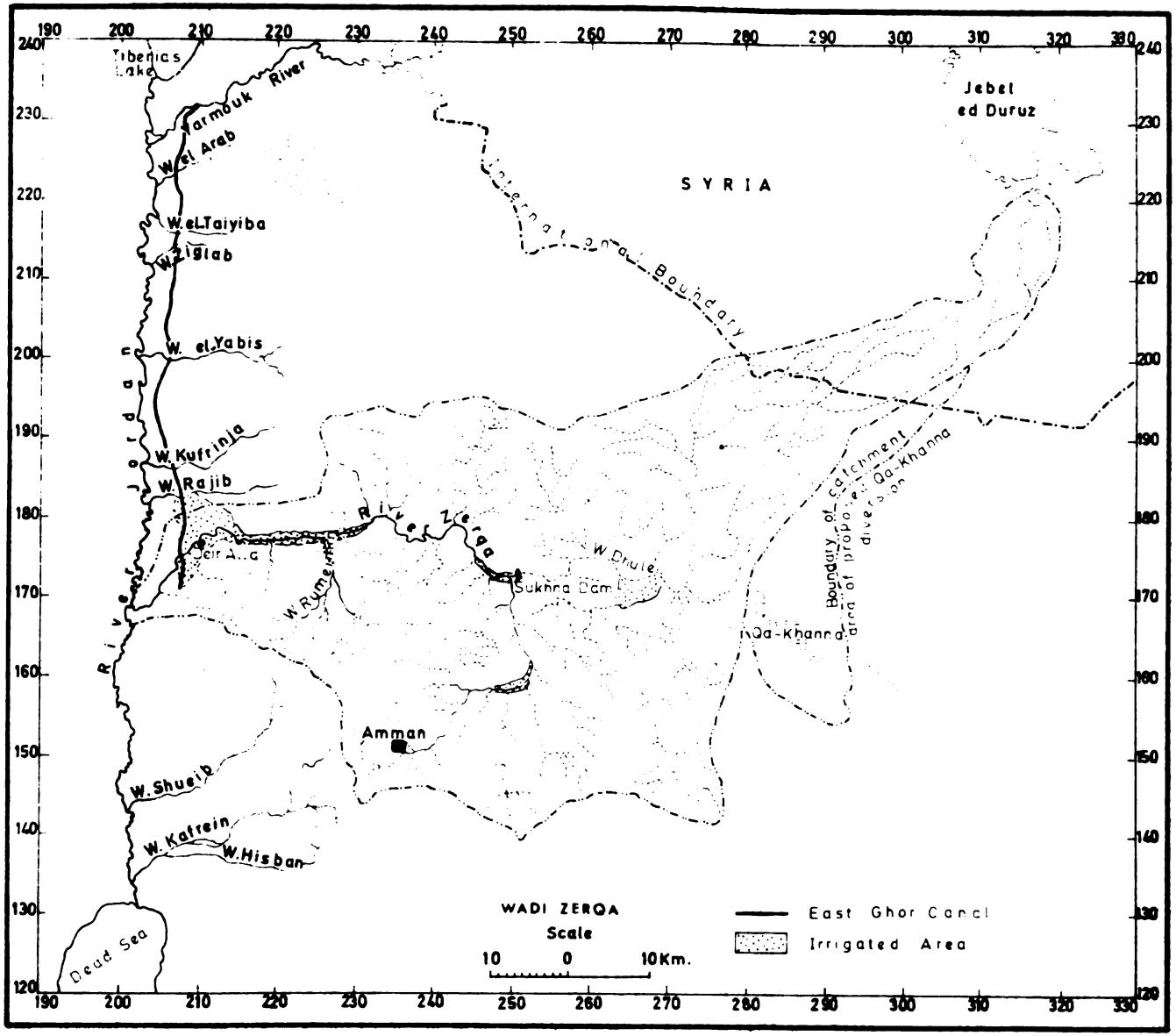
[1] Ibib. part V, p. 1.

MAP 13



SOURSE EAST JORDAN WATER RESOURSES

In elevation the catchment area rises very steeply at the escarpment along the Riftside from a general level of minus 350 meters to 1000 meters near Salt. Further east the general land drops to between 500 and 600 meters, but gradually rises to 850 on the slopes of Jebel Druze.

The rainfall over the catchment area is varied. To the west the area lies within the high rainfall zone, with annual rainfall exceeding 500 millimeters. To the east the annual precipitation rapidly decreases until in the desert region where mean annual rainfall is only 100 mm. Here the rainfall is very irregular and years may pass with no rain recorded. The rain occurs in this region mainly as thunderstorms of a very local character. Large river discharges have been observed which are unrelated to any recorded rain.

The northeastern part of the catchment area is drained by the Dhuleil system, (will be discussed later) which joins the Zerqa about two kilometers north of the village of Sukhna. The upper Zerqa drains the highlands around Amman. From the Dhuleil confluence onwards to the west, the river meanders in a deeply incised valley where it is joined by small tributaries. The largest of which are Wadi Rumeimin on the south and Wadi Jeresh on the north.

At the present time there is a perennial base flow in the river from a point just upstream of the Dhuleil confluence. Formerly there was base flow higher up the Zerqa

and Dhuleil but exploitation of the water reserves in the valley in recent years has stopped this flow.

At Sukhna upstream from the diversion Weir, flow appears from two strong perennial springs much of which is immediately utilized for irrigation along the Wadi sides. From this point onward, base flow steadily increases due to addition of water from spings. Few temporary diversions irrigate all available land at the lower levels.

There is no significant irrigation below Sukhna until the new Jeresh road bridge.

The area irrigated between the new and the old Jerash road is of interest, since the greater part is supplied from one canal on the right bank, which takes off about one Kilometer downstream of the new bridge. Considerable ingenuity and initiative have been shown in the construction of this canal. Due to the meanders of the wadi in this reach, irrigable lands occur as isolated pockets at the apex of bends, separated by cliff sections. To command those on the left bank, use has been made of small diameter pipes to syphon supplies across the river. Some increase in base flow occurs in this reach. Some two and a half kilometers below the old bridge the river is joined by Wadi Runeimin, which contributes to the flow. From this point there is no irrigation of significance until a point two and a half kilometers above the diversion weir near Dair Alla.

The diversion weir at Dair Alla is situated about two kilometers upstream of the point where the Zerqa enters the Ghor. The base flow is diverted by the weir into a

rectangular concrete lined canal on the left bank. An escape is provided back into the river about 700 meters downstream of the headworks. Just below this escape the canal crosses the river at a high level in a reinforced concrete flume. In this section of the canal there are several minor irrigation offtakes. The main canal continues to follow the foot of the hills for a distance of a little over one kilometer. Thereafter, the water is distributed by means of proportional weirs, into four main canals, and several minor canals. The system at Dair Alla will be considerably reorganized when the irrigation from the recently completed East Ghor Canal is fully developed. The East Ghor Canal will incorporate all irrigated land supplied from the Zerqa and located in the Ghor area.

When further storage works are constructed on the Zerqa, it will be necessary to institute strict control over all abstractions by means of offtakes, weirs and head gates. It will then be possible to increase the area under irrigation along the valley, particularly in the reach extending for fifteen kilometers downstream of Sukhna. The existing pumped irrigation schemes on the Dhuleil and Zerqa above Sukhna have shown the economic feasibility of farming in the area, which has ready markets in Amman and Zerqa for market garden produce.

The irrigated areas found along the course of the Zerqa river total seven thousand dunums. They are found along the river between Amman and Sukhna, around Sukhna and from below the new Jeresh road bridge to Dair Alla. (Map 13).

The Dhuleil System*

It was indicated earlier that the Dhuleil system drains the northeastern part of the catchment of the Zerqa river. (Map 13). This system is of special interest because it is being used as a settlement scheme for the Nomadic Bedouins in Jordan. The purpose of the discussion below is to indicate the pattern of development and the types of agriculture and agricultural products, produced in the area. There has not been enough time yet to determine the success of the project as a settlement scheme. Further research and more time are needed to judge the merits of such an undertaking. The type of development envisaged in the Dhuleil area is one of government sponsored and controlled settlement based on individual, peasant small-holdings. It is considered that this type of development is more likely to achieve, on the one hand, a rapid and sustained exploitation of water resources and, other, the prime aim of government policy which is the settlement of as many Nomadic Beduin as possible. This aim of government raises many problems foremost of which is the low capital low knowledge status of would-be settlers. To overcome these, 20 dunum holdings, and on them phases of development, embodied in farm plans, are recommended. In the first phase of initial settlement,

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*The Dhuleil System comprises a number of small wadis tributary to the Dhuleil, the largest of which are the Zatari and the Sueida.

a programme of fairly intensive vegetable production is envisaged and after some 4 years this is supplemented by apricot production. This phase produces a fairly substantial income quite rapidly and should provide a sufficient level of savings to enable the settler, in a short-time, to move into the second phase. This phase introduces local milk cows on to the holding as an integral part of the farm system. It is a temporary expedient, for it is somewhat less profitable than phase 1, but it is a necessary apprenticeship stage of training the settler in the ways of animal husbandry. Within five years, it should then be possible to move into the third phase of development, by which time sufficient funds and knowledge will have been accumulated to facilitate the practicing of intensive, highly profitable farming systems which alone will justify the heavy investments which irrigated farming require, and secure the economic use of precious water resources. The third phase includes plans for milk production, based on exotic dairy cows which are the most profitable, and beef and lamb production. And although these latter are less profitable, they should be attractive to the farmer who has not the skill required for dairying, particularly if they introduce an egg-laying unit which augments income significantly. The plan of development discussed above has not yet been complete.

Dry farming

On cultivable land within the project area, the principal pattern of land use combines the speculative

cultivation of rainfed winter cereals with the semi-nomadic grazing of sheep and goats. The main crop grown is winter wheat and since, on the plateau, successful growth depends on a low and uncertain rainfall, the attainment of economic yields is only occassionally achieved. In the valleys, which cover a relatively small area, additional water is available from run-off and river flooding so that, on their deep alluvial soils, cereal growing is somewhat less risky. The fact that winter rains occasion the flooding of valley bottoms, suggests that the practice of irrigating these favorable soils, if this were contemplated, would be undesirable.

Although this rudimentary form of land-use may appear of low productivity, in the absence of additional supplies of water, it undoubtedly uses the meager resources available to the best advantage. Nevertheless, even though it is not possible to estimate accurately the annual value of produce from the project area, it is apparent that it provides the local nomadic Bedouin with no more than a minimal standard of subsistence. This is substantiated by the fact that only a few years ago, before water on the periphery of the area had been discovered, the best cultivable land sold at no more than one dinar a dunum.

Irrigated farming

A number of private holdings have been established, within the last two or three years, on the peripheny of the project area. The first settler was Miss Coate, who originally found water in the area in 1961, and who began to exploit it in mid-1962 for irrigated farming purposes. Her

initiative was enough to stimulate others to undertake the risky business of locating water reserves and digging wells and there is no doubt that their efforts have been well compensated. These pioneer farmers have concentrated so far almost exclusively on the production of vegetables which have yielded quite well. The farming of these virgin soils has had the initial advantage of being completely weed-free, but there is no doubt that weeding costs will rise within a comparatively short-period. Miss Coate is on the point of establishing a dairy herd of exotic Friesian cows and there is the likelihood that others will follow suit.

Apart from growing a wide range of winter and summer vegetables, these Dhuleil soils are potentially capable of growing a number of other crops with economic yields. The pioneer farmers have themselves experimented with some of these including: vines, olives, cotton (wheat has given good samples) and potatoes. The haulms of the latter grew well but the low humus status of the soil led to compacting after irrigation which seriously restricted tuber growth. It is thought that after some years of farming these soils, potatoes and sugar beet should yield well. But these exploratory trials should surely lead to further government-sponsored experimentation.

Apart from the areas of irrigation supplied by the side-wadis already discussed there are several areas which lie outside of theEast Ghor Canal system. These are the areas irrigated by the wadis Shueib, Kafrein, Hisban, Zerqa-Main, Mujib, Faria and others.

CHAPTER IV

THE EAST GHOR CANAL IRRIGATION PROJECT

We now come to the most important of the existing schemes at present in operation in Jordan. The East Ghor Canal Project. This project not only comprises the largest area of irrigated land in the country, but forms the first stage of the total development of Jordan Valley water resources.

History

The concept of diverting the waters of the Yarmouk River to the lands of the East Bank of the Jordan River and perhaps even to the West Bank, had been studied and discussed at various times in the past. There have been a number of plans for developing the water resources in the Jordan Valley. In general most of these plans called for (a) bringing a large area under irrigation, (b) making the supply of water more dependable, and (c) making larger volumes of water available per dunum so that higher income crops could be grown and production could be increased.

After a long series of proposals and studies had appeared[1] and complicated negotiations had been carried on for years, the East Ghor Irrigation Project was selected

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[1]The Ionides Plan of 1939, the lower Milkplan of 1939, the Hager Plan of 1949, the MacDonald Report of 1951, The Beenger Plan of 1952, the TVA Plan of 1953, the Development and Progress of Johnston Negotiations of 1953, and the Arab Plan of 1954, the Cotton Plan of 1954, and the Baker-Harza Plan of 1955.

by the Hashemite Kingdom of Jordan and the United States Agency for International Development (USAID) with the aim of raising the standard of living for the small farmers of the area and to increase the national income of the country. The scheme is a modified version of the first stage of the Yarmouk-Jordan Valley Project set forth in the Master Plan Report of 1955.[1]

The Baker-Harza Plan (Feasibility Study)

The American engineering firms of Michael Baker, Jr., Incorporated and Harza Engineering Company cooperated between 1953 and 1955 in drawing up a detailed plan for irrigating 514,000 dunums of land in the Yarmouk-Jordan Valley. The completed plan, contained in an eight-volume report, was submitted to the government of Jordan on July 15, 1955. The total cost of making the plan was $2,481,031, of this $1,214,812 was contributed by the predecessor of the present USAID Mission, $1,056,219 by UNRWA, and $210,000 by the Jordan Development Board.

Major features of the plan were: (a) a storage dam on the Yarmouk River at Magarin (or alternatively a few kilometers downstream at Wadi Khalid), (b) a diversion dam at Adasiya near the mouth of the Yarmouk River, (c) a main

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[1]Yarmouk-Jordan Valley Project, Master Plan Report, Michael Baker, Jr., Inc., Rochester, Pennsylvania, and Harza Engineering Company, Chicago, Illinois, 1955.

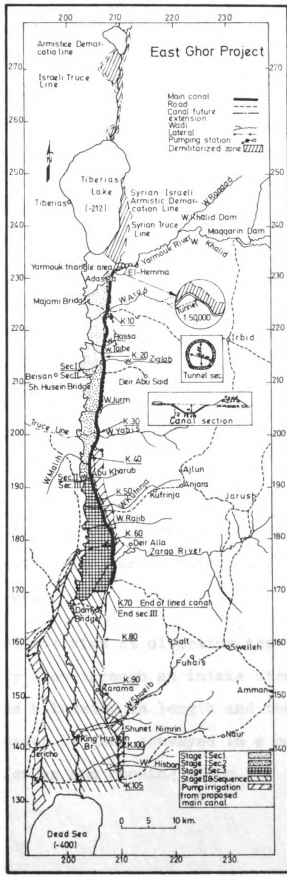
canal from Lake Tiberias and the Adasiya diversion dam extending 113 kilometers down the East Ghor, (d) a West Ghor Canal stretching 47 kilometers from a point near Jordan's northwest border almost to the Dead Sea (e) a siphon across the Jordan River to connect the East Ghor Canal with the northern end of the West Ghor Canal, and (f) four large hydro-electric plants on the Yarmouk River and two smaller ones on the East Ghor Canal (Map 14).

The plan relied on gravity irrigation to the maximum extent possible with only 104,000 dunums of land, about 1/5 of the total, being irrigated by pump. Nine pumping stations were included in the plan for non-gravity irrigation.

Total cost of the irrigation facilities was estimated at $116,874,000, or about $216 for each dunum of land to be irrigated. The hydro-electric power construction was estimated at $53,119,000, making total construction cost $169,993,000. The report stated that 12 years would be needed to complete the irrigation and power projects. It was estimated that the cost of operating and maintaining the irrigation facilities would be $1.86 per dunum per year.

The Baker-Harza report predicted that the project would raise net farm income in the valley from an estimated

MAP 14



Source: Agricultural Production And Income In E Ghor Canal Project

$725,000 to $14,237,000 annually in the first 20 years. This forecast assumed that there would be 30,700 irrigated farm units in the valley, and that the net income per farm would be $463. It further assumed that good farming practices would be followed and that the cropping pattern would be such as to yield the maximum income per dunum.

Project Description

The East Ghor irrigation project is seen as stage one of the overall development of Jordan Valley water resources for agricultural utilization. The development of this project has been one of the major efforts of cooperation in economic development between Jordan and the United States Agency for International Development. The project is located on the East Bank of the Jordan River in the northern part of the Jordan River Valley (Map 14). The total area of the project is 120,000 dunums. The project is bounded on the north by the Yarmouk River, on the east by the Main Canal, on the west by the Jordan River, and on the south by the Zerqa River.

The project aims at diverting the Yarmouk River waters by gravity flow through an intake structure leading into a tunnel one kilometer in length and three meter in diameter. The water is then conveyed in a canal parallel with the River Jordan and running along the foot of the

mountains for a length of 70 kilometers. Seven small perennial side-wadis flow into the Main Canal thus adding to the water supply. The total water supply feeds an irrigation and drainage system that covers 120,000 dunums. No water is used in the project from the Jordan River. The canal capacity is ten cubic meters per second at present and was designed to permit a doubling of capacity in the future.[1]

The concrete lined tunnel and other related structures are also designed and constructed to take the double capacity. The distribution and drainage systems, which total 700 kilometers, are built so that each farm unit in the Project Area receives water at its highest point through concrete laterals and head gates.

The area of the project has been divided into 3,424 distributable farm units[2], the average size of which is 35 dunums. The farm units were distributed to qualified farmers according to the East Ghor Canal Law of August 1962. This law specifies the qualification of recipient farmers and limits the size of individual ownership to 200 dunums.

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[1]The government of Jordan has recently begun the work of raising the sides of the Main Canal to double its capacity. Arab League funds are being used for this project. Work on this project has stopped since 1967.

[2]3324 used farm units or 97% had been distributed to owners as of May 1967.

Construction of the Project

Construction of the project began in July 1958, and was completed in July 1966 except for final touches on the Wadi Ziglab earth-fill dam which was finished in May 1967.[1]

The first work on the project was excavation of a six kilometer section of the northern end of the Main Canal. This was done by a crew employed by the government of Jordan. A contract was awarded to Imprese Venete Construzioni from Italy in November 1959 for construction of the tunnel and for lining and installing related structures of the first 22.8 kilometers of the Main Canal. In September 1961 the first 22.8 kilometers were completed and water was first delivered to farm units in Section One.

In May 1960 United States Agency for International Development provided funds for construction of a distribution system (laterals) and an initial drainage system for 33,000 dunums (Section Two) of land adjacent to the first 22.8 kilometers of Main Canal. Part of the distribution system in Section One (10,000 dunums) was built by the Shahin Company, a Jordanian contractor and the remainder was build by the government of Jordan.

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[1]Supervision of the construction of the storage dam on Wadi Ziglab was by the United Kingdom while assistance for construction was provided by the United States.

The contract with the above mentioned Italian firm was amended to provide for extension of the Main Canal to 70 kilometers. This was completed in June 1963. All the laterals and primary drains in the Project Area were completed in July 1966. The total length of laterals is 398.6 kilometers.

The following photographs (Figures 1-9) show stages of the construction of the canal and products grown.

Fig. 1. --A scene from the north Ghor Area showing farms and the east Ghor Canal*

*All photos were taken by the photography staff at the Agency for International Development.

Fig. 2 and 3. -- Photos above and below show beginning of work in East Ghor Canal showing location of canal in relation to eastern plateau.

Fig. 4. --Lining of Main Canal.

Fig. 5. --Completed section of East Ghor Canal

Fig. 6. --Farm workers splash through East Ghor Canal lateral during transplantation of young banana plants.

Fig. 7. --Banana plants, barely six months old in East Ghor Canal development area.

Fig. 8. --Water from canal irrigates crops.

Fig. 9. --Eggplants being harvested in East Ghor Canal development area.

Major flood protection channels and cross drainage facilities for the Main Canal were completed in July 1963. Additional construction of flood protection facilities for critical areas in Section I and II were completed in July 1966. The network of maintenance roads was completed in June 1966 to provide reasonable access to all facilities for Operation and Maintenance personnel. These roads were built by the operation and maintenance division of the Natural Resource Authority.

The installation of a telephone system by East Ghor Canal Authority technicians was completed in December 1966. This system assists in the operation and maintenance of the project facilities by providing rapid contact with 20 points on the Main Canal.

The East Ghor Canal Authority (EGCA) was organized in 1959 to supervise the construction of the project and to manage the project facilities. The EGCA in 1960 instituted a land redistribution program for ownership and water rights.

Other governmental institutions which are participating in the development of the project area are:

1. The Ministry of Agriculture, which provides extension and research assistance to farmers.

2. The Agricultural Credit Corporation (hereafter referred to as the A.C.C.) which provides long and intermediate term credit to the farmers.[1]

3. The Jordan Cooperative Credit Union which assists in developing agricultural cooperatives and provides them with short-term credit.

4. The Ministry of Public Works, which is active in the construction of farm-to-market roads. A 332 kilometer network of these roads is being built with USAID support.

5. Other ministries are involved in carrying out various public services.

Cost of the project was approximately $21,000,000, more than two thirds of which was provided by the U.S.A.[2]

Objectives of the Project:

Realization of the potential economic benefits of the East Ghor Canal Project for the general and economic welfare of its people is of the highest priority to the government of Jordan. In attempting to realize this, the government has placed highest priorities on the project in its plans and objectives for Jordan's economic development.

In brief, the objectives of the East Ghor Canal Project are:

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[1]The World Bank has provided loans to the Agricultural Credit Corporation to assist in farm financing.

[2]Including the cost of Wadi Ziglab Dam.

1. To provide farms in the area with water for full irrigation by constructing a main canal and a distribution system of laterals.

2. To consolidate land ownership and to redistribute farm units (limit in land ownership to a maximum of 200 dunums per person) so as to obtain a pattern of farms serviceable with the irrigation system.

3. To provide assistance to farmers for the development and modernization of the 3424 farm units of the project to assume maximum benefit from the irrigation facilities. Assistance includes:

   a. Technical services for land development
   b. Technical services for farming improvements (Extension Services).
   c. Financing for development and operation of farms.
   d. Establishing cooperatives to supply short term financial needs, supplies and marketing for the farmers.

4. To provide irrigation water which will increase the agricultural output of the lands by proper utilization of services.

5. To provide a high "standard of living" for families in the East Ghor Canal Irrigation Project Area by raising the income devoted to family living.

Management of the East Ghor Canal Project

Discussion of the manner in which the East Ghor Canal Project is administered requires the examination of the project from three angles: First, the legal framework which has governed the setting up of the East Ghor Canal Authority and its functioning, including the redistribution of land and the other aspects of the operation; second, the

actual implementation of the major provisions of the laws in force; third, the administration or management of the project in the narrow sense of the term. Each of these angles will be examined separately in the next three sections. A fourth section will set forth certain recommendations aimed at greater efficiency and effectiveness of the project and of any like project that will be launched as a result of new irrigation undertakings in the Kingdom.

The Legal Framework

Eight laws govern the establishment of the East Ghor Canal and its authority and their operation, the last law of which established a new authority of much broader scope. Three of these laws are of minor significance, and will not be discussed here. The first piece of legislation is Law 14 of 1959. It laid down the foundation for all future legislation. Law 13 of 1960 followed with certain changes. This law was amended later in the year in various major aspects. The situation was consolidated in the third piece of legislation: Law 31 of 1962, which again brought into effect significant changes. Laws 21 of 1963 31 of 1964 and 35 of 1965 brought about minor adjustments. Finally, Law 37 of 1966 came into being and brought with it radical structural changes.

No detailed examination and comparison of these laws will be undertaken here. However, a number of salient features will be selected and their evolution across the different laws traced, with the implications of this evolution indicated.

All five basic laws share the same major features as to the delineation of the project area that will be (or is being) irrigated by the East Ghor Canal, and the authorization of the East Ghor Canal Authority (or the National Resources Authority) to develop the area and to assign water allocations to it, to divide the area into plots or farm units thus changing the size structure in existence, to set a system of priorities for selection of holders, to set up committees of valuation and appeal which are to deal with the valuation of land and other rights to be surrendered by former landowners, and of the new units and water rights to be assigned to new holders, to determine the manner of settlement of account between the Authority and the new holders, and generally to operate the project and to develop it in social, economic and technical respects. These rights and powers of the Authority are not in question; what has changed over time is the definition of these powers and their content. This change will not be examined.

The points of examination are: definitional matters, including the notion of family, holder farmer, and lessee (or sub-lessee); organizational matters (including the formation of the Authority, the Valuation Committees, the Appeal Committee, and the Holders Selection Committee; and economic matters including the setting of the size of the farm units; with minimum and maximum sizes, and the settlement of the accounts involved in land redistribution.

Definitional Matters

The definition of the family remained basically unchanged all through. "Family" or "farm family" is taken to mean "all those persons living in one household and jointly supported by one head person whether they are offsprings, descendents or wives, including his descendents, wives, servants, relatives and any other person for whom the individual is legally responsible for managing his affairs and supporting him." (Official translation.) However, though the legal definition has remained unchanged, its application has changed considerably, as will be indicated below.

"Farmer" has been taken all along to mean a professional farmer who makes his living out of agriculture and who works other people's land within the project area, whether as a cash tenant or a share tenant. It is most

important to note that the laws are all silent about the farmer who works as wage laborer. Essentially, it is the legislation's purpose to do away with wage labor and to have farm units completely operated as family farms without hired hands.

A significant shift took place in the amended Law of 1960 from previous legislation (Law 14 of 1959 and Law 13 of 1960) with regard to the definition of land "holder." Until the amendment, the Authority, for allotment of farm unit purposes, considered the holder as "the person or persons in whose name or names the land or water or both is/are registered in accordance with a registration deed," and alloted one farm unit to this "person or persons." However, the amendment gave the Authority the right to "Consider them all or any of them as one holder." The word "all" (emphasis added) has had a drastic effect in implementation, an effect that has to some extent distorted the original purpose and import of the land reform measure of land reallocation.

Three types of "lessee" were given certain rights in the land. First, the lessee of state domain who had had the land for at least five years (later changed to three in the Amendment of 1960) without interruption and who had developed it. For the purpose of allocation, he was considered a "holder" with land and/or water rights. The

second type of lessee is the farmer who had had private land on lease for at least 15 years without interruption. A third category of operator who was treated as "holder" is the share tenant who planted trees on the leased land, with the knowledge and approval of the owner. The Authority has the right (beginning with the amendment of 1960) to treat this farmer "as having replaced the landowner in the share alloted to the farmer...'Furthermore,' in case the trees are jointly owned by the landowner and the farmer, the two parties shall be considered as one holder."

Organizational Matters

The composition of the valuation, appeal, and holders selection committees does not concern us much here, except in the sense that the tendency over the years has been to reduce the size of these committees in order to give them greater flexibility and to speed up work, and to add high-ranking members of the judiciary to the first two committees. Both developments are justifiable and of advantage to the work of the Authority and to the project.

The East Ghor Canal Authority itself has undergone an important change. It began by consisting of a Director-General and two members, whose appointment was decided upon by the Council of Ministers and approved by His Majesty the King. The Amendment Law of 1960 stipulated for

the formation of a Board for the Authority separate from its administration, although the Director-General was made Chairman of the Board. The Board further included two members who were appointed and approved in the same manner as the Authority members under the old law. The East Ghor Canal Authority enjoyed autonomy, and all along it came under the Prime Minister directly.

Law 37 of 1966 changed the situation structurally in important respects. The new Natural Resources Authority (N.R.A.), likewise a body enjoying autonomy, is headed by the Prime Minister as President. Its actual operation is under a Vice-President with ministerial rank. It further has six members: Director of the Agricultural Credit Corporation, Under Secretary for Economy, Under Secretary for Agriculture, Under Secretary for Municipal and Rural Affairs in the Ministry of the Interior, Director of Lands and Surveys, and a representative of the Development Board. The Natural Resources Authority also has a Director-General. The NRA is assigned the responsibility of exploitation, operation, and control -- in the widest sense possible -- of all natural resources, i.e. "all inanimate resources of natural wealth whether metalic or non-metalic, existing on the surface of, or under, the ground or in the territorial or inland waters or rivers. Natural resources shall also

mean all surface and underground water resources, including rivers, streams, wadis, lakes, reservoirs, cisterns, water springs, rainfalls and natural gases; as well as all minerals and pertinent ores, precious stones and similar others; and also soil, rock materials and their by-products used in constructional and paving works, including stones used for decoration purposes." (Official translation.)

The East Ghor Canal Authority has thus been totally submerged in the Natural Resources Authority--no entity for the East Ghor Canal Authority is maintained. How the East Ghor Canal Project is conducted in practice will be discussed in Section below. Apart from the structural change described, Law 37 of 1966 differs from Law 31 of 1962 in only a few other respects, as far as the East Ghor Canal is concerned.

Economic Matters

Serious changes have been enacted in farm unit sizes, as between one law and another. Three scales were enacted: in Law 14 of 1959, Law 13 of 1960, and Law 31 of 1962. The only point of general agreement in all laws is the minimum size if the soil is Class I or Class II, in which case the farm is to be no less than 30 dunums. The scale and the maximum size vary from there on as can be seen from the following tabulation.

TABLE 16

Comparison of Unit Size Scale in Law 14 of 1959, Law 13 of 1960, and Law 31 of 1962

Number of Irrigable Dunums Held Prior to the Project	Number of Irrigable Dunums to be Alloted to Holder
A. Law 14 of 1959	
30 - 50	To be alloted in full
51 - 100	50 dunums plus 50% of excess area
101 - 500	75 dunums plus 25% of excess area
501 - 1000	175 dunums plus 15% of excess area
Over 1000	300 dunums
B. Law 13 of 1960	
30 - 70	To be alloted in full
71 - 100	75 dunums plus 50% of excess area
101 - 500	87.5 dunums plus 25% of excess area
501 - 1000	187.5 dunums plus 22.5% of excess area
Over 1000	300 dunums plus 10% of excess area provided total doesn't exceed 500 dunums.
C. Law 31 of 1962	
30 - 50	To be alloted in full
51 - 100	50 dunums plus 25% of excess area
101 - 500	62 dunums plus 17% of excess area
501 - 1000	130 dunums plus 12% of excess area
Over 1000	200 dunums.

> As regards lands which are wholly or partially planted with trees, the Authority may, with the approval of the Council of Ministers, not be bound by the provisions of this upper limit, "as necessitated by the interests of the project." The provisions of this Article apply to allotments affected under Law 13 of 1960, "if this excess does not conflict with the technical division of alloted farm units."

The implications of the qualifications in Law 31 of 1962 to the maximum size, involving areas planted with trees, cannot be overestimated from the implementation point of view.

The principles and priorities set for the selection of holders were the same up to Law 31 of 1962 where they were changed, but they have remained the same since then. Before 1962, the priorities were as follows:

First priority:	Holders who themselves exploit their lands in the project area.
Second priority:	Holders who utilize their lands by lease or sharecropping within the project area.
Third priority:	Professional farmers residing within the project area.

Fourth priority:	Professional farmers from district inhabitants.
Fifth priority:	Professional farmers from inhabitants of other districts.

In 1962 an important change was introduced, demoting absentee landowners from second to fifth priority, and upgrading professional farmers. The new system of priorities stands as follows:

First priority:	As above
Second priority:	Professional farmers residing within the project area.
Third priority:	Professional farmers from district inhabitants
Fourth priority:	Professional farmers from inhabitants of other districts.
Fifth priority:	Holders who utilize their lands by lease or sharecropping within the project area.

One final point worth noting with regard to the eligibility of holders and farmers is that beginning with Law 14 of 1959 in which certain exclusions were made. Thus, in this law, persons falling under fourth and fifth priorities were excluded from land allotment if they had land outside the Project Area that fave them adequate income. (The term "adequate" has never been defined.)

Law 13 of 1960 extended the exclusion to persons falling under the third, fourth and fifth priorities. The provision of exclusion continued until Law 31 of 1962 when it disappeared.

Another economic matter is that of settlement of accounts between the Authority and the new holder. Upon the completion of the work of valuation committees the two sides of the accounts were recorded: What the Authority owed the holders for the lands taken over, plus any trees, improvements, and water rights, and what the new holders owed the Authority for the land and the new water rights. The difference between the two sides of each such capital account was to be settled, according to Law 14 of 1959 in ten annual installments if the holder owed a balance, interest chargeable at four percent per annum in either case. Law 13 of 1960 amended the installments to make them four for either party. The amended law of 1960 changed this further, making the installments ten if the holder owed the balance, but four if the Authority owed it. Again, Law 31 of 1962 changed the installments to ten for either party. Law 35 of 1965 further changed this provision, making the number of installments twenty if the holder owed the balance (provided no one installment is less than JD 50), but leaving it ten if the Authority owed it. No

amendment was introduced in Law 37 of 1966. The trend in respect to number of installments has been to enlarge it for the holder, thus making settlement of debt easy for him.

Beginning with Law 14 of 1959 the Authority undertook to perform many functions and services, in collaboration with the appropriate ministries and agencies, aimed at providing the farmers with orientation and helping them in technical, economic, social, financial, and health matters. The Authority was also empowered, within its means, to undertake directly any activities connected with agricultural loans, formation of cooperative societies, organization of marketing and extension services, soil preservation, setting up model farms, improvement of farm techniques, and other matters related to raising agricultural, economic, and social levels in the project area. The amendment of 1960 to Law 13 of 1960 went even further by empowering the Authority to determine the appropriate crop pattern, to develop agriculture, and to undertake processing and marketing.

Law 37 of 1966, however, is much more modest in the definition of the Authority's economic and social functions in the East Ghor Canal. Rather than entrust the functions enumerated above to the Authority, in collaboration with appropriate ministries and other agencies, the

latest law entrusts these functions to the appropriate ministries and agencies, in collaboration with the Natural Resources Authority. The change of emphasis is significant in that it sets out to avoid confusion of functions and duplication of responsibilities.

One major economic and social matter that is provided for in each of the laws and that remains unchanged is the provision that the farm unit is under no circumstances to be less than 30 dunums "approximately," (i.e., ten percent more or less,) if the land is of Classes I or II. In the case of death of a holder or a sub-lessee, the laws stipulate that "his rights in the farm unit shall revert to his heirs provided that the area of any farm unit is not thereby reduced to less than the minimum limit provided for under the law." (Official translation.)

The significance of this provision is that, formally, it puts a stop to fragmentation of holdings below 30 dunums (or 50 dunums, depending on the class of the soil) contrary to inheritance laws and practices. This measure is quite revolutionary in its nature, but it has not in practice meant what it signifies in the legislation, as the next section will show.

Implementation of Major Provisions of the Laws

The amendments introduced into succeeding pieces of legislation, some of which have been described, suggest the trends of thinking in government circles with regard to the matters concerning which the amendments were formulated. In most instances, these amendments reflect growing leniency or a greater desire to make the terms of allotment, or of settlement of accounts, easier for the new holders, or yet to minimize the hardship for the old landowners the area of whose land was large. There is only one amendment which works in the opposite direction, namely against certain old landowners. This is the shift in the priorities among holders introduced in Law 31 of 1962 whereby absentee landlords, or landlords who used to lease out their land, were lowered from second to fifth priority, and professional farmers (priorities 3, 4 and 5 in the old laws) were upgraded (to priorities 2, 3 and 4) as indicated above.

Furthermore, it is generally believed that, in addition to the change in provisions to which reference has just been made, actual implementation of these provisions has been marked with further leniency. In other words, in almost all matters left to the discretion of the various

committees stipulated for (for valuation and appeal, and for selection of holders), as well as to the discretion of the Authority, the tendency has been more towards leniency than towards a stricter interpretation of the provisions of the law, in effect at the moment. A few illustrations will clarify the point.

The definition of the "family" eligible for receiving one farm unit became less rigorous over time. As a result, in a very large number of instances grown-up children, or wives, of the same head of the family, though living with him and maintained by him, were alloted individual farm units.

Joint ownership by the farmer who had planted trees and the old landowner, or by the tenant who had been operating the land for more than 15 years and the old landlord has been allowed in very many cases. Although the law empowers the Authority to settle rights among the two parties, the Authority has allowed joint holdings rather freely. In fact, joint ownership seems to have gone much further, as Table 17 amply demonstrates. Many joint holdings are now creating friction, to the detriment of the project and of production in general.

What is even more serious than joint holding by strangers is the existence of a few hundred holders who

jointly (i.e. two or more persons) share in more than one farm unit. This makes the situation much more confusing and detrimental to management of farms and to production effort. The picture emerging from the observations so far made is shown in the following table.

TABLE 17

Number of Holders Alloted Farm Units Singly or Jointly

Number of holders alloted one unit each	942
Number of holders, two or more of whom share in one unit	1865
Number of holders, two or more of whom share more than one unit	367
Number of holders alloted more than one unit each	380
Total number of holders	3554
Total number of units	3361

The discretionary power of the Authority to go beyond the size of the farm allowed under the scale in case trees were planted in the land, also made possible the allotment of areas in excess of what could have been absolutely necessary, had the discretionary power been viewed as something to use in rare cases only.

The exclusion from allotment of persons under priorities 3, 4 and 5 (under the laws in force from 1960 to 1966) was not rigorously applied. As a result it is believed that some persons who have land outside the

project area from which they draw adequate income were given farm units, although they ought to have been excluded.

The selection of holders in accordance with the system of priorities was not always rigorous. It is also believed that persons who are not professional farmers, and who are not residents of the project area, or even of the district, have been alloted farm units.

Although leasing farm units is not allowed--the units being meant as family farms to be owner-operated--many instances have been reported where the land is being leased by the beneficiaries of the allotment. This is particularly true of new holders who were alloted farm units though they had not been entitled to them in the first instance.

Although fragmentation is not allowed under any of the laws, yet it is occurring in practice. This is because in many instances units were alloted to families where agreement had not been reached as to which members will give up their entitlement to the others. As a result, the land is still held by all and is operated in small patches. The situation reveals a big gap in the law with regard to inheritance, since the law is rather vague and lays down no mandatory action as to what should happen if several heirs claim the right to the same unit.

The valuation committees did not always operate within the same framework of guidelines. As a result, unjustifiable variations occured in the valuation of very similar land, if the valuation was undertaken by different committees.

Management of the Project

Until Law 37 of 1966 came into effect, the project had its own identity and Authority. Now it has no such administrative identity. It falls under one of the six departments of the Natural Resources Authority, the Department of Irrigation. Specifically, it is run by the Division of Operations and Maintenance of this department. "Operations" means water allocation, while "maintenance" means the upkeep of the installations. The Authority undertakes no other activities for the project area, although the law empowers it to undertake a number of technical, social and economic functions.

The operation and maintenance are under a Division Head, who is assisted by technicians for each of the functions. Five engineers serve under the assistant in charge of operations; they supervise water allocation for the three sections of the project. These engineers control the work of allocation inspectors whose function is to advise farmers with regard to the use of water, and to control the

work of the ditch-riders who go round opening and closing the sluices and collecting the request from farmers for water allocation. Between six and twelve of these ditch-riders operate under each inspector, depending on the size of the area under the inspector's responsibility.

On the technical, engineering level, the management of the Project is quite efficient and satisfactory. It is strict with regard to water allocation and the control of the ditch-riders, and irregularity is virtually unheard of. However, it is reported that some farmers have managed to make sluice keys, a serious matter that deserves to be attended to, quickly and firmly. The financial administration is also efficient with regard to the billing of farmers for water allocation at the three offices at Deir-Alla, Wadi Yabis and North Shounat. Settlement of accounts by the farmers is not very prompt: 26 percent of water dues in 1966 were not settled on time after the end of the year. Furthermore, the new holders who owe the Authority money are slow in settling the installments. Payment actually only began during 1966. According to the Authority's records, installments collected so far are JD 213,519 out of a total net debt of JD 2,349,620. On the other hand, the Authority owes old landlords a total of JD 2,278,872 out of which it has already settled JD 1,246,984. The relative discrepancy between the sums paid

by the Authority and by the holders compared to sums owed, is an indication of the slowness of holders to face up to their financial responsibilities.

The Authority has succeeded in alloting all the area of the project -- a total of 117,000 dunums in the three sections. However, deeds and final records are completed for 63,000 dunums. The pattern of allotment is presented in the following table, which covers some 90,530 dunums.

TABLE 18

Distribution of Land by Unit Size in East Ghor Canal Project Area

Size of Unit (Dunums)	Units			
	Number	Area	Percent of Total	
			Number	Area
Less than 30*	2332	33589	67	37
30 - 50	808	28560	23	32
51 - 62	112	6554	3	7
63 - 130	202	16672	6	18
131 - 200	27	5155	1	6
	3481	90530	100	100

*The existence of units under 30 dunums in area is contrary to the spirit and the letter of the East Ghor Canal legislation, where the minimum area is set at 30 dunums. The situation portrayed in the Table has been explained by officers in NRA as being the result of joint ownership where no settlement between the joint owners could be reached. Consequently, units less than the legal minimum have been allocated.

Recommendations

Not withstanding the observations advanced with regard to the laws and their implementations mentioned above, the East Ghor Canal operation is quite satisfactory, especially in its legal and economic aspects. Any suggestions to be made now have for aim the improvement of the situation both with regard to the East Ghor Canal area and to any new areas that will come later under irrigation in the Jordan Valley. The following recommendations start therefore from the position that the basis is worthy of being built upon elsewhere in the country, subject to the suggestions that follow. The suggestions are grouped under three headings: legal framework, administrative framework, and technical-economic framework.

Legal Framework

The minimum size of farm determined in the present study ought to be retained in legislation regarding the Jordan Valley. The recommendation of a rather small area -- 30 or 40 dunums -- is justified by the heavy pressure of population on land and the very small holdings existing elsewhere and by income expectations from such size. No very wide differential ought to be allowed among groups of landowners in different parts of the country -- especially as the valley is irrigated and fertile.

The maximum size ought to be no more than 200 dunums, whether or not the land of the original landowner is wholly or partly planted with trees. The justification of strictness here is, again, the fertility of irrigated land in the valley and the need to observe social considerations in not allowing a highly privileged landowner class to emerge. Furthermore, a very large farm will necessitate the employment of a large contingent of employed labor and will cease to be a family farm, for all practical purposes.

The letter of the law ought to be observed with regard to the definition of the "family". If the definition is allowed to become loose, the aspect of redistribution of land and limitation of size of holding will lose much of its reality. Therefore, it is here recommended that no more than one farm unit be alloted per family as "family" is defined by the law. Furthermore, in the case of heirs contending for the same unit, or for joint exploitation of it, if these heirs constitute more than one family under the East Ghor Canal law, the law ought to provide for a final settlement between them in such a way as to leave only one family in possession. Such settlement must be made mandatory and not discretionary. The law needs amendment in this respect.

It is also recommended to define "professional farmer" to include agricultural engineers, extension agents, and other persons similarly qualified. The object of such interpretation of the term would be to welcome into the valley agricultural technicians whose farming practice would have a valuable demonstration effect.

The law ought to be amended in such a way as to permit sale, under strict specified conditions, of farm units of which the holders want to dispose, either because the land is not very rewarding, or because the units are jointly held by persons who cannot operate smoothly together. In the latter case, the sale should only be allowed to single (i.e. not joint) holders.

In any further application of the law, it would be advisable for the Authority to use its discretion toward avoiding joint ownership between farmers or tenants who had planted trees and absentee landlords, or between tenants who had lease for over 15 years and absentee landlords. In all such cases, the Authority would be well advised to decide in favor of one party, depending on the merits of the case. Its discretionary power under the law ought to be used in favour of the operator rather than the absentee landlord.

Owing to the hardship imposed on the new holder when he is asked to begin paying installments for the farm unit right after allotment, it is hereby recommended that a period of grace of a few years (to be determined) be allowed before the first installment falls due, after which the account must be settled within the balance of the 20 years which the law requires. This would allow the farmer to establish himself before payment starts and would safeguard his operations against underfinancing. It would also spare him the need to borrow money from money-lenders at exhorbitant rates of interest. Alternatively, the installments stream can start modestly and grow over time, as the financial status of the farmer improves.

Administrative Framework

The East Ghor Canal Project, and any further areas that will be irrigated by major public irrigation works in the valley, ought to be placed under an autonomous Authority, a Jordan Valley Authority (JVA). This Authority, it is here recommended, must be separate from NRA. The JVA will have its own identity, and having no other responsibility, will be able to devote more attention to the Project Area in the technical-engineering, agricultural, economic, and social fields. All aspects of the work will benefit from such a reorganization, from allotment of farm units to allocation

of water to participation -- even if at an advisory level -- in the provision of technical and economic services to the new holders.

The Authority, whether the Natural Resources Authority as at present or any other body that may replace it, ought to participate in the planning of all service work for the project: extension, credit, cooperation, marketing, research and the like. It is not here recommended that the Authority take part in implementation of any plans, but only in their formulation. Such participation will be useful as a two-way exchange of ideas, discussion of problems, and search for solutions. Division of labor and specialization would require that the proper ministries and agencies themselves undertake to carry on any work that is to be done in the fields enumerated. However, most aspects of service work for community development in the Project Area touch on the field of more than any one agency. Hence, the need for a committee for planning whose function will not exceed the advisory.

It is also recommended that farmers' representatives serve on such a committee, preferably from among active cooperative society members. Such participation would facilitate the transmission of the measures of each of the agencies taking part in the work of the committee.

It ought to be emphasized with respect to the committee that it will be the counterpart at field level of the governing planning and advisory committee that is recommended elsewhere to be set up at headquarters level in Amman. The orientation and suggestions made by the latter committee will be transmitted to the field committee which, after relaying any questions or qualifications it would like to pose, will transmit further down the line the advise, suggestions, or actions it wants to encourage the farmers to take.

Lastly, a recommendation relating to administration in a broader sense is for the whole valley area to be made into one administrative district. The area presently falls under the districts of Jerusalem, Nablus, Salt and Irbid. This causes a great deal of administrative fragmentation and leads to dissimilarity of measures taken inasmuch as different administrators are involved. If the valley as a whole is made one district with its offices in the area, contacts with the government would be greatly facilitated and simplified.

Furthermore, the officials offering various community development and other technical services will all refer to supervisors or inspectors who will be placed in

the same district, not in cities far away and apart. The recommendation may, of course, lead to some irregularity in the delineation of district boundaries, but with flexibility the disadvantages of such irregularity can be minimized.

Technical-Economic Framework

Farmers currently get as much water as they ask for, given the overall availability of water. This is a serious matter. Although there is more water, globally speaking, than the collective demand for it on the average, a situation can well arise where shortages may develop. Furthermore, if farmers get used to obtaining all their requests in water without limitation or rationing, they will acquire a habit which it will be difficult to discard later on if rationing becomes essential. Furthermore, the absence of control may lead to the use of the wrong quantities for the crop planted. Finally, the lavish use of water by some careless farmers will deprive some others whose needs are legitimate and justifiable from part of their requests, in case total demand for water was nearing totaly availability. For all these reasons, the farmers ought to be trained in the careful utilization of water and should not be allowed more than is technically appropriate for their crops. The determination of the appropriate volume ought to be worked out between the management of

the project and the representatives of the Extension and Research Departments. The planning committee, referred to above, would be the proper body to set water duty limits by region and by crop acreage.

Related to the recommendation just stated, there is the need to train farmers not adequately experienced in intensive farming in the proper use of water and other aspects of irrigated farming in the valley. Such training should be undertaken systematically, through the joint efforts of the various agencies dealing with community and agricultural development. The Extension Department has the appropriate Audio-Visual means, in addition to word of mouth and demonstration to spread the information desirable. The cooperative societies can play a major role in this respect, in collaboration with extension, research and other agencies.

The Agricultural Credit Corporation and the agricultural cooperative societies can apply decisive pressure to influence farmers to adopt any cropping pattern that may be deemed appropriate by the proper agencies. The lending organizations can apply such pressure by insisting that loans (in cash or in supplies) will only be provided if the farmers applied the pattern suggested. Other farmers will probably be influenced by the demonstration-effect of the results obtained by those who accept the pattern.

The combined center at Wadi Yabis, bringing together the representatives of several services involved in agricultural and community development (ccoperation, extension, credit, marketing, mechanization, etc.) is a sound idea that promotes effectiveness, efficiency, and economy together. Two similar centers ought to be set up for the rest of the valley: at North Shounet and at Karameh.

It is necessary that the field administration of the project apply the strictest supervision over the ditch-riders, so that no irregularity may occur with regard to the allocation of water. Likewise, no leniency ought to be allowed in the case of farmers who make and use sluice keys to get water illegally.

The current water rate is one fils* per cubic meter of water for the first 2000 cubic meters, and two fils beyond that.

This rate brought in JD 85997 of revenue in 1966. (JD 22712 remained unsettled of the revenue total on closing of 1966 accounts). Against this, the expenses of the Division of Operations and Maintenance amounted to JD 90,255 for the same year. (This sum does not include the share of the project of the overhead expenses of the NRA because no such sharing is calculated by NRA.) The revenue falls short of the administrative expenses, which would

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*Fils equals one-thousandth Jordan dinar.

suggest that the water rates are too low. A proper cost accounting ought to be made, taking into account the project's pro-rated share of the overheads of the NRA and the amortization of the capital costs of the project. The rates ought then to be determined in the light of the data to be included. Furthermore, the determination of the rates cannot be undertaken in isolation from any policy that might be adopted with regard to the pattern of water used by farmers. But a priori merely by comparing revenue from sale of water, with administrative expenses above, there is a compelling case for increasing water rates.

An Economic Evaluation of the Project

Attempts have been made by economists to evaluate the impact of the East Ghor Canal Project on the economy of Jorday. Before the Canal was completed to its present stage three main studies were produced. These were:

1. Jordan Valley Agricultural Economic Survey[1]
2. The East Jordan Valley, a Social and Economic Survey[2]
3. The Yarmouk-Jordan Valley Project, Master Plan Report[3]

It will be worthwhile here to review each of these studies.

The Jordan Valley Agricultural Economic Survey

This survey covered 3,825 farms on a total area of 260,000 dunums. Some 80,000 dunums of the land was classed as non-irrigated, while the remaining 180,000 dunums were partially or fully irrigated. Total agricultural production on this land during the year of the study was 60,989 metric tons.

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[1] Jordan Valley Agricultural Economic Survey, (Mimeographed), UNRWA, Amman, Jordan, 1953.

[2] The East Jordan Valley, a Social and Economic Survey, Department of Statistics, the Hashemite Kingdom of Jordan, 1961.

[3] Yarmouk-Jordan Valley Project, Master Plan Report, Volume VIII, ECONOMIC, Michael Bader, Jr. Inc., Rochester, Pennsylvania, and Harza Engineering Co., Chicago, Illinois 1955.

Average gross income per farm was JD 319, average expenses were JD 242, and average net income was JD 77. Gross agricultural income for the area was JD 1,219,977 of which 93 per cent was attributed to crops, 6 per cent to livestock, and 1 per cent from other sources. Total expenses amounted to JD 925,962 or 76 per cent of the gross income, and the remaining net income was, therefore, JD 294,015. The farm size ranged from less than 10 dunums to more than 1,000 dunums. Three per cent of the farms, 86 units, were larger than 1,000 dunums and covered more than 68 per cent of the total farm land in the area. Ten farms were between 2,500 to 5,000 dunums in size. At the other extreme, 23 per cent of the farms, 909 in all, were 20 dunums or less and covered 0.71 per cent of the farms. Of the 3,825 farm units covered in the study, 51.8 per cent were 50 dunums or smaller. The wide variation in the size of the farm units minimizes, to a considerable extent, the value of income data presented on a per farm basis. Greater emphasis, therefore, should be placed on per dunum income figures. The gross income per dunum for the 260,000 dunums in the area studied was JD 4.7 and expenses were JD 3.6, leaving a net income per dunum of JD 1.1.

The East Jordan Valley, a Social and Economic Survey

The Jordan Department of Statistics conducted this survey under the direction of Mr. Watson, a Ford Foundation consultant. The survey centered on 3341 farm units covering 207,000 dunums in the present East Ghor Irrigation Project. The survey showed that 14.9 per cent was fully irrigated, 58.5 per cent partially irrigated, and 18.4 per cent was rain-fed. The remaining percentage was either fallow that year and/or uncultivable.

The gross income for the 3341 farm units was JD 781,199. Total expenses were JD 314,927 and total net income was JD 466,272. The average gross income per farm was JD 234, and the average net income was JD 140. The gross income per dunum on a fully irrigated farm of 20 to 39 dunums given as an example in the study was JD 12.3, expenses were JD 2.6, leaving a net income of JD 9.7 per dunum.

Agricultural production for the crop year 1959/1960 was 54,387 metric tons. This is a very low figure because 1959/1960 was one of the poorest years in Jordan's recent history. Also, the flow from Wadi Kufrinjah was drastically reduced by villagers up-stream who diverted water for their own use; as a result, almost all the crops in the valley area adjacent to this wadi failed.

Only 17,735 dunums of irrigated land produced two crops, while the dry land produced only one crop during the year of the study.

Comparison of the two studies

A major discrepancy in the two studies is the reported volume of expenses as a percentage of gross farm income. The UNRWA survey tabulates expenses at 76 per cent of gross income, and the Watson study of 1961 reports expenses at 40.3 per cent. This variation is attributed to the fact that the earlier study included payments for taxes, depreciation, and rent in tabulating total expenses, while the 1961 study did not include these charges. Neither of the studies included charges for interest.

The income and expense figures per farm unit are summarized in Table 19.

Table 19

Income and Expenses per Farm Unit

Item	UNRWA Study	Watson Study
Average Gross Income per Farm	JD 319	JD 234
Average Expenses per Farm	JD 242	JD 94
Average Net Income per Farm	JD 77	JD 140

The table above shows the gross income per farm in the Watson Study to be lower. This may be explained by the smaller size of the average farm (62 to 68 dunums) and

the poor yeilds of 1959-1960. Because of the first variation, comparison on a per dunum basis may be more useful as presented in the Table below:

Table 20

Average Gross Income, Average Expenses and Average Income per Dunum

Item	UNRWA Study	Watson Study
Average Gross Income per Dunum	JD 4.692	JD 3.757
Average Expenses per Dunum	JD 3.561	JD 1.515
Average Net Income per Dunum	JD 1.131	JD 2.242

Production and Income After the Completion of the East Ghor Canal

The first study to measure the economic benefits resulting from the East Ghor Irrigation Project was carried out by the United States Agency for International Development in Jordan in the spring and early summer of 1965. This study was similar to and a predecessor of the 1965-66 study, but dealt with the crop year running from May 1, 1964 to April 30, 1965. During that time, 2,760 farm units were in operation.

The sample for this study consisted of 60 farmers distributed over the project area. Only fifty of them were interviewed while the rest could not orwould not cooperate with the interviewer. They were selected by taking every

60th name from the master list. Eleven of the farmers owned more than one farm. Therefore the data acquired was for 70 units totalling 2450 dunums which represented 2.1 per cent of the 117,000 dunums in the irrigation project.

Agricultural Income

Gross income for the 2,450 dunums in the sample was JD 58,543, total expenses were JD 32,052 and net income was JD 26,461. These data on a per dunum basis were: gross income, JD 23.9; expenses, JD 13; and net income, JD 10.8.

Average gross income per farm was JD 836, average expenses amounted to JD 458, and average net income was JD 378. The average size of all farm units in the sample was 35 dunums.

The land use in the sample area included grain crops (18%), vegetables (48%), fruit trees (citrus and vanana) (16%) and the remaining 18 per cent was idle.

The following table contains figures for production and income for the crops grown in the sample area. Data were compiled separately for each crop.

Table 21

Production and Income for the Sample Area

Crop	Total Area Planted (Dunum)	Total Production Metric Ton	Average Yeild Per Dunum Metric Ton	Price Per Metric Ton JD	Total Gross Income JD	Total Expenses JD
Tomato	407	558	1.37	30.2	16.829	7,100
Wheat	333	71	0.21	29.8	2,100	620
Banana	209	273	1.40	72.0	16,550	12,860
Potato	177.5	170	0.95	29.1	4,930	2,889
Citrus	171.5	300	1.75	20.0	6,003	2,573
Eggplant	121	173	1.43	14.1	2,445	1,402
Cauliflower	118	139	1.18	14.5	2,025	1,021
Cucumber	37	50	0.58	30.8	1,545	963
Corn	75	50	0.66	32.9	1,628	379
Bread Beans	58	20	0.35	25.8	518	449
Water Melon	38	38	1.00	14.4	545	182
Lettuce	35	30	0.86	31.9	956	270
Sesame	35	2	0.63	59.6	131	676
Cabbage	32	53	1.64	7.9	415	223
Green Pepper	15	7	0.46	34.3	238	177
Green Onion	10	5	0.50	20.0	100	31

Table 21

Production and Income for the Sample Area
(Continued)

Crop	Total Net Income JD	Gross Income Per Dunum JD	Total Expenses Per Dunum JD	Net Income Per Dunum JD
Tomato	9,729	41.40	17.44	23.91
Wheat	1,480	6.31	1.86	4.45
Banana	3,690	79.19	61.53	17.65
Potato	2,042	27.18	16.27	11.50
Citrus	3,430	35.00	15.00	20.00
Eggplant	1,043	20.21	11.59	8.62
Cauliflower	1,004	17.16	8.65	8.51
Cucumber	589	17.75	11.07	6.68
Corn	1,248	21.70	5.05	16.65
Bread Beans	69	8.93	7.75	1.19
Water Melon	363	14.34	4.80	9.54
Lettuce	688	27.31	7.71	19.61
Sesame	55	3.74	2.16	1.58
Cabbage	192	12.98	6.97	6.00
Green Pepper	61	15.86	11.77	4.09
Green Onion	69	10.00	3.10	6.90

The 1964-65 study included a forecast that total gross income in the project area would be JD 5,591,400 by 1970, or JD 47.8 per dunum. This projection was based on the following assumptions: (a) citrus production would increase with more trees planted and more in bearing stage, (b) more land would be planted with high-income crops, (c) all land in the project area would be cultivated, (d) farming methods would improve, (e) irrigation water would be supplied and used efficiently, and (f) there would be adequate development of extension and credit services to the farmers.

The 1965-1966 Study

The study of production and income in the project area for the crop year ending April 30, 1966 was planned during the summer of 1965 and the interviewing was done from November 1965 to March 1966. This study was similar to the one of the previous year, although it differed in certain minor respects. Both studies were designed to acquire the same kind of information on production and income.

The sample for this study consisted of 120 farms covering an area of 4063 dunums which is four per cent of the 3003 farms being farmed at that time. The sample was

chosen by taking every 25th name on the master list which was arranged in geographic order from north to south. If one respondent could not be interviewed, the next one on the list took his place. In this way the sample of 120 was maintained. Although a third of the farmers in the sample owned or operated more than one farm unit, only data for the farm unit in the selected sample were acquired.

The following table presents data on each of the 16 crops that were grown by the 120 farm units in the sample. Data include the total area planted with each crop, the volume of crops produced, and income and expense figures both total and per dunum. The total gross income for the entire 120 farms during the crop year under study was JD 117,129; expenses were JD 61,849; and total net income amounted to JD 55,280. On a per farm basis then, gross income was JD 976, expenses were JD 515, and net income was JD 461.

Income per Dunum and for the Project Area

Gross income per dunum for the 4,063 dunums in the study sample was JD 28.8. Expenses per dunum were JD 15.2 and net income was JD 13.6 Figures indicate that the crops yielding the highest net income per dunum was bananas , almost JD 31. Crops providing the lowest net income per dunum were wheat and corn, both less than JD 5.

Table 22

Production and Income for the Sample Area

Crop	Total Area Planted (Dunum)	Total Production Metric Ton	Average Yeild Per Dunum Metric Ton	Price Per Metric Ton JD	Total Gross Income JD	Total Expenses JD
Wheat	1,574	242.0	0.15	28.83	6,977.5	2,208.9
Tomato	945	1431.7	1.52	26.59	38,075.0	17,693.7
Citrus	432	503.3	1.17	33.48	16,850.0	9,684.2
Corn	320	357.5	1.12	6.42	2,296.0	887.4
Banana	306	523.0	1.7	58.32	30,500.0	21,088.2
Eggplant	332	374.5	1.61	18.38	6,882.0	3,963.3
Cauliflower	114	187.5	1.65	11.32	2,122.5	720.8
Green Pepper	94	82.4	0.88	30.21	2,489.5	852.7
Bread Beans	77	38.3	0.50	30.56	1,170.6	270.7
Water Melon	69	109.0	1.58	26.05	2,840.0	1,272.1
Cabbage	56	113.0	2.02	12.65	1,429.5	727.5
Potato	54	31.6	0.59	34.57	1,092.4	741.7
Onion	22	25.5	1.16	25.88	660.0	263.1
Cucumber	19	13.40	0.71	27.76	372.0	97.2
Lettuce	8	8.0	1.00	35.00	280.0	71.3
Peas	3	1.5	0.5	40.00	60.0	22.0

Table 22

Production and Income for the Sample Area
(Continued)

Crop	Total Net Income JD	Gross Income Per Dunum JD	Total Expenses Per Dunum JD	Net Income Per Dunum JD
Wheat	4,768.5	4.4	1.4	3.0
Tomato	20,381.3	40.3	18.7	21.6
Citrus	7,165.8	39.8	22.4	16.6
Corn	1,411.3	7.2	2.8	4.4
Banana	9,411.8	99.7	68.9	30.8
Eggplant	2,918.7	29.7	17.0	12.6
Cauliflower	1,401.7	18.6	6.3	12.3
Green Pepper	1,636.9	26.5	9.1	17.4
Bread Beans	899.9	15.2	3.5	11.7
Water Melon	1,567.9	41.2	18.4	22.7
Cabbage	702.0	25.5	13.0	12.5
Potato	350.8	20.2	13.9	6.3
Onion	396.9	30.0	12.0	18.1
Cucumber	274.8	19.6	5.1	14.5
Lettuce	208.7	35.0	8.9	26.1
Peas	38.0	20.0	7.3	12.7

Since the sample chosen is representative of the total, therefore, the income for the project area is JD 3,372,876. Expenses were JD 1,780,979 and a net income of JD 1,591,902.

Land Use:

Of the 4,063 dunums in the sample area, 282 dunums, or 6.94 per cent were not planted during the crop year. The total cultivated area then was 3,781 dunums. Of this the total dunums planted including 635 dunums of double cropping, was 4,416. These data are shown in Table 23, both by section of the project area and as a total. All figures are in dunums.

Table 23

Totals for Sample Area, Idle Area, Cultivated Area, Planted Area and Double Cropped Area

Section Number	Sample Area	Idle Land	Cultivated Area	Planted Area	Double Cropped Area
1	1,270	170	1,098	1,237	139
2	1,281	72	1,209	1,452	243
3	1,512	38	1,474	1,727	253
Total	4,063	282	3,781	4,416	653

Table 24 shows the area planted with each crop, both in dunums and as a percentage of the entire 4,416 dunums planted.

Table 24

Land Use in the Sample Area

Crop	Total Area Planted (Dunums)	Area Planted (Per Cent of Total)
Wheat	1,574	35.64
Tomatoes	945	21.38
Citrus	432	9.79
Corn	320	7.24
Bananas	306	6.92
Eggplant	232	5.25
Cauliflower	114	2.58
Green Pepper	94	2.15
Broad Beans	77	1.75
Water Melon	69	1.56
Marrow	57	1.30
Cabbage	56	1.26
Potatoes	54	1.22
Jew's Mallow	32	0.75
Onion	22	0.50
Cucumber	19	0.43
Lettuce	8	0.18
Peas	3	0.06
Okra	2	0.04
Total	4,416	100.00

As already noted, approximately seven per cent of the land in the sample was not cultivated. Forty-seven per cent of the land was planted in grain crops, 44 per cent in vegetables, and the remaining 18 per cent in fruit trees, citrus and bananas. These percentages total 116 per cent, the additional 16 per cent representing the extent of double cropping

Crops Planted per Farm

Thirty-three of the 120 farmers in the sample planted only one crop, while twenty-one planted more than four different crops. One farmer did not plant any crops because the surface of his land is higher than the water surface in the delivery box. The remaining 65 farmers planted two or three crops.

Farm Ownership

More than one farm unit was owned by 41 per cent in the selected sample; two of them owned eight and ten units respectively. Two thirds of the farmers owned only one farm, while 29 farmers owned two farms each. The remaining ten owned between three and five farms each.

Sixty-six of the farm unit owners operated their own farms. Hired managers operated five of the units, while 39 were rented on a cash basis. The figures on the operating status of the 120 farm units are summarized in Table 25.

Table 25

Distribution of the Sample According to the Operating Status of the Farmers

Farm Unit Operating Status	Number of Farm Units
Owner operated	66
Hired manager	5
Sharecropper	39
Cash Rental	10
Total	120

Non-Crop Income

In addition to the income from crops summarized above, a number of farmers received income from non-crop sources. The total net income received from non-crop agricultural activities was JD 13,314. More than two-thirds of this came from the sale of sheep and milk, and the remainder was acquired from the sale of hair and wool, fat, calves, manure and eggs. Several farmers also earned a substantial income from operating gas stations or trucks or from renting tractors.

Agricultural Trends in the Project Area

A major focus of the USAID/Jordan development program in recent years has been upon irrigated agriculture, and the East Ghor Irrigation Project has been its principal effort in this direction.

The objective of this project was not only to build an irrigation system to bring water to the farmers at the highest point of each unit, but also to start the socio-economic development of the area. In other words, it was meant to improve the land tenure, the pattern of farming operations, the terms of land holdings and the level of living of the people in the area. In general, it was to create a satisfactory set of incentives for raising and sustained agricultural production and to increase the national income of the country.

It is obvious to the observer that positive results have been achieved in the Jordan Valley in terms of increased areas irrigated and increased agricultural production as well as social development. Herein, statistics have indicated that the amount of irrigable land which has been put under intensive irrigation as a result of the execution of the East Ghor Irrigation Project has increased from 25,256 dunums to 103,029 dunums of irrigable land.[1]

A sustained period of continuous irrigation in the project area during the last five years, improved farming and irrigation practices, proper use of fertilizers and

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[1]Memorandum entitled "Increased Number of Dunums of Lands Post-Canal" to Mr. Emorg Howard, Chief, Agriculture Division, USAID/Jordan, by Mr. Abdul Wahhab Awwad, dated February 20, 1967.

improved credit and marketing conditions have given rise to a measurable impact. Trends in agricultural production and income from the pre-canal period to the post-canal show the economic impact of the East Ghor Irrigation Project on the Jordanian economy.

This study shows that net income per dunum of land in the project area was JD 13.6 during the 1965-66 crop year. This is an increase of 23 percent over the JD 10.8 figure for the previous crop year, and more than six-fold increase over the JD 2.2 net income per dunum reported for the pre-project crop year of 1959-60.[1] This data is indicative of the great economic benefit that has resulted from the irrigation project. For comparative purposes there are four sources of information on production and income in the project area, two of them for the pre-canal period and two for recent years. The earliest of these is a study made by UNRWA in 1953; the second is a Jordan Department of Statistics study which was published in 1961. Both of these provide data on the entire Jordan Valley, an area larger than the present project area. USAID has conducted two post-canal studies, the one just completed for the crop year 1965-66 and an earlier one covering the crop year 1964-65.

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[1] The East Jordan Valley, op.cit., Table No. 105, p. 254.

Income per Dunum

Table 26 presents data on a per dunum basis for the four different years covered by these studies.

Table 26

Gross Income per Dunum, Expenses per Dunum and Net Income per Dunum for 1953, 1959-1960, 1964-1965, and 1965-1966[1]

Item	1953 JD	1959-60 JD	1964-65 JD	1965-66 JD
Gross Income per Dunum	4.7	3.7	23.9	28.8
Expenses per Dunum	3.6	1.5	13.1	15.2
Net Income per Dunum	1.1	2.2	10.8	13.6

Gross income for 1959-1960 was low because of a very poor season.

Income and Expenses per Farm

Income and expense data per farm unit as reported in the four studies are summarized in Table 27. This series presents an especially good measure of the improved economic well-being of the farmers. The two post-canal columns indicate the income data for the typical farmers since all farms in this period are about the same size. But the pre-canal averages ignore the variations of income which resulted from great variations in the size of farms during the pre-canal period.

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[1]Ibid., p. 174.

Table 27

Gross Income per Farm, Expenses per Farm and net Income per Farm for 1953, 1959-60, 1964-65, and 1965-66

	1953 JD	1959-60 JD	1964-65 JD	1965-66 JD
Gross Income per Farm	319	234	836	975
Expenses per Farm	242	94	458	515
Net Income per Farm	77	140	378	460

Total Agricultural Income

During the crop year 1964-65, there were 117,000 dunums of land in the irrigation project and the total gross income from this area was estimated, on the basis of the sample used in the study of that crop year, at JD 2,795,715. The study just completed indicates a total gross income of JD 3,372,876 for the crop year 1965-66 for the 117,000 dunums of the entire project. In the earlier of these two years, more than 18 per cent of the land in the study sample was not cultivated, while in the latter the idle was approximately seven per cent of the total in the sample.

Production (weight) per Dunum

The increase in gross income is partly due to the decrease in idle land and partly to greater double cropping in the field crops. But it is also the result of increased

yield per dunum. Data are available from the four crop years mentioned above on yield per dunum for the major crops that are grown in the irrigation project. Striking increases are noted for most of the crops that are involved, as shown in Table 28.

Total Agricultural Production (Weight)

The quantity of the agricultural production in the East Ghor Area during the 1965-66 crop year is 108,360 metric tons. Table 29 presents the total agricultural production of the East Ghor Area for 1953, 1959-60, 1964-65, and 1965-66. Table 30 shows that the total agricultural production in Jordan increased by 100.7 per cent between 1959 and 1965. It is not possible to determine the extent to which the East Ghor Project contributed to this increase, but it is certain that it was a major factor. However, an attempt was made to compute the growth rate of various crops in terms of both total production and monetary value to determine the importance of the East Ghor Project in relation to the total production of the country. Work is also still underway to develop a rough cost/benefit analysis of the project. It is planned to issue the benefit/cost analysis as a supplement at a later date. Attempts to make a meaningful assessment of the project's contribution to the country's economy were almost totally unsuccessful due to the lack of valid data concerning the 1962-63 and 1963-64 crop years in the project area.

Table 28

Average Yield per Dunum for the Major Crops in the Project Area for 1953, 1959-1960, 1964-1965, and 1965-1966 in Metric Tons

Crop	1953	1959-60	1964-65	1965-66
Tomatoes	0.502	0.557	1.371	1.515
Wheat	0.091	0.049	0.211	0.154
Bananas	N.A.	1.316	1.400	1.709
Potatoes	1.196	0.820	0.958	0.585
Citrus	N.A.	N.A.	1.750	1.165
Eggplant	0.970	0.983	1.433	1.614
Cauliflower	N.A.	1.557	1.179	1.645
Cucumber	0.194	0.353	0.577	0.705
Broad Beans	0.345	0.206	0.347	0.497
Water Melon	0.479	0.396	1.000	1.580
Corn	N.A.	N.A.	0.660	1.117
Green Pepper	N.A.	0.422	0.462	0.877
Marrow	N.A.	N.A.	0.736	0.596
Cabbage	N.A.	1.363	1.640	2.018
Jew's Mallow	N.A.	N.A.	3.750	2.313
Onion	N.A.	0.505	0.500	1.159

The contribution of agriculture to the Jordanian balance of payments problem is appreciable. Although gross imports increased from 13.3 to 15.7 million dinars between 1960 and 1965, it was offset by increases in gross exports which increased from 1.8 to 4.9 million dinars during the same period.

Table 29

Agricultural Production of the East Ghor Area for 1953, 1959-60, 1964-65, and 1965-66

Item	1953	1959-60	1964-65	1965-66
Agricultural production in Metric tons	60,989	54,387	95,315	108,360

Two differences between the UNRWA study and the Department of Statistics study must be noted. First, the gross income reported in the latter study is unusually low because it was based on an extremely poor crop year. Second, the expense data as tabulated in the UNRWA study are higher as a percentage of gross income than that in the other three sources of data because of the inclusion of charges for taxes, depreciation and rent. Because of this latter variation, only the gross income data in the UNRWA study can be correctly compared with the other sources.

Trends in agricultural production and trade from the pre-canal period to the recent past also show the beneficial effect of the East Ghor Project on the Jordanian

economy. Table 30 presents data on agricultural production by major components.[1]

The first tracts of irrigable land were distributed to farmers in 1961 and by 1964 almost all of the farm units in the first two sections of the project were distributed. It was during these years then that the project began to show results in the form of increased agricultural productivity. With this observation in mind it can be seen that agricultural imports increased roughly 16 per cent during the period 1960-65 while during the same period exports increased almost 170%. It can also be noted that agricultural produce made a larger contribution to total countrywide exports going from 46.8% in 1960 to 50% in 1965. Annual variations exist in these data, both production and trade, due to variations in the amount of rainfall from year to year which affect annual productivity. Nevertheless, the trends over the period considered are apparent.

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[1]Statistical Yearbook, 1965 and previous editions, Department of Statistics, Amman, Jordan.

Table 30

Agricultural Production[1]
(000 Metric Ton)

Crop	1959	1960	1961	1962	1963	1964	1965
Wheat	103.5	43.6	138.2	111.9	75.8	294.7	277.9
Barley	26.0	13.3	61.7	35.7	23.0	92.2	94.8
Other grains Field crop	24.6	11.9	28.5	33.9	17.8	57.3	65.1
Grains and Field Crops	154.1	68.8	228.4	181.5	116.6	449.2	437.8
Tomatoes	126.1	155.6	213.8	169.4	214.6	227.8	188.9
Other Vegetables	224.8	243.0	319.1	325.1	322.9	383.9	393.6
Vegetables	350.9	398.6	532.9	494.5	537.5	611.7	582.5
Olives	11.2	16.7	144.4	7.4	38.7	97.1	37.4
Citrus	5.8	7.1	16.3	21.4	38.8	37.1	47.0
Grapes	54.1	43.3	78.4	79.0	58.7	76.9	79.2
Other Fruits	41.2	36.7	52.6	57.6	46.8	48.8	55.2
Fruits	112.3	103.8	261.7	165.4	183.0	259.9	218.8

[1]Ibid. p. 30

CHAPTER V

PLANNED IRRIGATION SCHEMES AND DRAINAGE SYSTEMS FOR THE JORDAN VALLEY

We have so far looked at present irrigation schemes; their nature and development. We will now look at the planned schemes. The government of Jordan is undertaking the development of these schemes based on studies done by the National Resource Authority, the Baker-Harza Report, and Sir MacDonald's East Jordan Valley water resources.

The government of Jordan has (in 1966) begun work on an eight kilometer extension of the Main Canal which will provide irrigation water to an additional 20,000 dunums to the south of the 70 kilometers completed earlier. This extension is entirely Jordanian in planning and execution and is being financed from a Kuwaiti loan. It is expected that the economic benefits resulting from the irrigation project will encourage further extensions in the near future. There are, however, no plans for such extensions at the present time. Work on this extension has been stopped since 1967 because of reasons stated earlier.

The overall valley plan for the development of the Jordan Valley calls for the construction of two nearly parallel main canals which will cover the entire length of the project area. One, forming the continuation of the existing northeast Ghor Main Canal (discussed previously), will run along the bank of the Jordan River and the other,

branching off with a siphon across this river, will run along the west bank. The two canals, laid out on a very gentle slope, will supply a net area of 375,950 dunums out of a possible irrigable area of 447,500 dunums. Only 34,700 dunums will be irrigated by pumping from the main canals while 342,250 dunums will be irrigated by gravity. The remaining 71,550 dunums will be irrigated from the side-wadis, either by pumping or by gravity.

The regulated flows of the Khalid Bin Al-Walid and Maqarin Reservoirs on the Yarmuk River will, when completed, flow into the main canal system through the Wadi Arab Power station, while a diversion dam at Adassiya will divert the uncontrolled water of the intercatchment area between Mukheibeh and Adassiya to the same canal system. Waters of the side wadis, whether regulated or not, will be used to irrigate areas above the main canals before the balance is diverted into the main canal system. One exception to this is formed by the water of the Wadis Shueib, Kafrein and Hisban which will be diverted completely to the Southeast Ghor Main Canal -- which could otherwise have been irrigated directly from these wadis with groundwater.

At present, the existing irrigation in the Jordan Valley covers an area of some 300,000 dunums:[1]

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[1]Dar Al-Handasah Consulting Engineers, Beirut, and Netherlands Engineering Consultants, the Hague, Jordan River and Tributaries Regional Corporation, Jordan Valley project, Agro and Socio-Economic Study, Vol. 3, Annex J, p. 21.

a.	Northeast Ghor and northeast Zor areas	122,000 dunums
b.	Side wadis	79,000 dunums
c.	Other Zor areas	34,000 dunums
d.	Groundwater	54,000 dunums
e.	Springs	10,000 dunums

The areas under a and c, 156,000 dunums together, are at present supplied from the Northeast Ghor Main Canal. The areas under b and d are situated above and below the proposed Southeast Ghor and West Ghor Main Canals, whereas the springs only irrigate above these canals.

Some modifications will have to be made in this existing irrigation system to adapt it to the new plan. In principle all areas situated below the main canals will be irrigated from these canals by gravity. The groundwater pumps below the main canals will be removed to areas above these canals.

The areas to be supplied by pumping from the main canals are to be laid out in their final form right from the beginning. Switching of the irrigation method,, e.g. from groundwater to pumping from the main canal or the reverse will always entail extra cost. Irrigation by

groundwater, on the other hand can be substituted for an existing side wadi irrigation. This will be the case with the areas to be irrigated from the Wadis Shueib, Kafrein and Hisban, since this method will in the course of time be superseded by irrigation from wells and springs.

Layout of the Irrigation System

The layout of the irrigation system is based on the introduction of tertiary units. The size of these units, which depends on topographical conditions, will vary between 300 and 1200 dunums with an average of 800 dunums, between 20 and 25 farms.

According to the system now in existence, the Irrigation Authority delivers water to each individual farmer. For the whole project area of 447,500 dunums, depending on the farm size, some 11,000 to 14,000 gates would have to be operated by the Authority. This would require an enormous organization and administration.

In the proposed system the responsibility of the Authority will be limited to the supply of water to the tertiary units, whereas distribution to the individual farmers within these units is left to the farmers. Thus, the Authority only has to operate some 560 headgates, serving the tertiary units so that skilled manpower and operation and administration costs will be reduced considerably.

A further advantage of the introduction of tertiary units is that the water economy will be imporved. If the Authority has to meet the individual demands of more than 10,000 farmers, considerable fluctuations in demand will occur during short periods. As it is not possible to regulate the flow in the main canals with a length of 150 km, water will be wasted when the demand drops. However, when water is delivered to tertiary units, farmers will establish an internal rotation within the tertiary units and supply to these units will vary only gradually, so that the flow of the main canals can be adopted to actual demand.

It is essential for the success of the selected system, that cooperation can be established among the farmers in a tertiary unit. Experience in Jordan as well as abroad proves that such cooperation is feasible if the number of farmers, participating in one tertiary unit, is not too great. It may take some time for good cooperation to be achieved and in that case the Authority should temporarily assume responsibility for the water distribution inside the units, e.g. for a period of one to two years.

Apart from the above arguments with regard to operation and water economy, the following advantages of introduction of tertiary units should be mentioned:

The design and construction of the secondary canals can be carried out without the land allotment, provided sufficient right-of-way is arranged for on a provisional basis.

The procedure for redistribution and allotment of properties and other time consuming legal actions can take its course over the entire area without being bound to the construction schedule.

The possibility is created for proper sizing and orientation of the farm plots in respect to erosion problems.[1]

The Areas to be Irrigated

The net irrigable area have been determined from the soil maps and the topographical maps, and are indicated in Table 18 divided in areas above and below the main canals.

Table 31

Irrigable Areas in the Jordan Valley (dunum)[1]

Ghor and 200 Areas	Above Main Canals	Below Main Canals	Total
Northeast Ghor and northeast Zor	34,500	127,000	161,500
Southeast Ghor	25,000	117,750	143,750
Southeast Zor		17,000	17,000
West Ghor	45,250	64,000	109,250
Northwest and southwest Ghor		17,000	17,000
Total Jordan Valley	104,750	342,750	447,500

[1]Ibid., p. 2.

Large areas can be irrigated by gravity or by pumping from either the side wadis, the main canals or from groundwater and springs.

The most attractive solution is to use the baseflow of the wadis as far as possible for irrigation of the adjacent land. In this way the cost of conveyance and pumping to the areas along the wadis situated above the main canal is kept low. When the base flow exceeds the water requirements of the area along the wadis, it will be diverted to the main canals.

Likewise groundwater and water from springs is to be used for areas above the main canals.

Water conveyed through the main canals should preferably be used for irrigation of the areas below these canals.

Some areas situated above the main canals cannot be commanded by gravity or pumping from the wadis, or by groundwater or spring water. In these cases the water required has to be pumped from the main canals.

In conformity with the above guiding lines the next areas to be irrigated from side wadis, by gravity and by pumping, have been determined in Table 32.

Table 32

Net Irrigable Areas to be Irrigated by the Side Wadis (Gravity and Pumping) and by Pumping From the Main Canals (in dunums)[1]

Wadi Area	Irrigation from side Wadis		Total	Pumping From Main Canals	Total
	By Gravity	By Pumping			
Northeast Ghor					
Arab	3600	1250	4850	2850	7700
Ziglab	3350	800	4150	850	5000
Jurum	900	100	1000	1550	2550
Yabis	200		200	700	900
Kufrinja	1300		1300	8175	9475
Rajib	800		800	2425	3235
Zerqa	5050	200	5250	400	5650
	15,200	2350	17,550	16,950	34,500
Southeast Ghor					
Shueib	5000		5000		5000
Hisban	650		4500		4500
Total	25,350	2350	27,700	16,950	44,650

[1]Ibid, p. 3.

The source table includes areas of the West Ghor which have been omitted here because they are outside the study area.

The total area situated above the main canals, irrigated in this way amounts to 66,400 dunums. According to Table 31 the total net irrigable area above the main canals is 104,750 dunums, consequently 35,350 dunums will have to be irrigated with water from groundwater wells and springs, of which 10,150 dunums in the South East Ghor Area will supply.

Since it is assumed that the quantity of groundwater and water from springs, more or less concentrated in the southern part of the Jordan Valley, is sufficient for the irrigation of 50,000 dunums, extension of the area to be irrigated from wells and springs is to be sought in the Southeast Ghor Area. Therefore, the areas situated above the main canals which are irrigated by gravity from the Wadis Shueib, Kafrein and Hisban, 5,000, 4500 and 650 dunums respectively will in course of time be supplied by wells and springs and the flow of the three wadis be diverted into the southeast Ghor Main Canal. Then, only 1500 dunums are left to be irrigated by groundwater below the main canal.

A summary of the net areas to be irrigated in the Jordan Valley and the sources of irrigation water is given in Table 33 below.

Table 33

Sources of Irrigation Water and Irrigated Areas (in dunums)[1]

	Northeast Ghor Northeast Zor	Southeast Ghor Southeast Zor	West Ghor Northwest and Southwest Zor	Total
Irrigation from side wadis				
by gravity	15,200		4,000	19,200
by pumping	2,350			2,350
Irrigation from main canals				
by gravity in the				
Ghor Areas	122,000	116,250	64,000	341,250
Zor Areas				
Irrigation from main canal				
by pumping	16,950		17,750	34,700
Irrigation by groundwater				
and spring water		26,500	23,500	50,000
Total	161,500	159,750	126,250	447,500

[1]Ibid, p. 4.

Project Subdivisions

For purposes of this study the Jordan Valley has been divided into three subdivisions. These are the East Ghor North, the East Ghor South, and the West Ghor. (The last not included in this study for reasons indicated earlier) Each of these was further divided into two primary sub-areas, above and below the main canal. The Zor was segregated in tabulations to indicate its relative importance, although it will be an integral part of the area served by the main canals.

East Ghor North:

The East Ghor North subdivision comprises the lands lying between Yarmouk River in the extreme northern part of the valley and the Zerqa River, which forms an approximate mid-point dividing line of the lands east of the Jordan River. The lands extend from the Jordan River eastward to the steep slopes leading out of the valley. Nine sizeable wadis provide drainage, forming a series of small alluvial fans and interfan area. The general gradient is in a westerly direction, and the elevation ranges from approximately minus 212 meters along the Main Canal location in the Adasiya vicinity to about minus 226 meters near the Zerqa River Annual precipitation in this subdivision is of greater magnitude than any other portion of the valley and ranges from about 400 mm. near Adasiya to about 200 mm. near the River Zerqa.

Soils:

The soils of the Ghor have been formed mainly from alluvial materials that were stream borne and by general outwash from the uplands. This mantle was laid down over fine textured lake deposits (marls) and thins out as it approaches the "break" between the Ghor and Zor. Textures on the fans vary, but are predominantly medium with rock and gravels in the profiles being a limiting factor, especially in those areas adjacent to the hills. On the edges of the fans, clay loams predominate with clays occuping the interfan regions. Organic matter, while still relatively low, is higher in this northern area than any other part of the valley. Rainfall, together with other weathering agents, has played a principal part in modification of the soils. The lake-laid materials have undergone changes to such an extent that it is difficult in most cases to identify the original laminations and in most instances the structure has become softly consolidated. Marls were found to be present in the one and a half meter zone of depth in only 5 per cent of arable area.

Topography:

The series of alluvial fans in this area give rise to slopes who gradient is seldom greater than four per cent. Complex slopes of short runs occur on the upper

edges of the fans adjacent to the foothills. Gradient on the larger fans, such as those of the Wadi Arab and River Zerqa, is relatively smooth with long uniform slopes. The fans between the Wadi Rajib and River Zerqa are indicative of the larger interfan areas which are of medium to heavy texture with long gentle slopes. Above the location of the Main Canal, cover is generally composed of rock, while some vegetation removal will be required below the canal.

The Zor area is characterized by old stream channels which have been filled in by flood action. The resulting complex slopes will require a major degree of leveling in these instances.

Drainage

Conditions for adequate surface drainage are favorable, except for localized areas there should be little difficulty in establishing drainage outlets through natural stream channels.

Approximately seven percent of the arable area has characteristics which indicate present or potential subsurface drainage problems. These areas are primarily indicated by the presence of a water table within the meter and a half depth of soil profile. This condition has developed where there is a pronounced differential in hydraulic

conductivity of the soils in connection with a slope differential and in areas where fuguares have been neglected or abandoned. Field observation indicates the clay to be of the expanding lattice type. Under present limited irrigation, drainage problems are not acute; however, irrigation with a full water supply will tend to aggravate conditions in this area. Controlled application of water, development with shallow rooted crops, encouragement of water penetration through use of gypsum, and installation of closely spaced drains are recommended.

Problem areas on the Zor occur as a result of the proximity of the Jordan River Water Table, and from seeps or springs from the rough area which separates the Ghor and Zor. Installation of an interceptor ditch will effectively aid the latter condition while arable areas affected by the river water table can be productively farmed to shallow rooted crops with controlled irrigation practices.

Salinity and Alkalinity

In the area north of the River Zerqa soils are generally low in soluble salts and in exchangeable sodium and gypsum. It has been noted that in practically every

case when clay content is below 60 percent the total soluble salts are below 0.2 by percentage, and exchangeable sodium is well below the critical point of 15 percent. Field permeability tests also indicate an adequate infiltration rate for the majority of the areas represented by these samples.

In the few areas where an excessive degree of alkalinity was found, the subsoil was the zone primarily affected. This condition is generally restricted to small areas in the vicinity of Adasiya, and where found, the soils are producing shallow rooted crops successfully. These soils show a clay content in excess of 60 percent with correspondingly low permeability rates. Although the total area represented by these latter conditions is small, they should receive additional study as the project proceeds. Soil amendments such as gypsum, and crop rotation including deep rooted crops should aid water penetration. The beneficial effects of drying on clay soils, through summer fallow, are also considerably important.

East Ghor South

The East Ghor South subdivision extends from the River Zerqa South to the northern edge of the Dead Sea, and from the steep slopes of the eastern foothills westward to the Jordan River. Lands in this subdivision lying north

of the general vicinity of the surfaced road leading westward across the valley to the Damiya Bridge and the West Ghor, are rough and broken in nature. Southward from this vicinity the lands become generally smooth and gentle sloping.

The wide alluvial fans of the Wadi Shueib, Wadi Kafrein, and Wadi Hisban are partially irrigated with a limited water supply. The general gradient is west toward the Jordan River and the area slopes to the south from an elevation of about minus 226 meters at the River Zerqa to approximately minus 392 meters at the Dead Sea. Rainfall in the area decreases from about 250 mm. near its northern boundary to about 100 mm. in the southern section.

Soils

The most favorable soils are located on the broad, smooth, gently sloping alluvial fans of the three major wadis previously mentioned. Textures on the Wadi Shueib fan are loams, clay loams, and light clays with considerable rock in the area adjacent to Shunat Nimrin. Southward the fans of Wadi Kafrein and Wadi Hisban are lighter in texture with clay loams and loams predominating and sandy loam near Suweima. Soils on these fans are deep, porous, and relatively free of soluble salts and alkali. Where irrigated these areas produce good crops. Marl is seldom found within the one and a half meter depth.

Topography

The majority of the East Ghor South area is characterized by long, gently sloping gradients well adopted to irrigation agriculture. Major exceptions to this condition are found immediately south of the River Zerqa and north of Karama where numerous small wadis cross the area, and in the Zor. Leveling on the areas first mentioned above will be limited by shallowness, and the existence of marl and rock in the profile. Less apparent, but of significance, are the small ridges formed on the Ghor by wave action as the old inland lake receded, primarily found near the Katar south of the Ghor Nimrin area. Steeper gradients and rock cover are generally found above the Main Canal location as the result of stream outwash from the hills.

As in the other subdivisions, the Zor requires a significant degree of leveling and clearing. This is particularly true in southern areas where flooding action of the Jordan River and outwash from the Ghor and Katar have left practically filled channels, and thick growths of cane and salt cedar are prevalent.

Drainage

About one percent of the arable land area has evidence of a water table within the one and a half meter

zone. The majority of this land is located along the lower edge of the Ghor where water has been trapped by low alluvial ridges. Numerous channels pierce these "barriers" and removal of surface waters should be readily accomplished. The soils of these areas adjoining the Katar are generally heavy in texture and act as a vertical barrier for subsurface water. Fuguaras in the vicinity of Karama and Ghor Nimrin and artesian aquifers in the Ghor Nimrin and Ghor Kafrein areas create a drainage problem. Much of this land is within the area to be reclaimed by leaching practices. Infiltration tests have revealed the soils to be permeable.

Drainage problems on the Zor are primarily limited to small springs and waste irrigation water emerging from the Katar. An interceptor ditch at the "toe" of the slope is recommended for control in these localities. Minor areas present problems in the form of depressions resulting from partially filled stream channels leveling will materially aid this present condition.

Salinity and Alkalinity

Approximately 25 percent of Class 1, 2, and 3 soils are affected slightly by salinity, while Class 4 lands show high content of sodium, gypsum and other soluble salts. Washing on experimental areas have reduced salt contents and hence the lands became cultivable.

In the vicinity of Karameh, the caving of a number fuguaras has created a salinity problem, by forcing water with a rather high soluble salt content to the surface.

Near the Dead Sea, receeding waters left heavy salt deposits. Soils towards the Dead Sea tend to have light textures and should be readily reclaimable.

Summary and Conclusions

The arid climate of the Jordan Valley makes irrigation necessary for successful production of most crops. This is particularly true in the southern part of the area where rainfall contributes very little toward plant growth. All lands within the natural east-west topographic boundaries of the valley from the Yarmouk River to the Dead Sea within Jordan were classified as to their suitability for sustained irrigation agriculture. The gross land area within the project is approximately 942,800 dunums. Of this total, about 347,500 dunums are currently suitable for crop production, and about 172,300 dunums are capable of varying degrees of crop productivity after reclamation.

Soils are generally immature (highest development occuring in the extreme northern end), relatively low in organic matter, and of a calcareous and gypsiferous nature.

The basic fertility of the soils is relatively high with the exception of nitrogen and phosphorous. Textures range from light to heavy, with clay loams and clays predominate. Water holding capacity of the soils is good and penetration rates are satisfactory with the exception of a few scattered areas in the northern part of the East Ghor.

Topography of the project area is favorable for irrigation development with minor modifications. Light to moderate leveling will be required on the Ghor areas, primarily on the edges of alluvial fans and in areas adjacent to the Katar. Areas dificient topographically, primarily due to gradient, occur at the foot of the steep side slopes of the valley and to a lesser degree adjacent to small stream channels. Zor areas in general will require moderate to heavy leveling. Cover in the form of rock or cobble is most prevalent on the upper reaches of the Ghors and in the vicinity of stream channels. Vegetative cover exists as relatively small brush with heaviest concentrations found on the Zor in the form of cane, salt cedar and tamarisk. A minor area in the vicinity of Wadi Hisban is covered with scrub trees.

Surface drainage is favored by the natural slope from the side hills to the Jordan River and from north to

south, with the exception of localized areas where shallow depressions occur in the Ghors. Numerous stream channels provide natural outlets for surface water. Subsurface drainage appears to be of a more complicated nature due to the absence of significant layers of sand or gravel throughout the project, and due to relatively low permeability of some clays in the Adasiya vicinity, and along the "break" between the Ghor and Zor areas. However, field and disturbed permeability tests show that the majority of the soils are permeable. Soils high in soluble salt content and relatively shallow in depth to marl show appreciable quantities of gypsum in the profile and adequate infiltration rates. The largest group of soils with these characteristics occurs in the southern part of the valley. Leaching trials indicate that the major portion of these areas are susceptible to reclamation and they have been included in the arable area. Where the project area is fully developed to irrigation agriculture, an adequate and active drainage program is mandatory.

Alkalinity is not a serious problem in the Jordan Valley, except for a relatively few very small areas.

In the marl zones, heavy calcium carbonate and gypsum were laid down in stratified layers when the valley

was under water. Outwash soils from the adjoining hills are relatively high in calcium, and where they are quite thin over the marls, high soluble salt content is to be found.

Throughout the valley most of the overlayed soils are blocky to prismatic in structure, sound and not likely to puddle, swell, and seal during a leaching period. Almost all saline lands can be reclaimed, as indicated by trials at the Ghor Nimrin leaching plots and permeability tests made through the valley.

Because of the high gypsum content of a large part of the southern portion of the valley, some settling of the lands may follow leaching. This may nessitate some releveling of these areas.

Class 4 lands, all saline in character, constitute about 33 per cent of the 510,200 dunums classified as arable. Lands placed in Class 2 and Class 3 primarily because of a very slight degree of salinity total about 9 percent of the arable area. Of the Class 4 lands, about 2.4 percent are located in the East Ghor North; the remainder is almost equally divided between the East Ghor South and the West Ghor. The lower soluble salt and gypsum contents (the more modified profiles) can be attributed to heavier rainfall and present irrigation.

Chapter VI

Land Tenure

Until now we have been looking at the physical, and technical aspects of the development of irrigation schemes in Jordan. However, there are certain problems associated with land ownership and settlement which must be considered before these schemes can be implemented, in particular, the problem of land tenure and land reforms which lead into more efficient agriculture.

The Legal System

Like the other Arab countries which were under the Ottoman rule until the end of World War I, Jordan has an archaic system of land tenure. Furthermore, the system, based as it is on the old laws of inheritance whereby land is divided among all the heirs (albeit in the ratio of two shares for a male heir against one for a female), tends to compound its own short comings over time. According to the Ottoman system of land tenure, codified for the last time in 1958, the following categories of land are recognized:[1]

Mulk Land: which is in the full ownership of the proprietor and over which he has the right of free disposal. This category comprises mainly building sites in cities,

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[1]The description of these categories is standard and can be found in any book or essay on the subject. See, in particular, R.C. Tute, The Ottoman Land Code, (E.P.Dutton

towns and villages as well as land disassociated from the state land and transformed into mulk.

Miri Land: which refers essentially to state land, but where the state grants the heritable and assignable, right of possession to private individuals.

The title, however, remains vested in the State. The holder of the land in effect has an indefinite lease, provided he satisfies certain conditions. In principle, this land reverts back to the State if the holder dies without heir, or if he neglects to cultivate the land without acceptable excuse for three years or more. These provisions are rarely applied.

Mawat Land: Literally means dead land, and refers to land which belongs to no one and which has not been put for use by the public. A considerable part of the land in Jordan belongs to this category. It consists of uncultivable land (given the present technology and capital endowment of the country), and of land which is not granted for cultivation (a rare case in Jordan, if at all exists).

Matruka Land: which is land left for the collective use of the public in the form of roads, pastures, threshing floors, etc.

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[1](Cont'd.) and Co., N.Y., 1945) and Doreen Warriner, Land and Poverty in the Middle East, (Royal Institute of International Affairs, London, 1948).

Public Lands or State Domain: which as a category differs from Miri land in the following respect. State domain is either Miri land in cases where control over the land has reverted to the State on violation of the conditions of Miri, or land actually operated by the State or left for its operation, such as forest reserves, mines, land and buildings purchased by the State, or land that had been the property of the Ottoman Sultan and was transferred to the State upon the disappearance of the Ottomans.

Waqf and Trusts: which refer to land that has been endowed as an irrevocable and perpetual gift. The endowment may be for religious and charitable purposes (called Waqf Khayri), or for the benefit of religious or charitable objectives (called Dhurri). Only land in the Mulk category can be declared Waqf because the right of transfer attaches only to this type of land.

These centuries-old categories still exist in Jordan. Two major departures have taken place. The first is embodied in Law No. 41 of 1953, which provided for the conversion, under certain conditions, of land of the Miri category into Mulk. This law stipulates that all land falling within municipal boundaries is Mulk land, regardless of its earlier designation. The law extends to all localities which are not municipalities today but may be at a later date.

The second departure was embodied in the East Ghor Canal Law No. 14 of 1959. This law will be discussed below. Suffice it to say here that it treats the whole area of the East Chor Canal (land included under the new Law No. 37 of 1966 and all further land benefiting from future major irrigation works) as Mulk land. In addition, it stipulates that land units (the minimum area of which is 30 dunums each) may not be fragmented for any reason).

Land Tenure in Jordan

The predominant form of agricultural land tenure in Jordan is that of the owner-operator. The agricultural census of 1965 shows that 65 per cent of the agricultural area was operated by owners and another 20 per cent was operated by both owners and tenants. Less than 12 per cent of the area was operated by tenants. (Table 34) The major form of tenancy is that based on share-cropping. Share-cropping was more common in the Jordan valley than it was in the country as a whole (Table 35), but this situation has changed, at least in the East Ghor Canal area.

The shortcomings of sharecropping arrangements that are commin in Jordan, and indeed in the whole of the Middle East, stem from the unequal relation between the tenant and the landlord. The strength of the latter is increased because of the services he can provide, aside

from the use of the land. He supplies credit, seed, water, even labor and ploughing facilities under varying combinations, and charges heavily for the services. Furthermore, the tenant has generally no written contract so that, although the individual tenancy arrangement may be of long term, the power of termination of the arrangement is totally in the landlord's hand. Ottoman law makes very little provision for the protection of cultivators and their compensation if evicted. Apart from an ordinance in Palestine, the "Protection of Cultivators, Ordinance 1933-34," the applicability of which to West Jordan is anyway dubious, there is no legislation to regulate the important question of the relationship between landlord and tenant. The insecurity of tenure and the absence of protective legislation have serious implications on agricultural production. The relations of the tenant with the landlord cannot be easy, and the tenant is not likely to invest in the land. Indeed, his attitude to the land becomes that of the miner who tries to get as much out of it as he possibly can during his stay, not mindful of the future since he has no assurances that his association with the land will be long.

Table 34

Distribution of Holdings by Type of Tenure
(By percentage and area)[1]

Type of Tenure	Per cent of total area	Area (000 dunum)
Owned	65.2	4426
Rented	11.6	787
Rented for cash	0.5	34
Sharecropped	11.1	753
Other	3.4	231
Mixed	19.8	1344
50% or more owned	10.4	706
50% or more rented	9.2	624
Other	0.2	104
Total	100.0	6788

[1]Jordan Department of Statistics, Report on Agricultural Census 1965, Amman, June 1967, P.

The area in parentheses is attributed to the post enumeration sample.

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Table 35

East Jordan Valley, Number of Holdings and Area by Type of Tenure 1961[1]

Type of Tenure	Number of Holdings	% of Holdings	Area Dunum	% of Area
Entirely owned by operator	830	24.8	67550	32.5
Entirely share-cropped	1872	56.0	81160	39.0
Entirely leased short term	30	0.9	1300	0.6
Entirely leased long term	64	1.09	2390	1.01
Occupied free of rent	121	3.06	6170	2.09
Mixed owned and not owned	343	10.3	41960	20.2
Other mixed tenure	81	2.4	7410	3.06
Total	3341	100.0	20794	100.0

[1]Department of Statistics, The East Jordan Valley, A Social and Economic Survey, Amman, 1961. Table 63, p. 159 The source table presents data broken down by size holding. Percentage columns added.

Size and Distribution of Land Holdings

Until recently, the only published information available on size of land holdings and their distribution was found in the 1953 Agricultural Census[1] for holdings of ten dunums or more and in two studies on the Jordan Valley.[2] Information was also available on the East Ghor Canal area after the application of Law 14 of 1959 and its amendments involving the reallocation of ownership. In 1965, an agricultural census[3] supplied information on distribution of land holdings by size, but the final results diverged from the pilot sample survey to such an extent that a post-enumeration sample survey was undertaken in the spring of 1966 to check on the results. The findings proved acceptable as far as the number of holdings are concerned, but the data on the total area and the size of holdings are considered unreliable and generally understated.[4]

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[1]Jordan, Department of Statistics, 1953 Census of Agriculture, Amman.

[2]A 1955 study was prepared for UNRWA by Mr. Najmeddin Dajani, then Economic Analyst of UNRWA and appeared in February 1956 under the title Jordan Valley Land Tenure Survey; the second was prepared by the Department of Statistics and appeared in 1961 under the title: The East Jordan Valley, a Social and Economic Survey.

[3]Jordan, Department of Statistics, Report on Agricultural Census 1965, Amman, 1967.

[4]Ibid, p. 11.

In Tables 36 and 37, the pattern of ownership (or of holdings) is presented both for the country as a whole as given by the 1953 and 1965 censuses as well as for Jordan Valley. Furthermore, except for the East Ghor Area, comparisons over time would be unsafe because of the differences in concepts used and the general unreliability of the results. Caution must therefore be taken in drawing conclusions from the distribution patterns merging.

The available information on the distribution of holdings by size should therefore be considered as no more than indicative of the general pattern. A rough but clear similarity of pattern can be seen in the pictures presented in Tables 36 and 37. About one-third of the number of agricultural holdings seem to be less than 10 dunums in area and another one-third from 10 - 50 dunums. Large holdings, by Jordanian standards of 1000 dunums or more, numbered 666 in the 1953 census (but only 276 in the 1965 census, which is probably understated). Their area was put at 2,090,000 dunums, or about one-fifth of the area of all holdings above 10 dunums. It would thus seem that the predominant type of land holding is one of small size not exceeding 50 dunums, but that a sizable part, perhaps one-fifth of the cultivable area is in large holdings exceeding 1000 dunums in size.

Table 36

Number and Area of Holdings by Size Group[1]
1953 and 1965

Size Group Dunums	1953 Census No. of Holdings	1953 Census Area in 000 Dunums	1965 Census No. of Holdings	1965 Census % of Total No.
Less than ten dunums			33986	36.4
10 and less than 20			10194	10.9
20 and less than 30			9364	10.0
30 and less than 40			7621	8.2
Sub-Total 1-50	43899	11450	32573	34.9
50 and less than 100	21332	1472	14.221	15.2
100 and less than 200	15456	210	8.003	8.6
200 and less than 500	9028	259	3745	4.0
500 and less than 1000	1687	1108	688	0.7
1000 and less than 2000	421	555	198	0.2
2000 and less than 5000	178	507	60	0.1
5000 and less than 10,000	45	283	16	
10,000 and over	22	741	2	
Total Holdings of 10 dunums and over	92068	10510	59506	
Total all holdings			93492	100.0

[1]Jordan Department of Statistics, 1953 Census of Agriculture, Amman, n.d., pp 3 and 7; Report on Agricultural Census 1965, Amman 1967, Table on p. 86.

Table 37

Distribution of Ownership in the Jordan Valley December 1965[1]

Size	No. of Owners	% of Owners	No. of Fragments
Less than 5	1014	21.82	1368
5 and less than 10	544	11.71	451
10 and less than 20	728	15.67	1397
20 and less than 50	1029	22.15	2426
50 and less than 100	578	12.44	1972
100 and less than 200	360	7.75	1493
200 and less than 400	205	4.41	1954
400 and less than 600	70	1.51	848
600 and less than 800	40	0.86	402
800 and less than 1000	24	0.52	265
1000 and less than 2000	40	0.86	507
2000 and less than 5000	6	0.13	85
5000 and above	8	0.17	8
Total/Average	4646	100.00	13676

[1]UNRWA, Jordan Valley Land Tenure Survey, February 1956, Table, Appendix A, p. 23.

Table 37

Distribution of Ownership in the Jordan Valley
December 1965
(Continued)

Size	% of Fragments	Total Area Dunums	% of Total Area	Average Ownership Dunum	Average Fragments per Ownership
Less than 5	10.00	2110	0.49	2	1.3
5 and less than 10	6.95	4000	0.92	7	1.8
10 and less than 20	10.21	10680	2.46	5	1.9
20 and less than 50	17.75	33050	7.61	32	2.4
50 and less than 100	14.42	39770	9.16	69.8	3.4
100 and less than 200	10.92	51230	11.78	142	4.1
200 and less than 400	14.29	57390	13.22	280	9.5
400 and less than 600	6.70	34670	7.98	495	12.1
600 and less than 800	2.94	27650	6.37	691	10.1
800 and less than 1000	1.93	21810	5.02	909	11.0
1000 and less than 2000	3.71	54190	12.47	1355	12.7
2000 and less than 5000	0.62	17830	4.10	2971	14.2
5000 and above	0.06	80020	18.42	10002	1.2
Total/Average	100.00	434390	100.00	93	2.9

No systematic data is available on the fragmentation of agricultural land ownership in Jordan, although it is believed to be extensive. The Jordan Valley Survey of 1955 (Table 38) indicated that on the average there were 2.9 fragments of irrigated land per owner in the valley. It also showed that the least fragmentation occured among owners with less than 20 dunums while fragmentation was highest among owners with 400 to 5000 dunums. Conditions in the Jordan Valley in 1955 cannot be taken, however, as representative of other parts of the country, particularly of the old settled part of the West Bank and some parts of the eastern highlands, especially in rainfed agricultural land.

Proposals

It is felt that a thorough review of land tenure conditions is needed in Jordan with a view to removing obstacles which stand in the way of a more efficient use of the limited land resources and of higher productivity. The report of the mission by IBRD on the Economic Development of Jordan has modestly recommened in 1955:

> "The mission realizes that reform of long established practices backed by influential interests will not be easy to achieve. It strongly recommends, however, that selected members of the

> Agriculture, Land and Legal Departments be appointed as a Royal Commission to study the subject with a view to arriving at a legalized form of landlord-tenant relationship that will protect the interest of both parties and will encourage full use and development of the land. The resulting legislation should cover all the major interests of tenant and landlord, notably rent, allocation of expenses, security of tenure, compensation for improvements and termination of tenancy because of bad husbandry."[1]

It is recommended here that a wider enquiry be started at an early date with technical assistance from the FAO of the United Nations to study all aspects of land tenure problems in Jordan and to make proposals and submit draft legislation aiming in particular at the following:

Protection of the rights of tenants, particularly the sharecroppers, and of their security of tenure.

Preventing further fragmentation of holdings and devising means for consolidating very small fragmented agricultural holdings.

Re-distribution of large holdings of rain-fed land.

Improvement of living conditions and gradual settlement of the nomadic population.

Study of water rights and their regulations for efficient use of this scarce resource.

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[1] International Bank for Reconstruction and Development, The Economic Development of Jordan, John Hopkins Press, Baltimore, 1955, p. 131.

Extension of the system of land reform in the East Ghor Canal area to other parts of the country.

Prevention of practices aiming at circumvention of the provisions of this land reform.

Finding means of consolidating old rural debt and its gradual liquidation.

Proposing measures to synchronize land reform policies with measures relating to credit, marketing, water use, institutions, etc.

Ownership and Settlement

A major concern of government must be the selection of a settlement pattern which will ensure the most effective exploitation of the available resources.

The following are possible methods of exploiting water resources:

1. Now that ground water is known to exist in many areas, it can be left to private landowners to determine its extent and to undertake development on their own initiative.

2. The government can systematically explore and determine the extent of the acquifer. It can then sell the wells to the owners on whose land they are sited or alternatively it can charge for the use of water, if and when the landowner wishes to use it. In both cases, development would be left to private initiative in the manner of number one above.

3. The government can take it upon itself to develope the land and water resources of the project area, including the layout of farms and irrigation.

Although it would be wrong to be dogmatic on this issue, there is a strong presumption that if development was left to private landowners, it might not get started at all. In the case of number one, where exploitation of water resources is left in private hands, the cost of drilling wells and the risks of incurring unproductive expenditure through failing to strike water are obvious deterrents to development. In number two, where the government drills the wells and charges for the use of water, there is the possibility that landowners could arrest development and virtually hold the government to ransom for lower water charges. These demands would be difficult to resist since the government would be anxious to recoup (as far as possible) its drilling costs.

Perhaps an even greater objection to the private exploitation of water resources is the danger of land values. This could only lead to undesirable development from the government's point-of-view. On the one hand, it could lead to the buying up and accumulation of land in a relatively few hands, it is understood that this would be unacceptable

to government both because it is inequitable and it would not achieve the official objective of seeking to settle the nomadic farmer in some areas and to improve agriculture in general. On the other hand, if small-scale farming did arise, not withstanding high land values, these would impose a heavy repayment charge on the peasant farmer and cripple his attempts to intensify his farming system (through reduced saving) which the economic use of ground water demands. One has only to refer to the consequences of the unduly high compensation payments for land in the East Ghor to emphasize this danger. It could not be to the benefit of Jordan, if water resources were inadequately exploited and if the profits of land speculation were to benefit only a few landowners.

It follows that these dangers would be avoided if the development of water resources were achieved by a government controlled settlement schemes as in number three. This is not to suppose that such an approach would automatically achieve success; far from it. Many, though different, problems would arise and some of these are discussed below. However, a controlled settlement scheme is more likely to achieve the broad aim of government which is the general economic advance of the poor rural farmers in

these areas, if the economic exploitation of water resources makes this possible. In any case, if there is a risk that inadequate or undesirable development may result if left to private initiative, can such a risk be taken when the welfare of the rural people is at stake?

The controlled settlement of peasant farmers on newly irrigated land touches, of course, upon the difficult problem of land reform. The development of water resources by means of small scale peasant farm settlement will, therefore, almost certainly involve the transfer of land which implies the expropriation of private landowners and their subsequent compensation. This type of land reform has already been experienced in Jordan on a large scale in the East Ghor development of the Jordan Valley.

It is well known that these reforms have come up against several serious difficulties which should at all costs be avoided in the development of future projects. Firstly, it is generally agreed (except by the recipients of compensation) that the terms of compensation to previous landowners in East Ghor were far too generous. This meant that the whole project was over-capitalized from the start (in relation to the potential productivity of the land). Secondly, an over rapid ten year repayment of compensation

was initially demanded of the settlers. Both these factors place an excessive burden of debt repayment on the shoulders of the farmer. The consequence of this is to reduce current net farm incomes to the point where savings would be inadequate to finance the further development of family holdings, the reverse of what government would consider desirable.

In the event, the settlers have strongly opposed rapid debt repayment and charges have been reduced. But the excessive compensation terms cannot be undone. After this experience, it may be thought trite to say that reasonable terms of compensation and repayment should be insisted upon for future settlement schemes. Nevertheless, it should be constantly borne in mind that savings out of farm income are the major source of investment funds for the further development of peasant holdings. A surplus over and above subsistence must therefore be left in the hands of peasant farm families. If irrigated farming is shown to be economically attractive to the new farmer, then he will be readily settled. Nevertheless, government must be prepared to employ a considerable extension or advisory staff to help overcome the unavoidable deficiencies, mentioned above, of exclusive nomad settlement.

The best method of settlement in the project area will, of course, be a matter for some debate. But if the

settlement of small scale farmers is anticipated, then it is essential that the considerable experience of Miss Coate,* for example, at Abdelliyeh (in Wadi Dhaleil Area) should be studied carefully. The aim of settlement here is ultimately to hand over the titles of ownership of the holding to the settler once he has proved himself. Ultimate land ownership is looked upon as essential to provide the settler with sufficient incentive to undertake the necessary effort and later expenditure of capital which the full development of land and water resources requires. After carefully selecting settlers' families, Miss Coate installs them on a prepared holding (stones cleared and laid out, with house ready to occupy). They are paid an allowance of JD 10 a month in this initial phase; therefore, they are not even tenants but more or less employed labor serving an apprenticeship. The settlers have complete freedom over their cropping decisions, but they receive supervision and advice from a farm manager as to the most profitable crops to grow and the husbandry methods most suitable to the area.

In time the settlers are expected to develop into proficient farmers. At this stage they are handed the titles to their farms when they become fully responsible

*Miss Coate is a Protestant missionary who pioneered irrigation in formerly desert areas by pumping underground water. Soon after, many people with capital followed suit. The adjacent areas (Wadi Dhuleil) became the site of Bedioun settlement scheme.

for the commercial aspect of their production. The monthly allowance ceases and they reap the full rewards of their own efforts and decisions. They have, of course, to repay in full the money advanced to them.

Land Settlement

The methods of settlement employed and the suitable selection of settlers are of supreme importance and must have a profound effect on the successful development of any settlement scheme. Regarding the second point, it is declared government policy that only Bedouin people shall be settled in Bedouin areas. Consequently, developments in the project area will necessarily be based on Jordan nomads. Though it may be unpopular to say so, it should be pointed out on scientific and agricultural grounds that the chances of successful settlement, the rate of development and the possibility of introducing intensive farming systems -- which alone can justify the high investment irrigated agriculture requires will certainly be reduced with the exclusive settlement of former nomads. Ideally, a certain proportion of refugee farmers should be included in the scheme to serve as an educative element. They are experienced in irrigated farming, more business-like than the nomads (though less skilled in animal husbandry) and would thus serve as demonstrators who would be of enormous help to the newly-settled peasant quite uninitiated in

the ways of irrigated farming. So, the exclusive settlement of nomads will increase the uncertainty of initial stages of development, it will slow down the rate of development and make the successful introduction of more complicated, though highly productive farming systems less assured.

This is, in spite of the fact that, the general attitude towards Bedouin settlement is unduly pessimistic. He has been nomadic in the past because he was forced to be by economic circumstances. Indeed, economic land use in Dhuleil and other desert areas required nomadism. But it is held by senior officials that investments which have previously been undertaken on the holding including the cost of land though the repayment terms have not yet been worked out. It is interesting to note that in the first two years of development at Abdelliyeh, titles to ownership are being handed over to five out of nine settlers. One important proviso, which Miss Coate considers to be essential, is authority. In a government sponsored scheme this would also seem to be essential. One particular advantage of this is that the advisory services would be in a stronger position to persuade farmers to adopt the more intensive farming systems which the economic use of water requires and which is underlined by the suggested phases of development discussed later in this report. This process of

settlement is, of course, only one of many that could be employed in the development of the project being tried, tested and proven reasonably successful (it is understood that the apprenticeship period has been considered too long by some of the settlers) and should, therefore, merit serious consideration.

On the layout of settlement, Miss Coate considers that village settlement is the most effective way of fostering a co-operative spirit among settlers, who might otherwise feel isolated if their houses were sited on their own holdings. From the agricultural know-how point of view the introduction of village life would certainly make it easier for tenants to talk over their day-to-day farming problems and benefit, by discussions, from the knowledge of their more experienced neighbors. From an economic point of view, the village would be cheaper to supply with water, electricity and other services and it would be easier to arrange the collection of children for school attendance. Miss Coate also reckons that it would be a continuance of the Arab village tradition, but this argument is less relevant to the former nomad -- though to introduce him to a social existance is probably desirable, if only for the sake of his children.

A final point regarding settlement should be made. After a settlement area has been prepared for occupation, it is clearly impossible to hand over the holdings to settlers and leave them to get on with it. Not only is close and continuous supervision needed, but actual training is required in the techniques of irrigated farming, the production of new crops and the running of relatively complicated farm systems. The integration of stock into the farming pattern, for example, is a complicated business which will take some time to learn. But until this is done, the farmer will have no inclination or incentive to use a resting fodder crop and hence to preserve soil fertility. At the moment, for instance, the pioneer farmers on the edge of the project area hardly rest their land at all. On new soils, this has had no apparent bad effect to date, but it clearly will do so eventually.

In these early years of settlement, not only is close supervision essential, but government financing is also vital if successful development is to follow. This could take the form of a monthly wage (on the lines of Miss Coate) for subsistence of the family, but in addition loans will be necessary for stock, buildings, and planting material. This heavy financial aid would

certainly be necessary for the first few years, until standards of husbandry were sufficiently high to achieve satisfactory yeilds from crops and stock and until tree crops had come into bearing.

Farm Size:

The "Optimal" size of holding is an elusive notion which cannot, as many suppose, be sufficiently defined, for it depends on many variables. In the first place, it depends on the availability of land, labor, capital, management and water resources. A limitation of any of these will alter the optimal farm size. The management factor, for instance, is intimately concerned with the cultivators ability (given capital and labor) to operate intensive farming systems. There is definite evidence that the intensive cropping systems being practiced in Zarqa are highly profitable -- far beyond what is known normally. They would clearly enable a farm family to derive a good income from holdings much smaller than is commonly supposed. But if management ability is inadequate to cope with such intensive cropping, then larger holdings are needed. Likewise if capital is not available to allow the operation of these systems, the same consequence follows.

Secondly, the "ideal" farm size is dependent on the purpose of settlement. This might be to maximize

agricultural production, procure additions to food supplies at minimum cost, increase the employment of rural people, raise farm family incomes and so on. The purpose of settlement in the project area is a combination of all these aims. In precise terms, the aim is to settle as many people as possible (on the irrigable area) at a reasonable level of income. In this contest, the minimum size of holding (given the productivity of the farm system being operated) will be limited by the size of income which is considered reasonable and the level of savings thought desirable.

From this it will be seen that the crucial factor is the productivity or intensity of the farm system, that is why the need for an efficient advisory service is constantly emphasized here to foster their adoption -- for the more productive the system, the more people can be settled at higher incomes.

It is clear then that the selection of an "optimal" holding size must be an approximation balancing, on the one hand, what will appear to be the likely factor endowment position of labor, management ability, water, etc., And on the other hand, the aims of settlement policy.

In determining the desirable size of holdings in the project area a reasonable minimum family income is

taken to be JD 200 a year. A number of senior officials independently suggested this figure and the farm sizes developed later aim to equal or exceed this figure. The average size of family is taken to be 5.3 units providing 600 man days of farm labor a year and farm systems are designed not to exceed this family labor supply.

One particular factor affecting farm size in the project area is the establishment of tree crops. During the pre-bearing period they occupy land which yeilds no income for a long period -- though this can be partly overcome by intercropping between trees with annual crops. Nevertheless the overall effect will be the need for a somewhat larger arable area and, therefore, a large family holding to achieve the minimum income objective.

Land Reform

The need for reform

The information made available by the 1965 agricultural census, though not completely reliable, indicates that the pattern of land ownership is predominantly one of small holdings. This conclusion is in general agreement with the results of an earlier census taken in 1953 but which did not cover the smaller holdings of less than 10 dunums. According to the 1965 census almost half the

number of holdings in the country are less than 20 dunums in size and 95 per cent less than 200 dunums. There are about 280 holdings of over 1000 dunums and only 18 holdings of 5000 dunums or more.

On the other hand, fragmentation of holdings into smaller dispersed parcels is believed to be wide-spread and to have led to inefficiency of cultivation and production. The extent and problems related to fragmentation of holdings are accentuated by the antiquated legal forms of land rights, the pressure of rural population on the land, the division of ownership among members of large families by inheritance and by the process of land settlement itself which tends to parcel out the communal (Musha'a) land permanently.

As to the relations of the land operator to the land, the predominant form of relationship is that of owner-operator. Probably less than 12 per cent of the area of holdings in 1965 were operated by sharecroppers. However, another 20 per cent of the area was partly operated by tenants.

There are no laws or regulations which govern or organize the relationship of the tenant to the owner of the land, such relationship being still governed by custom and tradition.

The problem of land redistribution and consolidation is not at all an easy one. Apart from the initial legal, social and administrative difficulties it entails, its hurried application may imply a serious economic problem. For example, redistribution of land by raising the minimum size of private holdings to 30 dunums which is the minimum applied in irrigated land in the East Ghor Canal area, and reducing the maximum size to 200 dunums will not be capable of absorbing all landowners. However, with a rational distribution of existing land, coupled with an appropriate cropping pattern, it would be possible to raise income and employment in agriculture.

The general development of agriculture in dryland farming areas is inhibited by the agrarian pattern. This includes high-value short-term crops and specialized industries which requires little land. Thus, there is in Jordan the development of vegetable growing which falls into the former category, and of fruit, poultry production and peri-urban dairying which come within the latter.

The settlement of the nomadic population, estimated at 53,000 persons, deserves special attention. The government should start a phased programme for the sedentarization of nomads and their animals. The experience

gained in the pilot settlement scheme at Jafr* should facilitate the expansion of the settlement programme for the nomadic population.

Land Reform in the Jordan Valley

Land reform in the sense of limitation on the size of ownership and redistribution of land has already taken place in Jordan but is restricted to the land benefiting from large public irrigation works. This has been achieved through a series of laws relative to the East Ghor Canal area, and to any other areas in East Jordan that in the future may benefit from major irrigation projects. In other words, the rest of the Jordan Valley will be treated in the same manner when its irrigation, now under study, is affected as well as the areas which will benefit from the irrigation of the side wadis. Though restricted regionally, the land reform measures in Jordan are far-reaching in effect and were implemented without creating social problems, thanks to the flexibility of the laws governing the reform, their moderation, their realism and their fairness.

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*Jafr is an oasis in the southeastern part of Jordan where pumped underground water formed the basis for the settlement of a small number of Bediouns.

Several pieces of legislation have been enacted to govern the area of the East Ghor Canal Project.[1] The East Ghor Canal Authority was set up to implement the law and in 1966, a new body of much wider scope, the NRA, was formed to take its place. Laws 31 of 1962 and 1966 empower the Authority to take over all land benefiting from a major public irrigation work and to redistribute it according to certain principles and in plots of certain sizes. Minimum and maximum sizes are set, and the range is reasonable. The minimum, "about" 30 dunums of land of Class I and II, or 50 of Class III, assures the farmer of an income not out of line with the average income of the Jordanian individual, if not better, when citrus trees or bananas are planted. The maximum ownership was set at 200 dunums. A certain measure of differentiation in size of ownership was thus allowed to reflect the original size of ownership. This flexible approach avoided the imposition of strict egalitarianism in one small area in the agricultural sector, when such egalitarianism was not imposed elsewhere; it also avoided the creation of a privileged class of land owners in the valley where productivity, thanks to irrigation, is much higher than in rain-fed areas elsewhere in the country. Area previously held was alloted according to the following scale:

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[1]Law 14 of 1959, Law 13 of 1960 and the Ammended Law of 31 of 1962, Law 21 of 1963, Law 31 of 1964, Law 35 of 1965 and Law 37 of 1966.

Area Previously Held	Area alloted under the law to Holders
30 - 50 Dunum	To be alloted in full
51 -100 Dunum	50 dunum to be alloted, plus 25 per cent of area in excess of 50 dunums.
100-500 Dunum	62 dunum to be alloted plus 17 per cent of area in excess of 100 dunums.
500-1000 Dunum	130 dunum to be alloted plus 12 per cent of area in excess of 500 dunum.
100 and over	

In case where ownership previously was in plots smaller than 30 dunums, the Authority was required to sell or lease to the owner additional land to bring his total holding up to 30 dunums (if land was of Class I or II) or to 50 dunums (if land was of Class III). The most obvious aspects of East Ghor Canal laws have been land redistribution, the promotion of family farms and the setting of a minimum size of holding. The pattern of ownership and of size of holding before and after application of these laws can be seen in Tables 38 and 39. The change is obvious. The distribution now has a much narrower range, roughly between 30 and 200 dunums. The most interesting aspect of the redistribution of land under the East Ghor Canal Laws is the coincidence of the mean and the mode. The mean

is just over 45 dunums and falls in the 30-50 dunum size group, which represents 74.9 per cent of ownership and 54.8 per cent of area owned.

In reallocating the land in the project area, its value was assessed by committees set up under the law. The assessment took into account improvements and investments made by the owner, the planting of trees and any irrigation work done earlier by him. The new value was also set, including the right to water. The balance was registered to the debit of the landowner or to his credit, as the case may be. Settlement of the balance was to be effected in ten annual installments subject to interest at four per cent. Law 35 of 1965 raised the settlement period to 20 years if the landowner owed money to the Authority, provided no installment was less than JD 50, plus four per cent interest. If the Authority owed money, then it was to continue to settle in ten annual installments.

The accounts between the Authority and landholders as of end of May 1967 were as follows:

	JD Million
Value of capital assests and water rights taken over by the East Ghor Canal Authority	8.75
Value of land and water rights remaining with original owners	6.40

Capital value owed by new holders	2.35
Capital value owed by Authority to old holders	2.28
Installments paid by new holders	0.21
Installments paid by Authority to old holders	1.25

Selection of farmers was made under Law 31 of 1962 according to a system of priorities. Priority was given to holders who exploit their lands themselves and then to professional farmers residing in the project area. Professional farmers residing in the project area. Professional farmers from among district inhabitants and from other districts were given lower priorities, and last priority was given to tenants in the project area. The priority scale thus gives preference for professional farmers over holders who are non-operators themselves. Prior to 1962, non-operator holders had second priority.

Another principle embodied in the law is the control of the use of water through a charge which rises with increased water consumption. The rates, however, are so low that income from water charges in 1966 (JD 86,000) failed to cover administrative expenses alone for the year (JD 90,000).

What in effect is a very radical break with traditional and legal principle regarding inheritance has been incorporated into the law. This relates to the provision that farm units may not be fragmented to a size

smaller than the minimum area of 30 dunums. It is noteworthy that this provision created no resistance. The adoption of a similar principle in other areas in the country and a properly adopted application may offer practical means towards meeting the serious problem of fragmentation. However, this provision has not been applied rigorously in the East Ghor Canal area itself.

The last observation to be made refers to the consciousness expressed, originally in Law 14 of 1959 which set up the Authority and later in Law 13 of 1960, of the importance of combining irrigation and land redistribution with the provision of technical, financial and extension services. To this end, the law stipulated that the Authority set up social and economic programs of community development. This was amended in Law 31 of 1962 to the effect that the Authority, in co-operation with the various Ministries and competent authorities, would provide orientation and help in the various technical, economic, social, financial and health fields. The Authority is further empowered to undertake, within its means, any actions relating to agricultural loans, formation of co-operative societies, processing and marketing, extension services, soil conservation, setting up of model farms and general improvement of farming techniques and practices.

There is a notable change in this respect in Law 37 of 1966. To avoid duplication of functions with Ministries and other public agencies, the law changed the emphasis in the assignments set for the Authority to undertake. Instead of stating that the Authority ". . . is empowered, in collaboration with Ministries and Departments . . . ," the new law states that "the Ministries and Departments are required in collaboration with the NRA. . . . " The shift in emphasis aims at efficient operation and the avoidance of wasteful duplication of effort.

Some doubt arises with regard to the effect of certain changes that were introduced between the original piece of legislation, Number 14 of 1959 and the latest, Number 37 of 1966--changes that involved major issues. These issues are: definition of "holder," "family," area of "unit," maximum area allowed to holder and to family and in fact, the strict adherence to the provisions of whatever law was at the time in effect. The practical effect of changes in the law has been a general relaxation in the rules determining beneficiaries and areas assigned to them.

Table 38

Distribution of land ownership by size in East Ghor Canal Project Area, July 1960[1]

Size of Ownership Dunum	Number of Landowners: Number	Number of Landowners: Per cent of the total	Area Owned: Area Dunum	Area Owned: Per Cent Total Area	Average Area of Ownership Dunum
1-9	1309	35.7	5500	3.5	4
10-19	708	19.3	9930	603	14
20-29	378	10.3	9070	5.7	24
30-75	866	23.6	39090	24.7	46
76-100	113	3.1	9870	6.2	87
101-500	252	6.9	47810	30.2	190
501-1000	32	0.9	21780	13.8	681
Over 1000	10	0.3	15240	9.6	1524

[1]Department of Statistics, The East Jordan Valley, A Social and Economic Survey, Amman, 1961, Table 62, p. 155. Source indicated in Survey as being "Department of Lands and Surveys." Last Column added.

The total area doesn't include 46180 dunum of land owned by the State or any land in Al-Mashrou, but does includes all other lands lying between the East Ghor Canal and the Yarmouk and Jordan River; in the south the boundary is the most southernly limit of land to be irrigated from the main canal.

Table 39

Distribution of Land Ownership[1] in East Ghor Canal Project Area After the Reallocation of Land

Size of Ownership Dunum	Number of Landowners		Area Owned	
	Number	Per cent of Total	Area Dunum	Per cent Total
30-50	1046	74.9	34860	54.8
51-62	128	9.1	7480	11.8
63-130	195	14.0	16230	25.5
131-200	19	1.4	3070	4.8
Over 200	8	0.6	1970	3.1
Total	1396	100.0	63600	100.0

[1] Sweilem M. Haddad, "Principles and procedures used in planning and execution of the East Ghor Irrigation Project," paper presented to the International conference on Water for Peace, Washington, May 21-31, 1967.

This land ownership covers only 22 out of 24 development areas, having a total area of 6300 dunums or 52 per cent of 12,000 dunums of the project area. The remaining area of the project is almost completely alloted to new farmers but the kind ownership classification records were not ready at the time of preparing the paper for the conference.

It is noteworthy that 2158 holders had owned farm units smaller than the minimum holding allowed under the law in the farm of joint ownership through inheritance or additions. Due to the shortage of lands and to the great number of original holders, involved and in order to avoid displacement of these holders, the original law was modified to reduce the maximum limit of ownership from 500 to 200 dunums. The priority scale in the selection of farmers was likewise changed, so that professional farmers in the project area were given priority over absentee holders or those who utilize their land by lease or sharecropping. As such, a total area of 1,973.50 dunums of the project was alloted in the form of farm units shared by more than one holder.

The East Ghor Reform

The Jordan Government has already taken a bold step in the direction of land reform in the newly completed East Ghor project area which covers 12,000 dunums. Land has been acquired by the government and redistributed to farmers under Law 31 of 1962 and 37 of 1966. A reasonable compensation has been paid to the landowners. The value of the land is estimated according to the class of land at current prices, disregarding any appreciation in value from the construction of the project. To these is added the value of customary water rights as well as that of buildings, trees, etc. The assessment is done according to Article 14 of the East Ghor Canal law by a land Evaluation Committee presided over by a judge, and the evaluation is subject to appeal. The value is payable in ten years. (Extended to 20 years in 1965) and bears interest of four per cent. The area thus taken over is redistributed with a minimum of 30 dunums (3 ha) and a maximum of 200 dunums (20ha). The formula on which the distribution is to be made is given in Article VIII of the law. It is interesting to note that the law lays down:

> "Under no circumstances may any farm unit be divided or parcelled into several units the size of which is less than the minimum fixed in this paragraph."

This provision which is a radical break with tradition and legal principle regarding inheritance has been applied without creating great resistance. It must be said, however, that by far the larger part of the area affected had not been under cultivation only a few years earlier.

The East Ghor Canal experience has been demonstrably successful in spite of gaps in the strict application of the principles governing the selection of farmers who are to benefit from land redistribution, and governing the limitation of size of ownership. Consequently, change in the provisions of the present law -- in so far as beneficiaries and area of units are concerned -- should only be undertaken after enough time has passed for consideration. However, more rigorous application of the law ought to be sought in any further extension of its application to new areas.

There is great merit in having a separate body to manage the East Ghor Canal area, if not an autonomous authority then an identifiable unit in the present NRA. The area should be considered a crucial controlled experiment that needs special attention and observation since the results will greatly influence other larger areas to

be irrigated in the future. The efficient use of the various technical, economic, and social services, in co-ordination with the land redistribution and irrigation aspects of the project, requires treatment of the area as one unit under identifiable authority and management.

CONCLUSIONS

As is clear from the foregoing discussion, Jordan is a country of limited resources. Of the total land area only a small portion can be considered as cultivable and less than 10 percent of this is irrigated. Agriculture is still the most important sector of the economy, contributing about 17 percent of the gross national product and employing 35 percent of the labor force. Over three quarters of the population live directly or indirectly from agriculture. Non-irrigated agriculture relies on unreliable rainfall and therefore has been subject to great fluctuations in the past. Extention of agriculture to new lands is unlikely except with irrigation.

A number of irrigation schemes have been built or are in the process of being built. The purpose of these schemes is to expand irrigation to new areas especially in the Jordan River Valley. Of these the most outstanding has been the building of the East Ghor Canal using water from the Yarmouk River and from the side-wadis of the eastern highlands of Jordan.

Irrigation from the Jordan River has been practiced in the Jordan Valley for a long time. The same is also true of some areas along the side wadis. The overall irrigation

plans called for further extension of the East Ghor Canal at the foot of the mountains of the eastern highlands to irrigate areas lying to the west between the canal and the River Jordan which cannot be irrigated from the River Jordan. The waters of the Yarmouk are insufficient in the summer months, therefore, a supplementary source is needed. The dams on the side wadis are used to regulate the flow of these wadis and to store water to be fed into the canal whenever needed. The Ziglab Dam has been completed while work on the others was stopped by the 1967 Arab-Israeli war. The first stage of the overall plan has been the completion of 70 kilometers of the East Ghor Canal extending from the Yarmouk on the north to the Zerqa River to the south.

It is recommended here that the proposed 8 kilometer extension of the canal should be constructed as soon as possible. The government should also reconsider the Baker-Harza recommendation for further extension of the Canal to the Dead Sea. Furthermore, the government should commence the building of the second stage of Yarmouk-Jordan project. This involves the building of a West Ghor Canal west of the River Jordan with a syphon connecting it to the East Ghor Canal in order to irrigate areas west of the River Jordan expecially around the city of Jericho.

The building of dams on the side wadis should be speeded up. As has been pointed out the purpose of these dams is to irrigate more areas in the valleys themselves and

to supply the East Ghor Canal with more water during periods of shortage.

The watersheds of rivers especially where dammed would be better managed by planting grasses and trees on the slopes and not allowing goats or sheep to graze in these areas, leading to erosion and hence filling of dams with silt. The Forestry department at the Ministry of Agriculture has embarked on a forestation program in the water shed areas of the dams. Most officials have complained that not enough money is being appropriated for this program. The dam could become filled with silt before the forestation of the watershed area is ever completed.

The management of the East Ghor Canal in its technical and administrative aspects is very satisfactory, but it is less so in its legal and economic aspects. The suggestions made here have for aim the improvement of the situation both with regard to the East Ghor Canal and to any new areas that will come later under irrigation in the Jordan Valley. The following recommendations start, therefore, from the position that the basis is worthy of being built upon elsewhere in the country, subject to the suggestions that follow.

The minimum size of farms of 30 or 40 dunums is justified by the heavy pressure of population on land and the very small holdings existing elsewhere as well as by income expectations from such a size. No very wide differential ought to be allowed among the size of holdings by groups of land-owners in different parts of the country.

The maximum size, on the other hand, ought to be no more than 200 dunums. This limit is justified by the fertility of irrigated land in the Jordan Valley and the need to observe social considerations by not allowing a highly privileged landowner class to emerge.

The distribution of farm plots in the East Ghor Canal area is satisfactory and should be extended to other existing or planned irrigation areas. Land redistribution in non-irrigated areas may follow the same principles. The minimum and maximum holdings should be determined in the light of local conditions, type of land, the level of family income, and other relevant considerations. Along with limitation of landownership, adequate economic and technical services should be provided in terms of marketing, cooperation, extension and agricultural credit.

The purpose of any new legislation concerning land redistribution should be the stoppage of fragmentation, in name as well as in effect. The setting of minimum sizes should be based on correct and detailed studies keeping in mind that the fewest possible number of farmers should be forced to give up farming. Urban areas are already overcrowded and jobs are scarce. Special studies will have to made if we are to generalize land reforms.

The aspect of redistribution of land and limitation of the size of holdings will lose much of its reality if the law is not observed concerning the definition of the "family". The definition should not be allowed to become loose. Furthermore, the law should be amended in such a way so as to cover

problems of inheritance and settlement of disputes between contending heirs.

The definition of "professional farmer" should be extended to include agricultural engineers, extension agents, and other persons similarly qualified. The purpose is to welcome into the valley agricultural technicians whose farming practice would have a valuable demonstration effect.

The law ought to be amended in such a way as to permit sale, under strict specified conditions, of farm units. The sale should only be allowed to single (not joint) holders. The law should also be made clear as to the relationship of the tenants and landlords especially absentee landlords. The law should specify terms of settlement on the merits of the case.

Owing to the hardships imposed on the new holder when he is asked to begin paying installments for the farm unit right after allotment, it is hereby recommended that a period of grace of few years be allowed before the first installment falls due, after when the account must be settled within the balance of the 20 years which the law requires. This will allow farmers to be established and avoid borrowing from money lenders.

The experience of the East Ghor Canal area suggests that any land reform measure undertaken elsewhere in the country ought to be closely tied to the provision of the services that are needed for rural development. This would need activation of these services as well as the coordination of the efforts

of their respective administration.

The most prevalent form of settlement in the newly irrigated areas has been the village type of settlement, which was found to be better than the scattered type. Services are easier and cheaper to provide for people in a village than in scattered settlements. It is also easier to dissiminate information and ideas to a group.

The administration of the East Ghor Canal or any newly irrigated land should be placed under an autonomous authority, separate from the National Resources Authority as is done at present. The new Authority will devote more attention to the Project area in the technical-engineering, agricultural, economic, and social fields. In my view, the new authority should also participate only in the planning of all service work for the Project, extension, credit, cooperation, marketing, researchand the like. It is also recommended that farmers be represented in planning committees. Their function however should not exceed the advisory. The whole valley should also be made into one administrative district. The area presently falls under the Districts of Jerusalem, Nablus, Salt and Irbid.

Farmers at present get as much water as they ask for. This is a serious matter because farmers will acquire a habit of obtaining great quantities of water without any consideration for situations when it may become necessary to limit or ration water. The absence of control may lead to the use of the wrong quantities for the crops planted. Finally, the lavish use of water by some careless farmers will deprive some others

whose needs are legitimate and justifiable, from part of their requests, in case total demand for water was nearing total availability. The farmers, therefore, should be trained in the careful utilization of water. Strict supervision should be applied over the ditchriders so that no irregularity may occur with regard tothe allocation of water. Likewise, no leniency ought to be allowed in the case of farmers who make and use sluice keys to get water illegally.

The current water rate is one fils per cubic meter water for the first 2000 cubic meters, and two fils beyond that. The revenues at this rate falls short of the administrative expenses, which would suggest that the water rates are too low. A further study is needed to determine the feasibility of increasing these rates. New farmers should also be trained in the ways of intensive farming and all aspects of irrigated farming. The Agricultural Credit Corporation and the Agricultural Cooperative Societies can apply decisive pressure to influence farmers to adopt any cropping pattern that may be deemed appropriate by the proper agencies.

Two combined centers should be established at Karamah in the south and at the North Shounah in the north in addition to the existing one at Wadi Yablis. The purpose of these centers is to bring together the representatives of several services involved in agriculture, cooperation, extension, credit, marketing, mechanization, etc. These

centers promote effectiveness, efficiency and economy together.

Jordan has an archaic system of land tenure based on the old laws of land inheritance which has led to fragmentation of property. This applies mostly to non-irrigated agricultural land. This system needs major revision. Newly irrigated lands are subject to new land tenure laws and all the reforms in the system have been applied to the irrigated areas in the Jordan Valley. These reforms have shown great promise if and when they are applied and carried through.

The effects of the construction of irrigation schemes on the Jordan economy in general and agriculture in particular have been amply illustrated by the figures on production and income before and after the building of the canal. Net income per dunum of land in the project area was JD 13.6 during the crop year 1965/66, as compared to JD 2.2, before the completion of the canal. This example is indicative of the great economic benefit that has resulted from the irrigation project.

A sustained period of continous irrigation in the project area during the last five years, improved farming and irrigation practices, proper use of fertilizer and improved credit and marketing conditions have resulted ina measurable impact. Trends in agricultural production and naturally in income from the pre-canal to the post-canal period show the economic impact of the East Ghor Irrigation project on the Jordanian economy. Whether this economic

impact will continue to develop as rapidly as hoped rests on several factors. One is the continuing availability of irrigation water and the avoidance of soil salinization. On the human side, the continuance of Arab-Israeli hostilities will clearly have a very serious inhibiting effect. Even if hostilities cease, the problems of increasing population, lack of technically trained personnel, strict implementation of the laws, and better management of the project have to be overcome.

The realization that their political and economic future is at stake has accentuated the desire of the Jordanian people to ensure the success of their irrigation policy. The possibilities of failure are too serious to contemplate.

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