THE IMPACT OF TECHNOLOGICAL CHANGE ON AGRICULTURAL OUTPUT OF FIELD CROPS, FRUITS AND VEGETABLES IN JORDAN

By
Nahida Yousef El-Saies

Supervisor
Dr. Amer Zahi Salman

This Thesis was submitted in Partial Fulfillment of the Requirements for the Master's Degree in Agricultural Economics and Agribusiness

Faculty of Graduate Studies
University of Jordan

October 2003

الجامعة الأردنية

نموذج تفويض

أنا ناهدة السايس، أفوض الجامعة الأردنية بتزويد نسخ من رسالتي للمكتبات أو المؤسسات أو الهيئات أو الأشخاص عند طلبها.

التوقيع:

التاريخ:

The University of Jordan
Authorization form

I, Nahida El-Saies, authorize the University of Jordan to supply copies of my Thesis to libraries or establishments or individuals on request

Signature:
Date:

This Thesis (The Impact of Technological Change on Agricultural Output of Field Crops, Fruits, and Vegetables in Jordan) was successfully defended and approved on ……..,2003

Examination Committee: **Signature**

Dr. Amer Salman, Chairman …….
Assoc. Prof. of Agriculture and Water Resource Economics

Dr. Ahmad Shukri Al-Rimawi, member ……..
Prof. of Agricultural Extension and Rural Development

Dr. Emad Al-Karablieh, member ……
Assist. Prof. of Agribusiness Management

Dr. Doukhi A. Hunaiti, member …….
Assoc. Prof. of Agricultural Economics and Rural Development

Dedication

To my Family, Husband, Friends and all those who made this work possible through their constant support and encouragement. But most of all to my Mother, whose encouragement, and soothing words spurned me on and invigorated my determination.

Acknowledgment

Special and sincere gratitude, respect and appreciation to my advisor *Dr. Amer Salman* for his inspiration, professional guidance, follow ups, continuous encouragement, friendly manner and support that made this work possible through out the research work.

I would highly thank *Dr. Emad Karablieh* for his great help, insight, invaluable assistance and counsel during my period of research work. With a deep sense of gratitude, immense pleasure and feeling of privilege I offer my sincerest thanks to him.

I would like to offer my gratitude to the examination committee members for their valuable comments on this study, and offer my appreciation to all those who were ever ready to offer of their time, knowledge and expertise.

I would also to offer my wholehearted thanks to my father, mother, brothers, sisters and Issam for their great support, encouragement and moral support.

Last but not least I would like to thank the staff of the Department of Agricultural Economic and Agribusiness who have been a great source of inspiration, self-confidence and everlasting encouragement

Table of Contents

Committee Decision ii
Dedication iii
Acknowledgment iv
Table of contents v
List of tables' vii
List of figures x
List of abbreviations xi
Abstract xii

CHAPTER ONE, Background 1
1.1 Introduction 1
1.1.1 Jordan's Economic Situation 2
1.1.2. Characteristics of Jordan's Agriculture Sector 4
1.2 Justifications and Problem Statements 8
1.3 Objectives of the study 13
1.4 Methodology of the Study 13

CHAPTER TWO, Review of Literature 18

CHAPTER THREE, Agricultural Growth and Productivity 25
3.1 Development of Growth of Agricultural Products and Their Productivity 25
3.1.1 Development of Field Crops Production in Jordan 27
3.1.2 Development of Vegetable Production in Jordan 29
3.1.3 Development of Fruit Trees Production in Jordan 31
3.2 Horizontal Expansion in Jordanian Agriculture 33
3.2 Vertical Expansion in Jordanian Agriculture 36
3.3.1 Increasing Cropping Intensity 36
3.3.2 Increasing Productivity in Jordanian Agriculture 39
3.3 Development of Crops Productivities 40
3.4.1 Development of Field Crops Productivity 40
3.4.2 Development of Vegetable Productivity 49
3.4.3 Development of Fruit Trees Productivity 53

CHAPTER FOUR, Factors Affecting Technological Change 56
4.1 Technology Adoption in Jordanian Agriculture 56
4.1.1 Environmental Factors 56
4.2 The Role of Socioeconomic Factors 67
4.2.1 Farmer's Age 68
4.2.2 Educational Level of Farmers 70
4.2.3 Household Labor 73
4.2.4 Tenure System of Agricultural Land 79
4.3 Technical Factors 82

4.3.1 Mechanical Technological Change and Farm Machinery 82
4.3 Institutional Factors 90
4.4.1 Source of Extension 90
4.4.2 Source of Finance and Credits 94
4.4 Market Factors 98

CHAPTER FIVE, Economic Analysis of Technological Change 102
5.1 The Impact of Technological Change on Total Agricultural Production 102
5.1.1 Measuring the Role of Labor and Capital on Agricultural Production 102
5.2 Results of the analysis of Gross Output with agricultural inputs 103
5.2.1 The Impact of Labor and Capital on Gross Output 103
5.2.2 The Impact of Labor and Capital with Time on Gross Output 104
5.2.3 The Impact of Labor, Capital, Time, Area, Pesticide, Fertilizer and water on Gross Output 105
5.3 Results of the Analysis of Agricultural Gross Domestic Product (AGDP) with Agricultural Inputs 106
5.3.1 The Impact of Labor and Capital on Agricultural Gross Domestic Product (AGDP) 106
5.3.2 The Impact of Labor, Capital with Time on Agricultural Gross Domestic Product 108
5.3.3 The Impact of Labor, Capital, Area and Water on Agricultural Gross Domestic Product 108

CHAPTER SIX, Conclusions and Recommendations 110
Conclusions 110
Recommendations 112

References 116
Abstract (in Arabic) 118

List of Tables

Table 1:	The basic data of Jordan Economy	3
Table 2:	Development of Area and production of field crops, Vegetables, and fruit trees in Jordan during the period (1986-2000)	27
Table 3:	Growth rate of total value of field crops, vegetables and fruit trees and their percentage share in total horticultural output during (1986-2000)	32
Table 4:	Irrigated and non irrigated areas under fruit trees, field crops and vegetables in 1983 and 1997 in Jordan (dunums)	34
Table 5:	Development of irrigated and rainfed area in Jordan (1986-2000)	35
Table 6:	Irrigable Areas in Jordan Rift Valley	37
Table 7:	Cropping Intensity in Jordan Valley (1988-2000)	37
Table 8:	Development of planted area of main field crops for the period 1986-2000	42
Table 9:	Development of harvested area of main field for the period 1986-2000	43
Table 10:	Development of field crop production for the period 1986-2000	45
Table 11:	Average Yield of Field Crops in Jordan 1986-2000	46
Table 12:	Growth rate of production, area and productivity of main field crops during the period 1986-2000	48
Table 13:	Development of planted area, average yield, production and Growth Rate of vegetables for the periods (1986-2000) in Jordan	51
Table 14:	Development of planted area, average yield and production of winter vegetables for the periods (1986-1993) and (1993-2000) in Jordan	52
Table 15:	Development of planted area, average yield and production of summer vegetables for the periods (1986-1993) and (1993-2000) in Jordan	53
Table 16:	Development of area, production, and average yield of fruit trees in 1986 -2000 in Jordan	54

Table 17: Development of total quantities of imported pesticides in Jordan during (1986-2000), (1000 liter/ or 1000 kg) 56

Table 18: Quantity of imported, locally produced and exported pesticides by kind (L& Kg) in 2000 58

Table 19: Quantities of fertilizers consumed in Jordanian agriculture in tones 60

Table 20: Comparison of the percentages distribution of agricultural holders by age and sex according to 1983 and 1997 agricultural census. 68

Table 21: Percentage of agricultural labor according to age classes 68

Table 22: Comparisons between the percentages distribution of holdings management methods by size holding according to 1983 and 1997 census. 69

Table 23: Comparisons of the percentage for educational level of holders by holding classes according to 1983 and 1997 agricultural census 72

Table 24: Employment in Jordan and in the Agricultural Sector (1983-2000) 74

Table 25: Number and parentage of family and hired labor by level of education, 1997 77

Table 26: Number and percentage of agricultural labor (family & hired) by level of education 77

Table 27: Comparison of the number of holding and area between 1983, 1997 census 79

Table 28: Comparison of relative and accumulated distributions of holding and area between 1983 and 1997 census 80

Table 29: Number and percentage of holders is the owner of tractors in 1983 and 1997 censuses. 83

Table 30: Number and percentage of holders is the owner of combine harvester in 1983 and 1997 censuses. 84

Table 31: Number and percentage of holders is the owner of plower in 1983 and 1997 censuses. 86

Table 32: Number and percentage of holders is the owner of mechanical motors in 1983 and 1997 censuses. 86

Table 33:	Number and percentage of holders is the owner of pumps in 1983 and 1997 censuses.	87
Table 34:	Number and percentage of holders own transport facilities in 1997.	88
Table 35:	Percentage source of agricultural extension in Jordan during 1997	92
Table 36:	The role of formal credit institution in financing agricultural sector	94
Table 37:	The development of total agricultural credits in Jordan	95
Table 38:	Comparison between percentage for the source of finance according to holding size between 1983 and 1997 census	96
Table 39:	Number and percentage of holder according to source of finance	97
Table ٤٠:	Regression results of agricultural gross domestic product, labor capital	105
Table ٤١:	Regression results of gross output, labor capital with time	106
Table ٤٢:	Regression results of Agricultural Gross Domestic Product, Labor Capital	107
Table ٤٣:	Regression results of Agricultural Gross Domestic Product, Labor Capital with Time	108
Table ٤٤:	Regression results of gross output, labor, capital, area and water	109

List of Figures

Figure 1:	Agricultural import value, average 1995-2000	9
Figure 2:	Development of area of field crops, vegetables and fruit trees in Jordan during the period (1986-2000).	26
Figure 3:	Development of production of field crops, vegetables and fruit trees in Jordan during the period (1986-2000).	28
Figure 4:	Development of planted area of main field crops for the period 1986-2000	40
Figure 5:	Development of average harvested area of main field for the period 1986-2000	44
Figure 6:	Development of average field crops productivity for the period 1986-2000	47
Figure 7:	Development of imported quantities of pesticides per 1000 dunums1980-2000	57
Figure 8:	Percentage of holdings depending mainly on family labor to perform agricultural operation	75
Figure 9:	Percentage of holdings depending mainly on hired labor to perform agricultural operation	76

List of Abbreviations

ACC: Agricultural Credit Corporation

CBJ: Central Bank Of Jordan

DOS: Department of statistics

du: dunum

JCC: Jordan Cooperative Corporation

FAO: Food and Agriculture Organization of the United Nations

JVA: Jordan Valley Authority

JV: Jordan Valley

MCM: Million Cubic Meters

MOA: Ministry of Agriculture

MOP: Ministry of Planning

MWI: Ministry of Water and Irrigation

WTO: World Trade Organization

The Impact of Technological Change on Agricultural Output of Field crops, Fruits and Vegetables in Jordan

By
Nahida Yousef El-Saies

Supervisor
Dr. Amer Zahi Salman

Abstract

The objectives of this thesis are to study and analyze the impact of technological change on agricultural output of field crops, fruits and vegetables in the Jordanian agricultural sector for the period (1986-2000). Also to study the factors that affect the size of agricultural output in the Jordanian economy, two methods have been used for analysis:

Descriptive analysis, it has been shown the development of Agricultural output based on secondary data collected from the Central Bank statistics and the annual statistics, for the period (1986-2000) from the Department of Statistics and Ministry of Agriculture. The followings were the main results of descriptive analysis. In the eighties, the agricultural sector achieved high growth rates due to the expansion of irrigated farm areas, the introduction of modern production technologies, and a favorable environment for investments in the sector, the absence of major obstacles for Jordanian exports to foreign markets. By the early nineties, the growth rate of the sector declined due to the economic crisis in Jordan, the international and regional political developments and the Gulf war. The contribution of the Jordanian agriculture to the country's GDP at current prices increased from JD 83 million in 1980 to JD 114.6 million in 2000. The high growth rate of the agricultural sector during 1980's was due to maturing of public investments in land and water development; private investments in new technology; and the shift to the production

of high value horticultural crops. The total land area has been decreased from 2.7 thousand dunums in 1980 to 2,49 thousand dunums in 2000, which can be considered as a negative indicator, due to an expansion in urban area on the account of agricultural area. On the other hand, number of holdings has been increased from 57 thousands in 1983 to 72.8 thousands in 2000. This reveals the high rate land fragmentation, the reduction in the size of the agricultural holding and the increase in the agricultural holders. The planted area with vegetables decreased during the first period then it is increased with an annual rate of 3.7 %, whereas the total vegetable production increased by 0.34 % during the period (1986-2000), the main reason was due to the increase in water supply available in the highland areas and in the Jordan Valley. The area of fruit tress increased from 498 thousand dunums in 1986 to 869 thousand dunums in 2000 with an annual growth rate of 3.78 %, whereas the production is increased from 163 thousand tones to 371 thousand tones with an annual growth rate of 5.6 % for the same period. The value of fruit production increased from 29.9 millions JD to 85.3 millions JD with an annual growth rate of 7.2 %.

Quantitative analysis, an economic model has been built to indicate the impact of technological changes in the size and factors that affect the agricultural output. The Cobb-Douglas production function is adopted to estimate an aggregate production function. The function is estimated in log linear form by the ordinary least squares methods (OLS). The results of the analysis of the production function for labor and capital indicated an increase return to scale. Also the size of the planted area has a positive role in the agricultural output. The results shown a positive impact on technological change and they were significant, it was clear that the technology used is biased to capital.

The Impact of Technological Change on Agricultural Output of Field Crops, Fruits and Vegetables in Jordan

CHAPTER ONE

Background

1.1 Introduction.

The importance of the agricultural sector in Jordan lies in its social and environmental impact rather than the economical contribution. Although agriculture is modest contributor to the national income relative to many countries, it remains important to about 20% of the population who rely on it as a major source of income (World Bank, 1989). The government has three basic objectives for the agricultural sector, namely: (1) to conserve basic agricultural resources and protect the environment; (2) to increase the return on agricultural investments and improve farmer and farm labor income sufficiently to discourage rural-to- urban migration; and (3) to increase the net income and growth rate of agriculture and contribute to a greater share of national income (MOP, 2000). The agriculture's direct contribution to GDP has been declining since 1992 where it was 11% of GDP and dropped to 2.4% in 2000 (DOS, 2002). It is estimated however that about 28% of the economic activities are related and depends on agriculture.

On the other hand, contribution of agricultural exports to the total national export has dropped from 20% in 1992, to about 10% in 1996 and to less than 8% in 2000 (DOS, 2002). The value of agricultural foodstuffs import has shown fluctuation over the last decade; the minimum was 410 million JD in 1994 and the maximum of 646 million JD

was in 1996. Its contribution to the total imports dropped from 24% in 1992 to about 16% in 2000 (DOS, 2002). The agricultural sector has an important role in providing job opportunities where the numbers of jobs are increasing. They have increased from 45,000 jobs in 1992 to 68,000 in 1996 and to 114,000 in 2000 (DOS, 2002).

The decline in the agricultural sector began in the late eighties due to 1989 economic crises (World Bank 2001); it began with a major devaluation of the Jordanian Dinar. The decline was aggravated in 1994 when the government imposed trade liberalization policy and was directly influenced by accession to World Trade Organization (WTO). As a result of that, protection of the local or national agricultural products has stopped and the direct support to farmers and animal growers has been decreased. The occurrence of successive drought for three years (1999-2001), the limited amount of irrigation water and low quality water were additional factors in the decline of agricultural production. In addition, the growth of other economical sectors in Jordan has caused relatively small agricultural contribution. However; it is important to note that there are unobserved agricultural activities, such as small-scale investments, home gardening and family owned agricultural business, which have significant contributions.

1.1.1 Jordan's Economic Situation:

Jordan with an average per capita income in 2001 of 873.3 Jordanian Dinars (JD), about US$ 1,230 (CBJ, 2002), classified by the World Bank as a lower middle-income developing country (World Bank, 2002). The population in 2001 is estimated at 5,182.0 million persons (DOS, 2002). More than half the population is under the age of 16 and so

the labor force is less one-quarter of the population. The population growth rate is about 3.6 percent per annum, one of the highest rates in the world as shown in Table (1).

Table 1: The basic data of Jordan economy

GDP:	$8.5 billion
GDP per capita:	$1.230
Population:	5.18 m
GDP growth (2001)	4.5 %
Inflation:	3.0%

Source: CBJ, 2002.

Attempts at macro-economic stabilization over the past five years, though volatile, have been fairly successful and have been accompanied by broad economic reforms undertaken in cooperation with International Monetary Fund (IMF), World Bank, European Union (EU), US-AID and other donors. Jordan displayed strong willingness to modernization. The process includes far reaching trade liberalization (conclusion of EU-Jordan Association Agreement in 1997, accession to WTO in 2000, conclusion of Free Trade Agreements (FTA) with USA (2000), European Free Trade Agreement (EFTA) (2001), accession to Greater Arab Free Trade Area (GAFTA) and conclusion of an increasing number of bilateral trade agreements with regional partners, fiscal reforms, improved debt management, investment promotion and the successful launch of privatization. (Hjort et al., 1998). Memberships in these agreements illustrate the changes that occur during last short period. The agreements stipulate that Jordan must reduce trade-distorting policies in agriculture such as domestic support policies.

The high rate of population growth (3.2% in 2001) and the general increase of GDP per capita lead to an increase in the demand for agricultural commodities, Table 1. If the local

supply of agricultural product is not encouraging, this would expand the already existing large food gap, malnutrition and reduce the agricultural export, that have an adverse effects on Jordan's balance of foreign currency .

The available data and indicators show an increase in demand for water for household, industrial and agricultural uses. Due to limited water resources available in Jordan; this will naturally increase the competition for water between the different sectors (El-Naser, 1999). The increasing pressure to save water needs more economical use of irrigation water and progressive application of treated wastewater in agriculture. Furthermore, the high population growth and the industrial development lead to a stronger competition for land, especially in the high rainfall zones. This development will put pressure on the agricultural sector to intensify production, raising the output per unit of land.

1.1.2. Characteristics of Jordan's Agriculture Sector

Agriculture's direct contribution to GDP has been around 5 percent since 1995, about 2-3 points less than its contribution in 2000, (CBJ, 2001). It is estimated, however, that 25-30 percent of economic activity depends on agriculture. In 1997, the average GDP per agricultural holding (roughly equivalent to a farmer) was estimated at about JD 2,700 or, on a per capita basis, around JD450. This is only one-third of the national average per capita income (CBJ, 1999).

In the mid-1980s and particularly in 1986, the development process in Jordan suffered from a severe bottleneck. The decline in economic growth was precipitated by external

events, principally decreases in external assistance, remittances from abroad, job opportunities for the Jordanian labor force in Gulf countries and Jordanian agricultural exports to markets such as Iraq and Saudi-Arabia. These factors, coupled with decelerating economic growth; in 1987 real per capita GDP was the same as in 1981; a rapid population growth rate of 3.5%; a decrease in a private real investment by 23% in 1987, a real growth rate of GDP not exceeding 1.2%; an increase in unemployment to 14.6% for the same year; resulted in a large growing deficit in the external balance of payments reaching JD 53 million, compared to a JD 152 million surplus in 1985. All of those factors forced the Government of Jordan (GOJ) to adopt the intervention mission in 1988, in order to obtain a sound balance of payments by reducing imports and increasing exports. The economic environment has changed significantly since the devaluation of the Jordanian Dinar in 1988. Total agricultural exports increased from JD 32 million in 1988 to JD 98 million in 1992, it reach the maximum with JD 271 million in 1997 then start to decrease and reach JD 169 million in 2000 (World Bank, 2001).

On the other hand, agricultural imports increased from JD 190 million in 1988 to JD 410 million in 1994, it reach the maximum with JD 646 million in 1996, then start to decrease to reach JD 602 million in 2000. One of the objectives of the intervention mission was to reduce imports and increase exports. However the opposite proved to be the case. The agricultural imports increased from 19% in 1988 to about 26% of total imports in 1991, whereas in absolute terms the total imports increased from JD 1022 million in 1988 to JD 1710 million in 1991, and then start to increase at accelerating rate to reach JD 3259 million in 2000. Normally, a devaluation of domestic currency leads to a greater incentive

to export and a smaller incentive to import. In the Jordanian case, foreign components of domestic production inputs are very high (e.g. about 70% for agricultural sector). Therefore, the essential inputs have become very expensive and do not compensate for the marginal increase in exports.

Furthermore, Jordan's main merchandise exports include phosphate, potash, and chemicals. Jordan mainly imports transport equipment, machinery, and crude oil. Its major trading partners are other Arab countries and the European Union. Jordan's exports do not cover the value of imports and foreign grants, loans, and other forms of capital transfers. Although Jordan's trade deficit has been large, it is offset somewhat by earnings from tourism, remittances sent by Jordanians working abroad.
The total food imports in 2001 reach to JD 520 million, of which JD 64 million for importing vegetables (CBJ, 2002).

The Government tries to enhance market competition by different measures. These measures include: eliminating the special tax concessions and tariff exemptions for government investments and institutions; removing special concessions for major public enterprises and imposing budgetary constraints on their operation and investment finance.

In January 1999, the government officially declared a state of drought. Following one of the driest winters on record, dam water levels have reached an unprecedented low, access to regional surface irrigation sources has been cut and the Kingdom witnessed an overall lack of vegetative growth never experienced before. Remote sensing data confirm that the

hardest hit areas were located in the most productive zones, namely the uplands and the Jordan Valley (MWI, 2000).

As a result, rainfed field crops have been drastically reduced, with vast areas of cultivated but non-productive land was obvious in every governorate. Rainfed fruit production has been severely reduced, vegetable production has been virtually eliminated and irrigated fruit and vegetable production based on all sources except deep boreholes, has been reduced, reversing the growth noted over the past six years. By the same token, sheep and goat production has been severely reduced and production costs increased to the extent that most flock owners were making a loss.

The overall effect is that the Jordanian agriculture is under a severe threat. This threat will not manifest itself in widespread food shortages due to the already comparatively high dependency on imports. Nevertheless, about one-quarter of the population will be affected to various degrees of severity. This includes complete loss of income, indebtedness and, at worst, destitution as small farmers sell off their assets to pay debts and agriculturally dependent landless laborers find themselves jobless with no alternative job opportunities open to them.

In order to reorganize the circumstances, the government has reduced the price of barley and wheat bran, the barley was reduced from around JD 95 in 1998 to around JD 75 per ton in 2000 and the wheat was reduced from JD 85 in 1998 to JD 65 per ton in 2000. The government has also provided a free water service to flocks and for the rescheduling of

loans from the Agricultural Credit Corporation (ACC). With an eye to the future it is also directing water use in the Jordan Valley towards permanent crops rather than summer vegetables. Although valid and valuable, such actions do not go far enough to address the present difficulties. In order to re-establish a platform for next year's cereal, fruit and livestock industries, other emergency support measures are required which are outside the Government's present financial capability. The rainfall season in 2001-2002 was moderately good. Therefore, in April 2002 the government eliminates the price subsidy for livestock and cereal producers. The price of barley increased from 75 JD/ton to 105 JD/ton and the price of wheat bran increased from 60 JD/ton to 80 JD/ton (the average international price of barely at that period was 141.7 /ton). Furthermore, the government determined the procurement price of cereal by 170 JD/ton for wheat, and 100 JD/ton for barley.

1.2 Justifications and Problem Statements:

With its limited water resources, Jordan is a net food importing country. The most important imported commodities are raw foodstuffs and feeds (Figure 1). Imports of wheat, the staple food grain, averaged about 500 thousand tons in the mid-1990s, costing an average of US$80 million. Imports of major feed products, including maize, barley, soybean meal, and compound feeds, amounted to about 970 thousand tons during the same period with an average cost of US$144 million. Other major imported agricultural products are sugar, powdered milk, crude palm oil, rice, lamb and mutton, cheese, and beef and veal. Prepared foodstuffs are also imported but they account for less than 5 percent of the total value of food and agricultural imports.

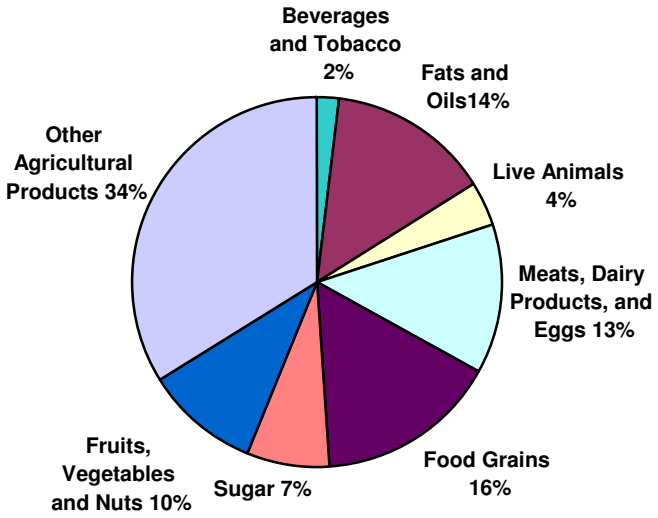

Figure (1). Agricultural Import Value, Average 1995-2000

However, technology transfer involves a great deal more than simply the production of new technology or technological packages. The new technology that is implemented ought to contribute to the increase of sustainable food production in such a way that both the nutritional level and the general economic well being of low-income farmers are improved. Concerns for efficiency, equity, and the environment are explicit. Another important aspect is the research on resource management aimed at attaining balanced production systems at somewhat high levels of productivity.

Cereal productivity could be improved by introducing new production technologies. These technologies include: Best-bet technological package; fertilizer application, high yielding varieties, optimum rate of seed and using seed drill, barley-forage legumes rotation.

Research results showed that the introduced technologies increase yield of cash crops and vegetables in Jordan Valley and highland irrigated areas. Therefore, the adoption of new technologies will have a direct impact on incomes of the targeted farmers (Rassam and Tully, 1986).

The missing elements in the dissemination of new production technologies in the rainfed and irrigated areas are failing to consider the socio-economic factors for farmers, where the producer skill in receiving and decoding information, farm-level endowments (land quality and type and agro-climatic conditions) are among the important factors influencing the demand for new technology. The profit maximization theory is not sufficient enough to explain the adoption process of new technology. Farming systems and the importance of joint-products are also important in the decisions made by farmers (Rassam, 1984).

The issues outlined above require that further research should address the socio-economic dimensions of the structural change in the rainfed and irrigated agriculture. Interest in the social and economic aspect of technology development and transfer has increased considerably in the recent years. These constraints reduce the farmer's profit and affect his/her plans for the next season. Many researchers argue that adoption of agricultural production technologies in developing countries is influenced by economic and social factors as well as by physical and technical aspect of farming and the risk attitude of farmers. However, because of capital scarcity, especially for small farmers, and risk consideration farmers are rarely in a position to adopt a complete package.

The growth of agricultural output can be explained by increasing inputs used in the production process, and/ or by the adoption of new technology. Therefore, the growth of capital investment in agriculture, as land improvements, buildings, machinery and equipments, wells, and irrigation tanks will be analyzed. Agro-climatic factors may not favor technology adoption in some areas. For, example, land tenure and size of holdings limit the progress of technology. Farm size, number of parcels and patterns of ownership are the most important factors in understanding farmers' behavior towards new technologies. Personal and psychological factors could explain the technology adoption process.

Socio-economic factors could explain the adoption of technology in irrigated and rainfed farming. The relationship between these factors to the growth in fixed assets will be examined. Therefore when farmers adopt new technology they aim to promote efficient and sustainable use of rural resources while increasing economic opportunities in rural areas so that farm incomes are more equitably distributed within the sector and are closer to urban incomes.

The high growth rate of the agricultural sector during 1980's was created by combinations of several factors: (1) the maturing of public investments in land and water developments in the Jordan Valley; (2) private investments in new technology- drip irrigation, plastic culture, etc.; and a shift to the production of high value horticultural crops, coupled with a buoyant domestic and export market. However, agriculture is a relatively minor component of the economy. Throughout the past decade, the contribution of the agricultural sector to gross national product continued to provide 6% of the nominal GDP and employed a corresponding

proportion of the Jordanian labor force. However, the low contribution of the agricultural sector 3.7% of GDP in 1997 (CBJ, 2000) does not reflect its relative importance. It is known that the agricultural sector generates income for other sectors (transport, marketing and retailing), furthermore, the agricultural prices are calculated as farm gate prices, which are relatively low. Therefore, the agricultural sector provides society with more than what the price reflects. Yet the performance of the agricultural sector remains weak and more efforts are needed to increase output potential, particularly in the rainfed regions.

Unfortunately, Jordan is experiencing significant and widespread environmental degradation. A primary result of this degradation is the erosion of biodiversity; desertification, salinization, water logging reduce productivity and jeopardize long-term sustainability. The modern agricultural technology has a direct negative impact of environments at all losses: ecosystem, species, water and wild life

Improved and new technologies are expected to lead to increased food production, increased incomes, and the improved well-being of farmers. The benefits, however, will depend mainly on the speed of transfer and on how the technology is actually transferred. Nonetheless, in developing countries, care should be taken to avoid excessive specialization and to increase efforts that optimize the talents and skills of individuals and their organizations. Special attention should be given to the efficient use of scarce resources in traditional farming systems, particularly in the semi-arid regions

1.3 Objectives of the study

The main objective of this study is to assess the impact of technological change in agricultural output of field crops, fruits and vegetables in Jordan, to achieve this objective the following specific objectives has to be fulfilled by:

(1) Examining the growth of agricultural selected products and their productivity,

(2) Examining the role of socioeconomic factors of farmers on explaining the technology adoption,

(3) Examining the impact of technology adoption on total agricultural production.

1.4 Methodology of the Study

The development of agricultural output and productivity of field crops, fruit trees and vegetables in Jordan will be analyzed at the state level. The study is based on secondary data collected from the Department of Statistics. The data will be divided into three parts:

1. Time-series data on area, production and productivity of field crops (wheat, barley, lentils, chickpeas etc) for the period 1985-2000.
2. Time-series data on area, production and productivity of fruit trees and for the period 1985-2000.
3. Time-series data on area, production and productivity of vegetables outputs such as tomatoes, cucumber, eggplants, squash etc. for the period 1985-2000.

Annual compound growth rates by fitting semi-logarithmic function (Norton, 1988) for areas, production and productivity for the above three sub-sectors will be used to examine the performance of the agricultural sector in Jordan.

Data on technology used by farmers that already exist in the General Results of Agricultural Census 1983 and 1997 will be used to examine the adoption rate of the main agricultural technologies introduced in Jordanian agriculture. Source of extensions, source of finance, and other data related to holder and household characteristics will be related to technology adoption. Also farm machinery, fixed assets on farm will be analyzed by using simple tabular analysis. The factors that could explain differences in technology adoption are:

(1) Environmental factors, such as Agro climatic zone

(2) Socio-economic factors,

The variables expected to be correlated with the technology adoption are:

- The information-related variables, namely, the years of schooling, farmer's age,
- The availability of household labor,
- The farm-level endowments,
- Ownership of agricultural land,
- The non-farm sources of income, total income of the household

(3) Technical factors such as farm machinery and the use of mechanical technology.

(4) Institutional factors such as extension services, source of finance and credits

Therefore, it is necessary to describe the current status of agricultural technology adoption in rain-fed and irrigated areas using the descriptive and analysis of variance will be conducted to differentiate technology adoption according to farm size in order to formulate policy recommendations.

The Aggregate data on outputs, employment and inputs will be used to examine the structural change in agricultural output as a result of adopting new technologies. Therefore, information on primary inputs of land, labor, capital investment and intermediate inputs will be collected. The private and capital stock in the agricultural sector will be estimated by incremental capital output ratio (ICOR).

Production technology consists of certain alternative methods of transforming input materials into produced goods and services. The neoclassical definition of production technology is based on a production function which may be specified in a mathematical form. More specifically, the single-output production function $f(x)$, where x is an input vector, is defined as a positive, continuous, twice-differentiable function with certain monotonicity and concavity properties. Production functions incorporate several technical characteristics such as: efficiency of production, technical change, and biases of technical change, elasticity of substitution, distributive share, and economies of scale. These are generally expressed in terms of the production function's first and second derivatives. The total change in output can be decomposed into three forces: a change in input use, economies of scale and a technological change. The influence of those forces on the output change can be empirically quantified.

The theorists have developed various mathematical concepts to characterize the important dimensions of functional structure for economic analysis. An exhaustive survey of functional form is beyond the scope of this study, but a short overview of the development of functional form is necessary.

Cobb and Douglas (1928) observed that the logarithms of output and inputs in aggregate data appeared to be linearly related. Therefore, Cobb suggested the form

$y = a\, x_1^{\alpha} x_2^{\alpha-1}$. From the 1920's until the early 1950's the Cobb-Douglas (C-D) function was the function chosen for production analysis due to its elegance, simplicity and ease of interpretation and estimation.

An agricultural production function indicates the relationship between the physical aspects of crop growth and the controllable and uncontrollable inputs used to produce a given crop yield. The technology of wheat production consists of certain alternative methods of transforming inputs into output, which may be specified as use of dummy variable. The production function approach will be used as:

$$\mathbf{Y_t = f\,(x_{1t}\,,\, x_{2t}\,,\ldots,\, x_{nt}\,),} \qquad (1)$$

Where Y_t is the physical amount of agricultural output produced in year t and x_1 , x_2 , ..., x_{nt} ., are quantities of inputs used to produce that amount of product in year t. If equation (1) was a true production function, then x_n would include all the major inputs influencing agricultural production. The variables that can be examined to explain the growth of agricultural production are specified as:

$$\mathbf{Y_t = f\,(L_t,\, Kp_t,\, Kg_t,\, La_t,\, W_t,\, F_t,\, P_t)} \qquad (2)$$

Where:

Y_t: agricultural output either in quantity or in monetary term in year t,

L_t: agricultural labor input measured in man-year in year t,

Kp_t: private capital stock in agricultural sector in year t,

Kg_t: governmental capital stock in agricultural sector in year t,

La_t: irrigated areas in year t,

W_t: quantity of water used for irrigation in year t,

F_t: amount of chemical fertilizers used in year t,

P_t: amount of pesticide used in year t.

When selecting a functional form for use in empirical work, the choice is often between forms that exhibit good behavior globally, and those that possess simplicity Griffin (1987). The econometrician has wide latitude in deciding which of the many possible algebraic functional forms should be used to build an econometric model. However, the criteria employed to make a choice between the various functional forms are largely dependent upon the purpose of the particular analysis (Maddala, 1992). Therefore, starting from some simple functional forms as Cobb-Douglas will be used.

Cobb-Douglas Functional form is considered one of the most functions that are used to estimate the production function in general and to estimate the agricultural production function in particular, Cobb-Douglas function depends on the two variables, labor and capital, and it has the form as follows:

$$Y= A X_1^{\alpha} X_2^{\beta}$$

$$Y= A L^{\alpha} K^{\beta}$$

Where:

Y: Agricultural output in Quantity

A: Constant, Intercept

L: Agricultural Labor Input

K: Estimated Agricultural Capital

(α, β): Production elasticity's for Labor and Capital

To estimate the previous exponential function, the normal logarithmic form should be estimated to become a linear functional form as follow:

$\ln Y = \ln A + \alpha \ln L + \beta \ln K + U$

Where:

U: is the error term for the function.

α, β are the partial production elasticities to be estimated

Y, L, K are output and primary inputs mentioned above.

CHAPTER TWO

Review of Literature

The effect of adopting new technology on crop yields has been of interest to agricultural scientists for many years. Since the main purpose of planning for agricultural development is the optimum utilization of the limited resources of land, water, capital and labor to increase productivity of crops for increasing the income to improve the standard of living for farmers. A number of studies were conducted during the last decade about the adoption of new technology from many aspects and several scientific points of views, such as the introduction of new techniques or practices, and the impact of socioeconomic factors of farmers on explaining technology adoption. Our study draws on three strands of the impact of technology adoption literature that are related to the study:

a. Studies related to the growth of agricultural production and their productivity:

Rassam (1984) and Rassam and Tully (1986) explained that the impact of education on agricultural productivity is generally envisaged through innovative, allocative, worker. The innovative effect come from the possible usefulness of schooling in relation to 'receiving', 'decoding' and 'using' the new information through improved 'communication skills', superior 'contacts' and sharpened 'judgmental faculties'. Education enhances the farmers' capacity to maximize the perceived profit function by allocating the resources in a more effective cost-efficient manner, by choosing which and how much of each output to produce and in what proportion to use the inputs - allocative effects. The failure to consider gender related differences in labor availability and demand may result in low adoption

rates and lower yield impact than expected. Also in rural communities where agriculture is mainly a subsistence activity, women are found to have a heavy share of the agricultural work and in some cases female input is greater than male.

The agricultural sector has witnessed a noticeable retreat in its contribution to GDP, the reason behind that refers to a number of influencing factors that reflects negatively to the growth of agricultural sector. The contribution of agricultural sector in the GDP reached to 7.96% in 1993, the main reasons behind the decline in agricultural growth is the fast and noticeable increase of growth rate in Jordan. Al-Hallaq and Rahahleh (1999) also the contribution of agricultural sector to employ labors was very low in comparison with other sectors, where as it amounted in the year 1993 to about 6.4%, (Al- Hallaq and Rahahleh, 1999).

Many studies were conducted to estimate agricultural production and productivity; some of these studies were aimed to measure the production function for the agricultural sector and define sources of growth for the period (1986-1993) and to estimate the elasticity of substitution among the input used, and to find the real average growth rate of agricultural production, it was realized that the production function follows the law rate of return, and the elasticity of substitution between capital and labor was negative, the studies also indicate that there is a decrease in the comparative advantage of the agricultural sector in the Jordanian economy, also it is indicated the decrease of agricultural labour from the total labour and was increased negatively during that period while using technology by intensifying capital in an increasing way in agriculture was the main source for the growth of agricultural production (Jaludi, 1995).

Studies illustrated that there are many factors influencing the value of agricultural domestic product, in Saudi Arabia, the agricultural domestic product was influenced by cropped area, that has the first impact on the amount of agricultural production, while the second impact was on the number of animals which represented the size of agricultural investment, where as the third impact was on the number of tractors that represented the size of technology (Al-Doais, 1992),

Studies in Jordan illustrated that production inputs such as capital and labor have an important role in the increase of the agricultural value added (Abu-Fodeh, 1997). The results indicated that the value added of the agricultural sector is affected positively by the government and trade agricultural facilities, also the results indicated that agricultural labor in Jordan and the average income of individuals has a negative impact on the value added in the agricultural (Estatya, 1999). Studies also indicated that the agricultural sector has no response on technological change and the technology is biased to capital (Abdul-Razzaq, 1998).

b. Studies concerned with the role of socio economic factors and its relation to technology adoption.

Lionberger (1968) pointed out that the size of holdings is related positively to the adoption of new farm practices. Roling (1982) and Rogers (1983) found that there is a positive relationship between the farmers who have large size holdings and the adoption of new technology. Feder and Slade (1984) indicated that large-scale farmers will adopt the new techniques earlier than other farmers. Lee et. al., (1983) found that farmers with small holdings, have lower minimum tillage adoption rates on cultivated cropland than do others with large holdings. Byerlee and Polanco (1986) explained that small-scale farmers lagged

behind large-scale farmers in adoption. Karablieh (1995) pointed out that farm size is not significantly related to the use of new varieties, or early planting, whereas it is positively related to the adoption of machinery, herbicides and fertilizer application. Therefore, the agricultural technology practiced and adopted in Jordan will be analyzed by holding size as displayed in the coming sections.

The obstacles of agricultural development have been classified on the basis of, whether they lie within the farmer or within the farm environment. Obstacles residing within farmers themselves and their immediate cultures have been identified as traditional beliefs, illiteracy, lack of motivation for achievement, insufficient resources to take advantage of opportunities, low-level skills and limited aspirations. Because of those traditional beliefs, values and cultural practices, farmers are felt to be unconcerned with improvement, unwilling to take risks, or unable to take advantage of existing opportunities of using new technologies (Sofranco, 1984).

The mechanization of agriculture has proceeded more rapidly in the Middle East than in any of the other major areas of the developing world during the (1975-1985) period as indicated by (Binswanger 1986). Such technological change has been the response to both market forces and government policies. Labor shortages are commonly thought to be widespread in agriculture and are the principle reason for farm mechanization. It is often argued that the growth of incomes from the oil boom (roughly 1974-1982), which was diffused throughout the region by migration, has made capital more abundant in national economies, even in rural areas. At the same time, it is commonly argued that the

withdrawal of labor from the rural areas reduced the supply of agricultural labor. Accordingly, farmers responded by resorting to more mechanized farming techniques. The mechanization of agriculture is a response to a change in the labor-capital price ratio in the agricultural sector. Farmers mechanize agricultural operations because they are not willing to pay a large percentage of their income to a large number of workers as they would under the traditional technology. It is not difficult to assess the importance of the local-guest labor price ratio and the capital-local labor price ratio as the main factors lead to a greater use of guest labor and mechanization in Jordan, where the local labor wage rates are higher than the wage rates of guest labor.

c. Studies that are related to the impact of technology adoption to total agricultural production.

The technological change can be defined as a change in the parameters of a production function resulting directly from the introduction of a new production technique; it could be a "neutral shift" leaving the rate of substitution of one factor for another unchanged, and a non-neutral shift which is a change in the slope of the production function. It is conceivable that the effect of technologies may vary from one region to another and even from farm to farm. However, increasing total agricultural production output can be realized by three methods as indicated by (Norton, 1988), which are;

- Increasing the agricultural areas by bringing the unused, but potentially productive lands under cultivation.
- Increasing cropping intensity
- Economies of scales.

One of the most important means of accelerating national development in economy is the adaptation and evaluation of new agricultural technology that can be adopted by farmers; this adoption can result in higher incomes for farmers, greater economic efficiency, and growth in the national economy (Johnson and Kellogg, 1984). Adoption of technology has received frequent attention over the years. Sofranko (1984) reported that, agricultural technology is viewed as representing much more than only mechanization. It includes introduction of new farm inputs, such as a new fertilizer, or new plant varieties that are resistant to diseases, and introduction of new techniques or practices, such as new planting and cultivation techniques.

In a comparison study for the development of agricultural production and productivity in several Arab states (Iraq, Jordan, Egypt and Syria) where they considered the issue of developing the agricultural production for the period (1972-1986) within a comparative framework to reveal and present the agricultural performance in every country by using the data comparative analysis, where a comparison form has been designed to execute the study.

The results showed that Jordan came on top of the four countries regarding average productivity of production inputs and the technological development in agriculture. Where the value of the estimated data for the general trend of the variables was about 5.67% annually which highlights Jordan's success in using agricultural inputs and benefit from the agricultural technological development. Syria came second with an average of 2.39% followed by Iraq with an average of 0.88% and Egypt with an average of 0.76% (Al-Khateeb and Al-Badri, 1994)

CHAPTER THREE

Agricultural Growth and Productivity

3.1 Development of Growth of Agricultural Products and Their Productivity

Agricultural productivity in Jordan, in terms of returns to both water and labor, is relatively high but can be improved. There is a scope for further improvement in irrigation efficiencies especially in Jordan Valley that depends mainly on irrigated water. This could be achieved by farmer education and training and by improving the focus and delivery of research, extension and other producer services. A particular need is to make such services more demand-driven and farmer-focused.

The total production in Jordan of the three major groups of crops averaged 1.1 million tons per year equivalent to 37 percent of total agricultural income for the period 1986-2000. Table (2) shows the development of area and production of field crops, vegetables and fruit trees during the study period more details would be in the following paragraphs.

Figure (2) shows the development of area of field crops, fruit trees and vegetables during the study period. The planted area of field crops has an annual increase of 0.58% during the period 1986-2000 this is due to low and irregularity of rain fall and erratic distribution (Jaradat, 1988). The planted area of fruit trees has an annual increase of 3.78during the period 1986-2000 this is due to the increase price of the fruits and the introduction of improved varieties of fruit trees. While the production of vegetables had a slight increase

with an annual increase rate of 0.34% during the same period this was due to marketing difficulties and the substitution of vegetables with fruit trees.

Figure (3) shows the development of production of field crops, fruit trees and vegetables during the period 1986-2000. The production rate of field crops has an annual increase of

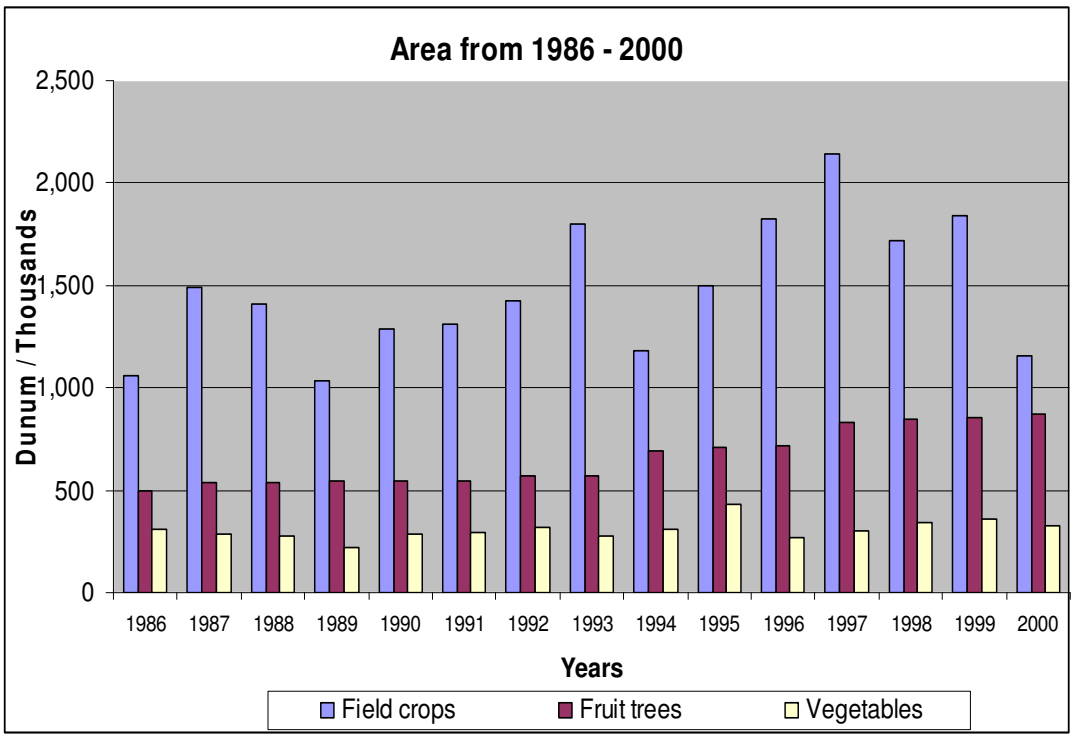

Figure (2): Development of Area of field crops, vegetables and fruit trees in Jordan during the period (1986-2000).

4.73% during the study period. This is due to the growing drought-resistant varieties of field crops such as wheat and barley. While the production of fruit trees has an annual increase of 5.63% during the period 1986-2000, this is due to the increase of water supply particularly in Jordan Valley. The production of vegetables had an annual increase rate of 3.70% during the same period this increase was due to the increase of irrigation in highland and in Jordan Valley.

3.1.1 Development of Field Crops Production in Jordan

Field crops, mainly cereals are produced without irrigation during the winter months (October to March) in the arid, Mediterranean region of Jordan, but production of the main cereal crops, wheat and barley varies considerably from year to year depending on the total amount of rainfall and its distribution between the six months in question.

Mild, wet winters and hot, dry summers are the main environmental characteristics of the region. However, rainfall is irregular and erratic in distribution (Jaradat, 1988), and there is always a high risk of drought setting-in at any time during the growing season. This variability in seasonal precipitation is the major factor affecting yields, and farmers than

Table (2): Development of Area and production of field crops, vegetables and fruit trees in Jordan during the period (1986-2000).

Year	Field Crops		Fruit Trees		Vegetables	
	Area	Production	Area	Production	Area	Production
	dunum	Ton	dunum	Ton	dunum	Ton
1986	1,060,239.0	62,898.0	498,591.0	163,263.0	312,621.0	560,245.0
1987	1,493,528.3	160,827.8	540,345.0	166,912.5	283,823.9	664,218.0
1988	1,406,472.3	156,316.7	540,909.2	244,728.8	277,304.6	664,555.7
1989	1,033,560.5	101,379.0	543,580.1	257,182.1	223,586.1	536,816.0
1990	1,289,012.6	149,721.6	545,469.2	610,149.6	281,951.6	808,400.5
1991	1,314,045.0	119,616.5	549,136.1	284,484.4	289,691.7	695,168.0
1992	1,426,175.2	175,405.9	573,997.6	346,419.6	313,804.9	874,293.1
1993	1,801,556.4	114,510.8	570,693.2	246,915.6	273,204.0	679,027.2
1994	1,177,201.5	109,022.6	695,923.7	366,117.3	313,242.6	870,174.1
1995	1,499,647.6	145,296.2	707,087.3	292,291.5	429,309.0	1,060,988.3
1996	1,822,093.7	139,857.1	718,802.7	328,921.8	271,482.9	795,168.1
1997	2,144,539.8	123,442.6	831,437.1	320,576.4	302,823.8	832,071.5
1998	1,719,024.7	114,120.1	846,466.1	407,738.4	337,994.2	887,351.5
1999	1,839,854.4	69,161.6	857,275.7	239,378.3	357,416.2	903,150.4
2000	1,155,785.4	125,849.1	869,450.7	371,286.7	328,817.2	966,007.4
Growth Rate Year 86-93	6.85%	7.78%	1.70%	5.31%	-1.67%	2.43%
Growth Rate Year 94-00	-6.14%	1.36%	6.20%	6.00%	2.68%	5.16%
Growth Rate Year 86-00	0.58%	4.73%	3.78%	5.63%	0.34%	3.70%

Source: DOS. (1986-2000). Annual agricultural statistics,

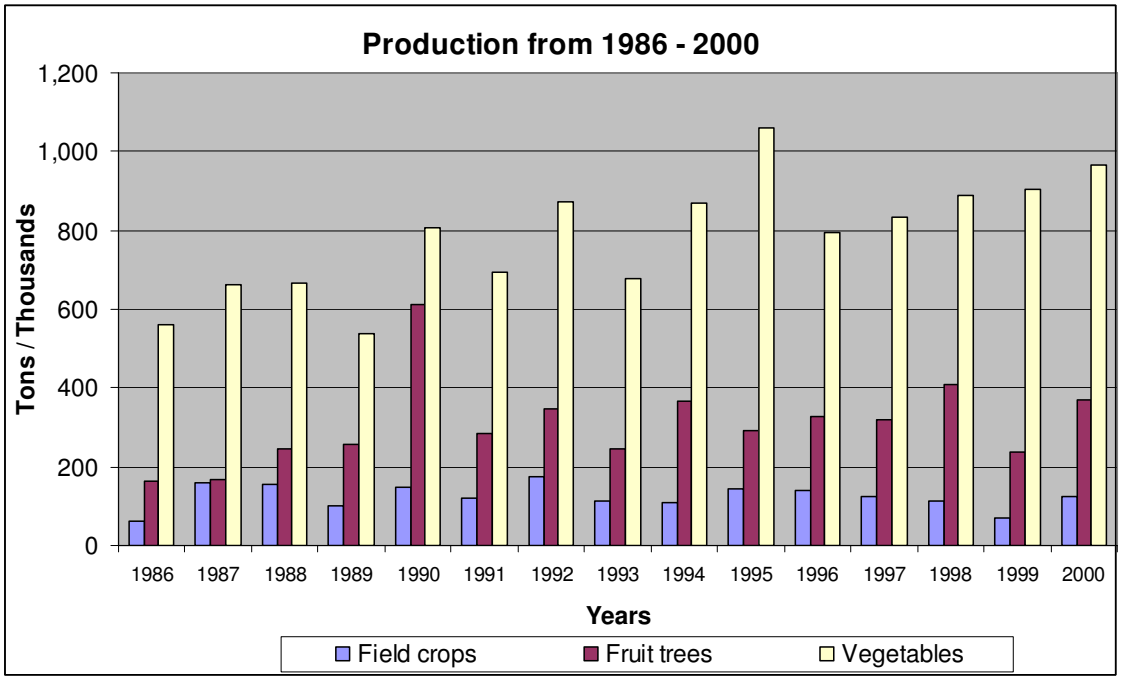

Figure (3): Development of Production of field crops, vegetables and fruit trees in Jordan during the period (1986-2000).

maximizing yields in good years often consider avoiding the risk of crop failure more important. In addition to growing drought-tolerant varieties of wheat, barley and other field crops to help avoid crop failure, farmers in low rainfall areas implement strategies of crop diversification and integration, mainly by raising livestock to maintain a reasonable income (Haddad, 1991). Moreover, there are many factors that increase the risks associated with field crops production in low rainfall areas, such as the susceptibility of some varieties to diseases and frost damage (Katkhuda & Yassin, 1997).

Nevertheless, around 1.3 million dunums of wheat and barley are grown each year but, in poor years, very late rains may delay or prevent some 30% of the anticipated plantings in the North-West-Central regions, and may prevent germination in some of the remaining

areas. This reliance on rainfall means that the marginal/semi-arid zones will not be considered in dry years.

Local wheat production produces around 7.3% of the country's wheat requirements, which, in 1996, amounted to 52 thousand tones. A further 2-3% is generated under irrigation in the Jordan Valley, in Bedouin resettlement Schemes in the Central and Eastern Governorates and by Agribusiness Projects on the South Eastern plateau but, even in the best production years, the national cereal harvest only covers about 10% of domestic requirements. Imports of grain for food and feed through commercial channels normally averaged 1.2 to 1.4 million tones per year (Katkhuda, N. and Yassin, A. 1997).

However, the planted area of field crops has an annual increase of 6.85 percent during the period 1986-1993 then it has an annual decrease of 6.14 percent during the period 1993-2000 as shown in Table (2). The total production of field crops increased with an average 7.8 percent during the first period and increased by 1.36 percent annually. This is due to the increase of wheat production under irrigation. This was represented by the leasing of the southern desert region near Al-Mudawara to commercial companies, which use highly mechanized technology with a central pivot irrigation system.

3.1.2 Development of Vegetable Production in Jordan

The planted area with vegetables decreased with an annual rate of 1.67 percent during the first period then it is increased with an annual rate of 2.7 percent, whereas the total vegetables production increased by 2.4 percent during the period (1986-2000) as shown in

Table (2). This is due to the substitutions of vegetables with fruit tress in the first period as the price of fruit trees products is increased and marketing bottleneck in vegetables due to export difficulties. At the same time, productivity of vegetables improved and supply of a large number of vegetables was in excess of domestic demand as well as of the available export markets. It became clear during 1986-1988 that supply of certain vegetables like tomatoes, eggplants, cucumber and squash was higher than demand while the domestic demand for some vegetables like potatoes and onions was much higher than supply. Productivity levels of over supplied vegetables were much higher than the under-supplied ones, a factor that made farmers to decide and to risk planting these crops in large areas while expecting higher incomes. Complaints of farmers of low prices and losses incurred in growing vegetables peaked in the mid 1980's (Hijort, et. al., 1998). In 1987, the MOA intervened to regulate and rationalize the cropping pattern. The intervention called for the reduction in the area cropped with oversupplied vegetables like tomatoes, squash, eggplants and cucumber, which happened to be highly productive and somewhat tolerant to soil salinity, on one hand, and the promotion of under supplied and less perishable vegetable like potatoes and onions. The Government offered to purchase the output of promoted crops through AMPCO but at prices considered by farmers as non-rewarding. During the three years period 1987-1989, the area of tomatoes, eggplants and squash dropped drastically but the area of potatoes and onions did not substantially increase. The overall assessment of the Government intervention to regulate cropping pattern revealed many gaps and inefficiencies as well as weak farmers' response. The area cropped with vegetables rose sharply in 1991 in the wake of the lifting of Government intervention in the vegetables cropping pattern. Another change in the area cropped with vegetables took

place in 1992 onwards. The vegetable area increased gradually to reach 329 thousand dunums equivalent to an increase of 5.1 percent in the base year of 1986. The main reason behind the increase in the area of vegetables was the increase in water supply available to these crops in the highland areas and in the Jordan Valley (Hijort, et. al., 1998).

3.1.3 Development of Fruit Trees Production in Jordan

The area of fruit trees increased from 498 thousand dunums in 1986 to 869 thousand dunums in 2000 with an annual growth rate of 4 percent, whereas the production is increased from 128 thousand tones to 371 thousand tones with an annual growth rate of 6 percent for the same period as shown in Table (2).

The expansion of Jordan's production of fruits was mainly due to the extension of irrigation (mainly in the Jordan Valley) and the introduction of improved agricultural technology. The relative importance of the various agricultural products during the period 1986-2000 is shown in Table (3).

Fruit and vegetables represented the most valuable crops, being about six times more important than grains with respect to their contribution to the total value of agricultural production. There was a significant decrease in grain production during that period. A significant change in the relative importance of various sub-sectors seems to have taken place during that period as well. The allocation for the cropped area among the various crops changed significantly during that period. The added value of plant production averaged 31,7 millions per year for the period 1986-2000 as shown in Table(3).

Table (3): growth rate of total value of field crops, vegetables and fruit tress and their percentage share in total horticultural output during 1986-2000

Year	Field crops		Vegetables		Fruits		Others		Total Plant Production
	Millions JD	% share	Millions JD	% share	Millions JD	% share	Millions JD	% share	Millions JD
1986	5,982	6	55,973	57	29,909	30	6,915	7	98,779
1987	16,643	14	61,843	51	34,193	28	9,604	8	122,283
1988	18,618	17	41,364	38	39,467	36	10,514	10	109,963
1989	15,485	12	53,715	43	47,968	39	7,003	6	124,171
1990	21,642	13	77,564	45	64,233	37	9,517	6	172,955
1991	14,210	8	77,346	44	74,573	43	9,093	5	175,222
1992	21,429	10	100,352	49	70,167	34	13,025	6	204,973
1993	14,914	9	66,095	40	72,712	44	12,639	8	166,360
1994	12,489	5	97,626	42	110,821	48	9,052	4	229,988
1995	16,956	8	90,268	41	93,921	42	19,906	9	221,051
1996	17,000	10	61,377	35	82,750	47	16,445	9	177,571
1997	16,839	8	87,543	44	78,427	40	15,522	8	198,332
1998	14,260	7	84,687	40	94,836	44	19,766	9	213,548
1999	4,271	2	88,711	48	72,167	39	19,281	10	184,519
2000	9,077	5	82,146	41	85,359	43	24,130	12	200,799
Growth Rate Year 86-93	12.1%	5.2%	2.1%	-4.3%	11.7%	4.9%	7.8%	1.7%	6.7%
Growth Rate Year 94-00	-6.8%	-8.1%	3.2%	0.4%	2.3%	-0.3%	9.7%	6.0%	2.7%
Growth Rate Year 86-00	2.8%	-1.2%	2.6%	-2.2%	7.2%	2.4%	8.7%	3.7%	4.8%

Source: DOS. (1986-2000). Annual agricultural statistics,

The share of fruit trees decreased from 12 percent during 1986-1993 to 2.3 percent during 1993-2000. The value of fruit production increased from 29.9 millions JD to 85.3 millions JD with an annual growth rate of 7 percent. Finally the total value of horticulture products increased from 98 millions JD in 1986 to 200 millions JD in 2000 with an annual growth rate of 4.8 percent.

3.2 Horizontal Expansion in Jordanian Agriculture

One of the major reasons for increasing agricultural production is the increasing of cultivated area and expansion of irrigated area in Jordan. There is a pressure to expand the total area of cultivated land and to enhance the productivity of that land in order to provide a secure food supply for the growing population. This leads to a variety of land use conflicts, not the least of which is the conflict between the continuing development of cultivated land and the preservation of wilderness area and wildlife habitats to insure conservation of biological diversity of genetic resources of plant and animals.

There is only limited potential in Jordan to bring hitherto unused, but potentially productive land under cultivation. The increased population has already used the largest part of the areas in the various agro-ecological regions, which are suitable for agricultural production. Large-scale expansion of marginal land with low productivity, and with fluctuating production is very critical from an economic and ecological point of view.

In addition, any attempt at a horizontal expansion of acreage in irrigated areas would be economically unsound, because of the high opportunity costs of water in Jordan.

Due to variations in rainfall, the increase of irrigated area, the shift to cultivating more profitable crops and major changes in the traditional markets for Jordan's agricultural products, the irrigation pattern has changed. The area of field crops fluctuates sharply from year to year on a decreasing trend. The irrigated field crops increased from 1.7% in 1983 to 8.2% of total field crops area. Due to the profitability and comparative advantage of vegetables in Jordan, especially in Jordan Valley, the cultivated area under irrigation is

increased with an annual growth rate of 5 percent to reach 92% of vegetables area as shown in Table (4).

Table (4): Irrigated and non-irrigated areas under fruit trees, field crops and vegetables in 1983 and 1997 in Jordan (dunums)

Years	1983	1997	Growth Rate
Fruit Trees			
Irrigated Area	82,068	330,068	9.9
Non-Irrigated Area	343,156	501,369	2.7
Total Area	425,224	831,437	4.8
Percentage of Irrigated Area	19.3	39.7	5.2
Field Crops			
Irrigated Area	28,654	131,679	10.9
Non-Irrigated Area	1,657,126	1,476,391	-0.8
Total Area	1,685,780	1,608,070	-0.3
Percentage of Irrigated Area	1.7	8.2	11.2
Vegetables			
Irrigated Area	142,591	277,691	4.8
Non-Irrigated Area	69,171	25,133	-7.2
Total Area	211,763	302,824	2.6
Percentage of Irrigated Area	67.3	91.7	2.2
Total Cultivated Areas			
Irrigated Area	253,313	739,437	7.7
Non-Irrigated Area	2,069,453	2,002,894	-0.2
Total Area	2,322,767	2,742,331	1.2
Percentage of Irrigated Area	10.9	27.0	6.5

Source: DOS, Agricultural census, 1983, 1997

The drastic change in Jordan occurred in fruit production (olive tress). This area increased continuously to reach 40% of irrigated areas in Jordan in 1997. Table (5) shows that the irrigated area increased from 452 thousand dunums in1986 to 761 thousand dunums in 1993 with an annual average growth rate of 6.7 percent and increased the irrigated area to 883 thousand dunums with annual growth rate of 2.1 percent. On the other hand, the total cultivated areas under rainfed conditions decreased from 2,028 thousand dunums in 1986 to 922 thousand dunums in 2000.

There was a positive growth rate for the period (1986-1993) with an average of 2.2 percent. However, the cultivated areas under rainfed condition are decreased with a

negative growth rate of 12.8 percent for the period (1993-2000). In conclusion, there is no horizontal expansion of cultivated area in Jordan during the period (1986-2000). The total cultivated area decreased from 2,481 thousand dunums to 1,805 thousand dunums for the periods (1986-2000). Furthermore, there is an increasing of the percentage share of irrigated areas in Jordan. The percentage of irrigated areas increased from 32 percent for the period (1986-1993) to 104 percent for the period (1993-2000). During the study period the percentage of irrigated area increased with an average of 6.8 percent annually due to the huge investment in irrigation and exploring new water resources.

Table (5): Development of irrigated and rainfed area in Jordan (1986-2000)

Year	Irrigated (0,000) Dunum	Rainfed (0,000) Dunum	Total (0,000) Dunum	Percent of Irrigated Area
1986	452.1	2028.9	2481.0	18.2
1987	470.5	1279.7	1750.2	26.9
1988	505.5	2524.6	3030.1	16.7
1989	524.2	2558.6	3082.8	17.0
1990	560.2	1928.4	2488.6	22.5
1991	661.0	1622.8	2283.8	28.9
1992	730.6	1310.7	2041.3	35.8
1993	761.3	2413.9	3175.2	24.0
1994	707.6	2203.6	2911.2	24.3
1995	753.0	2017.9	2770.9	27.2
1996	756.1	2503.5	3259.6	23.2
1997	860.6	1726.4	2587.0	33.3
1998	938.5	1786.9	2725.4	34.4
1999	845.4	2098.1	2943.5	28.7
2000	883.3	922.5	1805.8	48.9
Growth Rate Year 86-93	6.7%	2.2%	3.1%	3.5%
Growth Rate Year 94-00	2.1%	-12.8%	-7.7%	10.7%
Growth Rate Year 86-00	4.6%	-5.1%	-2.1%	6.8%

Source: MOA, (2000), own estimate.

It has also been realized that there has been a decrease in agricultural areas in the highland due to the expansion of urbanization. It can be stated that there is only limited potential in

Jordan to add new areas to the existing agricultural lands. In fact, there is a continuous shrinking of agricultural area highlands area, especially adjacent to towns and villages.

3.2 Vertical Expansion in Jordanian Agriculture

For vertical expansion there are two possibilities: First is to increase crop intensity, and Second is to increase the productivity of agricultural inputs by adopting new technologies, training, and agricultural extension.

3.3.1 Increasing Cropping Intensity

There are different cropping patterns in the Jordan Valley. The predominant crops are vegetables and fruit trees with about 56% and 36% respectively. The total planted area in the JRV was 311,849 dunums, of which about 41% in North, 30% in Middle and 12% and 17% in Southern Ghor and Safi Ghor respectively.

Vertical expansion by increasing cropping intensity is a relevant alternative in order to increase agricultural production. Increasing cropping intensity is limited to Jordan Valley. Therefore, cropping intensity in highland will not be discussed. However, the irrigable area in Jordan Valley is about 364 thousand dunums. The total irrigable area in Safi Ghor is about 77 thousand dunums as shown in Table (6).

Table (6): Irrigable Areas in Jordan Rift Valley

Region	Area in 1000 dunums			
	Irrigable	Rangeland	Non-Arable	Total
Jordan Valley	364.1	75.0	357.0	796.1
Southern Ghor	76.8	36.9	13.7	126.6
Wadi Araba	508.8	90.0	1346.2	1945.0
Total	949.7	201.9	1716.9	2867.7

Source: World bank, 2001.

The actual irrigated area in Jordan valley is shown in Table 7 and has an average for the period (1988-2000) about 222 thousand dunums. The actual irrigated areas in Safi Ghor are about 47 thousand dunums.

Table (7): Cropping Intensity in Jordan Valley (1988-2000)

Year	Irrigated Area	Cultivated Areas	Cropping Intensity
1988	207,848	301,914	145.3
1989	187,659	254,483	135.6
1990	238,013	312,253	131.2
1991	235,053	310,089	131.9
1992	209,118	280,855	134.3
1993	226,059	278,853	123.4
1994	233,515	275,102	117.8
1995	217,132	262,944	121.1
1996	217,888	261,113	119.8
1997	254,218	314,959	123.9
1998	240,634	288,038	119.7
1999	239,639	282,234	117.8
2000	252,406	319,814	126.7
Average	222,650.41	285,256.37	128.43

Source: DOS, unpublished data

Table 7 shows also the cultivated area on the irrigated area. The overall cropping intensity in the JV fluctuated slightly from one year to another during the period 1988-2000 with the exception of 1988 in which cropping intensity amounted to an all high of 145 percent due to the exceptional rainfall in that year. During 1988-1997 the over all cropping intensity for the four zones ranged from a high of 145 percent in 1988 to a low of 117 percent in 1994 and 1999. However, the fluctuation in area cropped each year by zone was much higher than the overall average. Cropping intensity in North, for example, fluctuated the least among the zones and ranged from 117 percent to 134 percent during the period 1990-1997. The main cause in the variation of cropping intensity is the level of sufficiency of water supply in each region. Water resources in North region are conveyed to middle and

southern region through KAC but only when farmers take their share of water. Water resources that originate in Northern region

Vegetables: the average planted area with vegetables for the period (1986-2000) in the Jordan Rift Valley is149, 301 dunums. Major vegetable crops grown in the JRV are tomatoes (26%), potatoes (12%), eggplants (10%), squash (9%), Jew's mellow (5%) and cucumber (5%). The total planted area is approximately 173,350 dunums, distributed in four districts by about 23%, 40%, 13% and 24% in the four zones North, Middle, South and Safi, respectively. In 1997, vegetables are mainly planted in North (23%), Middle (40%), and Safi (24%), while the rest is planted in Southern Ghor.

Fruit trees: the average planted area with fruit trees for the period (1986-2000) in the JRV is 84,481 dunums. The predominant trees are citrus (65%), and banana with about (16%). Citrus are dominated mostly in North by 84% of the total citrus area in the JRV. While Bananas is dominated in zones South and Safi 43% and 37%, respectively.

Field crops: the average planted area with field crops for the period (1986-2000) in the JRV is 69,348 dunums. The predominant crops are wheat (40%), barley (32%) and maize (6%). Field crops area represents about 9 % of the whole planted area of the JRV and it is mostly dominated in North.

In the case of highland area, most of this land is planted with essential field crops, mainly wheat and barley. The area in the regions with an average rainfall exceeding 300mm are estimated to be about 420 thousand dunums, or equivalent to 30% of the total area utilized in

field crop cultivation in that region. The results of research studies show that substituting fallow by legumes following the rotation "wheat-legumes" had contributed to an increase in wheat yields, as compared to results of the traditional "wheat-fallow" crop rotation. The land left fallow is estimated at 700 thousand dunums. These areas are usually planted with a two-year crop rotation, which is wheat/barley-fallow (Katkhuda, N. and Yassin, A. 1997).

The research results of ICARDA experiments in this region pointed out that it is possible to substitute 500 thousand dunums of fallow land with pasture forage cultivation, *e.g.*, vicia and vetches grain to be used for sheep rearing. The productivity of these regions could be also raised if it were possible to use supplementary irrigation through water harvesting methods. Therefore, an extension programme is needed to replace the fallow by legumes from crop rotations.

3.3.2 Increasing Productivity in Jordanian Agriculture

Considering the limited agricultural resources in Jordan and the constraints of rehabilitating new land to be put under cultivation, increasing production by raising the productivity is one of the most important methods. This alternative should be given priority, since a large potential to achieve considerable increases in the average yields exists.

The expansion of Jordan's production of fruit and vegetables was mainly due to the extension of irrigation (mainly in the Jordan Valley) and the introduction of improved agricultural technology.

3.3 Development of Crops Productivities

3.4.1 Development of Field Crops Productivity

One of the objectives in the third five-year development plan (1986-1990) was to increase agricultural productivity as one of the tools to promote continuous growth in the agricultural sector. Table (8) shows the planted area of main field crops for the period 1986-2000.

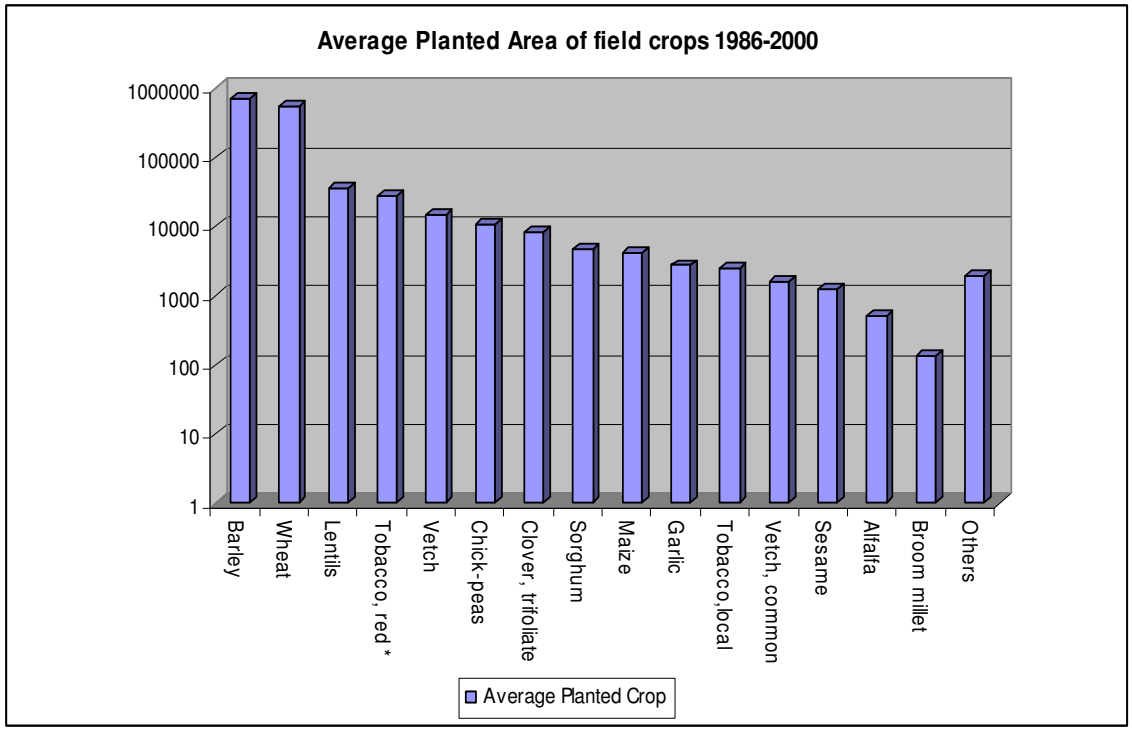

Figure (4): Development of planted area of main field crops for the period 1986-2000 (thousand dunums)

Barley occupies about one-half of the planted area of field crops. However, the total of field crops increased form 1,060 thousand dunums in 1986 to 1,156 in 2000 with a large variability from year to year dependent of rainfall variability. Additionally, the planted area is not a sufficient indicator, where a risk associated with field crops, many farmers do not harvest the plants if the plant height is not enough for mechanical harvesting or yield does not justify the harvesting cost. The un-harvested area usually grazed by sheep or

goats. Figure (4) shows the planted area of main field crops, it is clear that barley is the most planted crop then wheat since barley is planted in semiarid zones with low rainfall less than 200mm.

Table (9) shows the harvested area of the main field crops. Barley is the most crops show a difference between planted area and harvested areas. This is because barley is mainly planted in the marginal zone with less than 200mm. On the other hand, many sheep owners planted barley with the purpose of direct grazing by sheep. Consequently, the barley productivity is very low compared with other crops or compared with other neighboring countries.

Table (10) shows the field crops production for the period 1986-2000. The average wheat production in the third planned period increased from 48 thousand tons (1981-1986) to 75 thousand tons in 1992. Increasing wheat production in the period 1990-1992 might a result of wheat subsidy polices. Table (10) shows the production of field crop various from year to year. The previous three tables show the data during the period 1986-2000. The three variables changed dramatically from year to year. The fluctuation in the total areas planted with field crops from one year to another is a result of the irregularity and heterogeneity of the distribution of rainfall.

Table (11) shows the field crops productivity. Wheat yields increased from 52 kg/du in 1986 to 140 kg/du in 2000. Furthermore, the average wheat productivity decreased form 104 k/du for the period 1986-1993 to 93 kg/du for the period 1993-2000. Barley yield decreased also during the study period.

Table (8): Development of planted area of main field crops for the period 1986-2000(thousand dunums)

Year	Wheat	Barley	Lentils	Tobacco red	Vetch	Chick-peas	Clover, trifoliate	Sorghum	Garlic	Tobacco local	Vetch, common	Sesame	Others
1986	594355	357602	32314	27697	20325	15953	51	2927	0	44	0	1375	6468
1987	843193	511468	51187	29180	15570	16386	6179	4735	3830	754	0	857	10188
1988	701768	559556	53140	29180	13004	16790	5104	12500	6443	6284	1580	384	741
1989	562117	373441	31670	29305	13079	1670	10428	6386	1386	1340	1049	160	1530
1990	605312	550994	43008	29305	19806	5320	8275	17860	742	4916	1550	1566	359
1991	564665	655247	24751	15471	19922	14852	4495	4078	2633	1520	812	3773	1828
1992	534129	793290	30237	29203	8569	8769	1480	9042	3751	661	1241	601	597
1993	679160	972097	82325	29347	3570	14475	7010	4932	2639	1277	1178	1751	1762
1994	424536	663675	24232	28819	7816	6576	7800	198	3424	1884	345	683	375
1995	512323	879395	28465	29209	11092	2637	8578	212	3742	11222	1252	1001	3050
1996	329265	768064	43376	29000	11258	4113	9938	768	4757	616	2143	1336	467
1997	568852	917937	30813	29000	14152	19969	9112	372	2651	1377	2525	987	872
1998	504637	1085325	29023	29000	19251	8888	16893	6029	2097	538	2623	1754	882
1999	506627	1206267	16347	29000	29880	13117	17847	290	1575	2500	4764	202	21
2000	476438	574899	10664	29000	11329	14245	15894	225	1830	1995	3166	2704	470
Avg Y86-00	560492	724617	35437	28114	14575	10917	8606	4704	2767	2462	1615	1275	1974
Avg Y86-93	635587	596712	43579	27336	14231	11777	5378	7808	2678	2100	926	1308	2934
Avg Y94-00	500230	883457	33156	29047	13543	10503	11634	1628	2839	2676	2250	1302	987

Source: DOS, (1986-2000), Annual agricultural Statistics.

Table (9): Development of harvested area of main field for the period 1986-2000 (thousand dunums)

Year	Wheat	Barley	Lentils	Tobacco, red	Vetch	Chick-peas	Clover, trifoliate	Sorghum	Garlic	Tobacco ,local	Vetch, common	Sesame	Others
1986	465991	196749	28322	27697	13833	11599	51	2927	0	44	0	0	7843
1987	799814	452078	50829	29180	15380	15796	6159	4460	3810	754	0	857	9712
1988	699044	554301	53140	118	13004	16790	5104	12500	6443	6284	1580	384	741
1989	540855	324560	31488	29305	13079	1670	10428	6386	1386	1340	1049	160	1530
1990	573064	480202	43008	29305	19157	5320	8275	17860	742	4916	1454	1566	359
1991	514431	570957	24225	15471	19851	14852	4495	4078	2633	1520	812	3763	1828
1992	513400	691720	29380	29203	8569	8769	1480	9042	3751	661	1241	601	597
1993	375749	272894	82244	29347	3570	14475	6989	4932	2639	1277	1178	1751	1762
1994	297146	302942	24232	28819	7816	6576	7800	198	3424	1884	345	683	375
1995	405553	357405	28465	29209	11092	2637	8578	212	3742	11222	1252	1001	3050
1996	283491	264609	43376	29000	11258	4113	9938	768	4757	616	2143	1336	467
1997	379202	415832	30813	29000	14152	19969	9112	372	2651	1377	2525	987	871
1998	288348	334344	29023	29000	19251	8888	16893	6029	2097	538	2623	1754	882
1999	40876	36817	4113	29000	3084	4431	13464	290	1575	362	2844	137	21
2000	182037	133798	10663	29000	9187	11955	13831	225	1830	1694	3166	2704	470
Avg 86-00	423933	359281	34221	26177	12152	9856	8173	4685	2765	2299	1481	1179	2034

Source: DOS, (1986-2000), Annual agricultural Statistics.

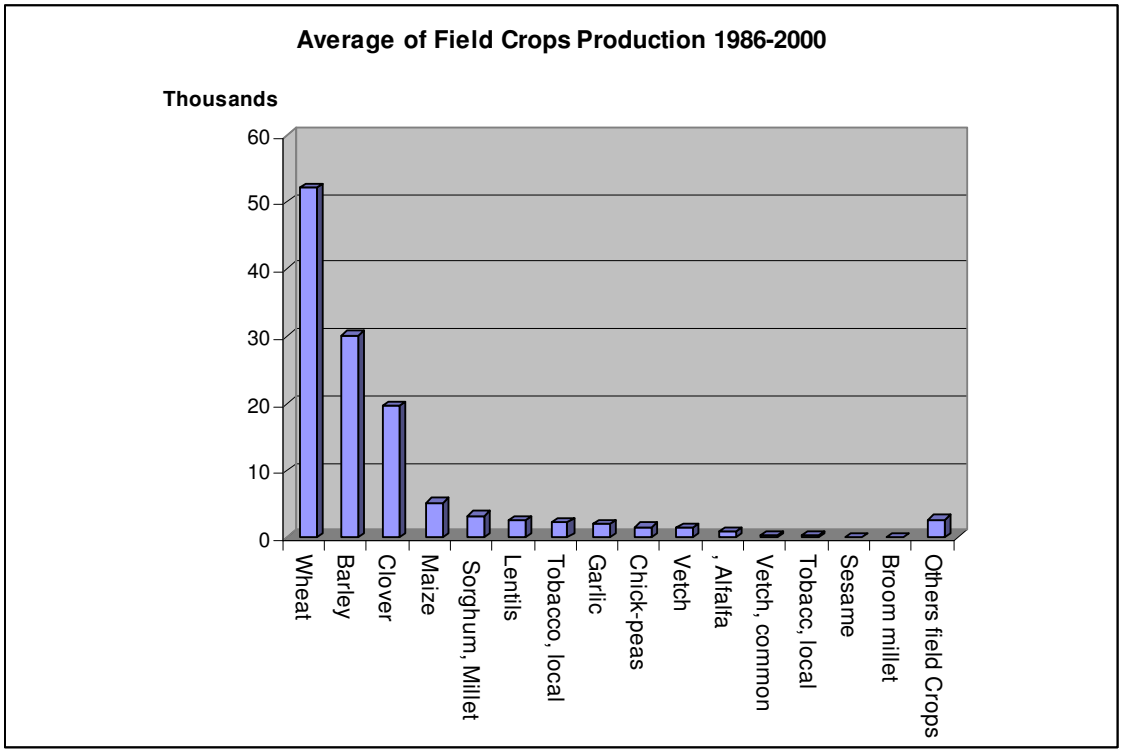

Figure (5): Development of Average Production of main field crops for the period 1986-2000 (thousand dunums)

Vetch productivity shows an incredible figure, and it is unrealistic. The average productivity of vetch under experimental condition does not exceed 100 kg/du (Haddad, et al, 1997). Similar to vetch is chickpeas. Therefore, special attentions should be made during collection of area and production of legumes crops, such as lentil, chickpea and vetch.

Table (11) shows the instability and fluctuation of the yield from one year to another as a result of unstable climatic conditions, especially rainfall. Unreliable rainfall, low returns, small holdings, increasing land prices, increasing off-farm opportunities and reduced farm labor supply has reduced farmers' interest in planting field crops.

Table (10): Development of field crop production for the period 1986-2000 (Thousand tones).

Year	Wheat	Barley	Clover	Sorghum, Millet	Lentils	Tobacco, local	Garlic	Chick-peas	Vetch	Vetch, common	Tobacco, Red	Sesame	Others field Crops
1986	30842	9004	60	1778	1750	1677	0	593	1270	0	3	78	13883
1987	79806	33048	9067	3010	5245	2770	2025	1251	1419	0	151	24	23014
1988	78773	44850	10142	4469	6529	3452	3569	1803	2000	218	200	128	185
1989	54520	20571	14037	5584	1572	2827	197	124	1180	145	102	23	498
1990	82970	42406	8932	5213	4121	2406	519	343	1444	455	489	102	324
1991	61844	39935	4276	5721	1184	1072	2063	1449	1230	74	187	105	477
1992	75435	68878	592	13645	2839	3172	3013	1695	2551	213	53	232	263
1993	57094	31798	6750	5339	4771	3287	1561	2613	229	255	94	301	355
1994	46852	27353	17474	299	1400	1211	2033	1631	871	150	306	102	219
1995	58457	31726	27431	318	2142	3468	2899	490	794	253	1291	123	805
1996	42678	29171	48143	843	1973	942	2361	2575	1172	369	156	207	145
1997	41785	29428	27280	309	2061	2599	2414	3563	1224	1668	102	46	225
1998	35974	27392	27436	1861	1582	2289	2315	3084	1140	241	18	179	47
1999	9251	4940	32363	198	185	540	2671	264	4466	367	21	12	2
2000	25434	12070	59566	392	1108	2575	2609	1992	595	314	94	218	54
Avg Y86-93	-26252	-22794	-6690	-3561	-3021	-1610	-1561	-2020	1041	-255	-91	-223	13528
Avg Y93-00	31660	19727	-52816	4947	3664	712	-1048	621	-366	-59	0	83	301
Avg Y86-00	52114	30171	19570	3265	2564	2286	2016	1564	1439	315	218	125	2700

Source: DOS, (1986-2000), Annual agricultural Statistics.

Table (11) Average Yield of Field Crops in Jordan 1986-2000

Year	Wheat	Barley	Clover, trifoliate	Sorghum	Lentils	Tobacco, local	Garlic	Chick-peas	Vetch	Vetch, common	Tobacco, red *	Sesame	Alfalfa	Others
1986	51.9	25.2	1176.5	607.4	54.2	68.2		37.2	62.5		60.5	56.7	1737.6	2146.4
1987	94.6	64.6	1467.3	635.6	102.5	200.1	528.8	76.3	91.2	0	94.9	28	0	2258.9
1988	112.2	80.2	1987.2	357.5	122.9	31.8	554	107.4	153.8	137.7	118.3	334.3	0	249.2
1989	97	55.1	1346.1	874.5	49.6	75.8	142	74	90.2	138.1	96.5	144.2	0	325.2
1990	137.1	77	1079.4	291.9	95.8	99.4	699.7	64.4	72.9	293.5	82.1	65.2	0	901.4
1991	109.5	60.9	951.4	1402.8	47.8	123.3	783.7	97.6	61.8	90.7	69.3	27.7	0	0
1992	141.2	86.8	400	1509.2	93.9	80.1	803.1	193.2	297.7	171.4	108.6	385.6	613.8	440.4
1993	84.1	32.7	963	1082.3	58	73.5	591.5	180.5	64.1	216	112	171.8	2018	201.3
1994	110.4	41.2	2240.4	1511.4	57.8	162.4	593.6	248.1	111.5	435.4	42	148.6	386.4	584.9
1995	114.1	36.1	3198	1504.5	75.2	115	774.6	185.7	71.6	202	118.7	122.9	7709.5	263.9
1996	129.6	38	4844.4	1098.2	45.5	253.9	496.4	626.1	104.1	172	32.5	155.2	937.8	311.1
1997	73.5	32.1	2994	830.6	66.9	74.1	910.6	178.4	86.5	660.3	89.6	46.7	1150	258.5
1998	71.3	25.2	1624.1	308.7	54.5	32.9	1103.8	347	59.2	91.7	78.9	102.1	0	52.7
1999	18.3	4.1	1813.3	685	11.3	8.3	1695.4	20.1	149.5	77	18.6	61	2619.3	82.1
2000	139.7	90.2	4306.9	1742.4	103.9	0	1425.3	166.6	64.7	99	88.8	80.7	0	114
Avg Y86-00	99	50	2026.1	962.8	69.3	93.2	793	173.5	102.7	198.9	80.8	128.7	1144.8	546
Avg Y86-93	103.5	60.3	1171.3	845.1	78.1	94	586.1	103.8	111.8	149.6	92.8	151.7	546.2	815.4
Avg Y93-00	92.6	37.4	2748	1095.4	59.1	90	948.9	244.1	88.9	244.2	72.6	111.1	1852.6	233.6

Source: DOS, (1986-2000), Annual agricultural Statistics

Despite government efforts to encourage the planting of trees on highlands areas not suitable for field crops, farmers convert good flat land suitable for field crops to olive or fruit orchards, which have much better returns.

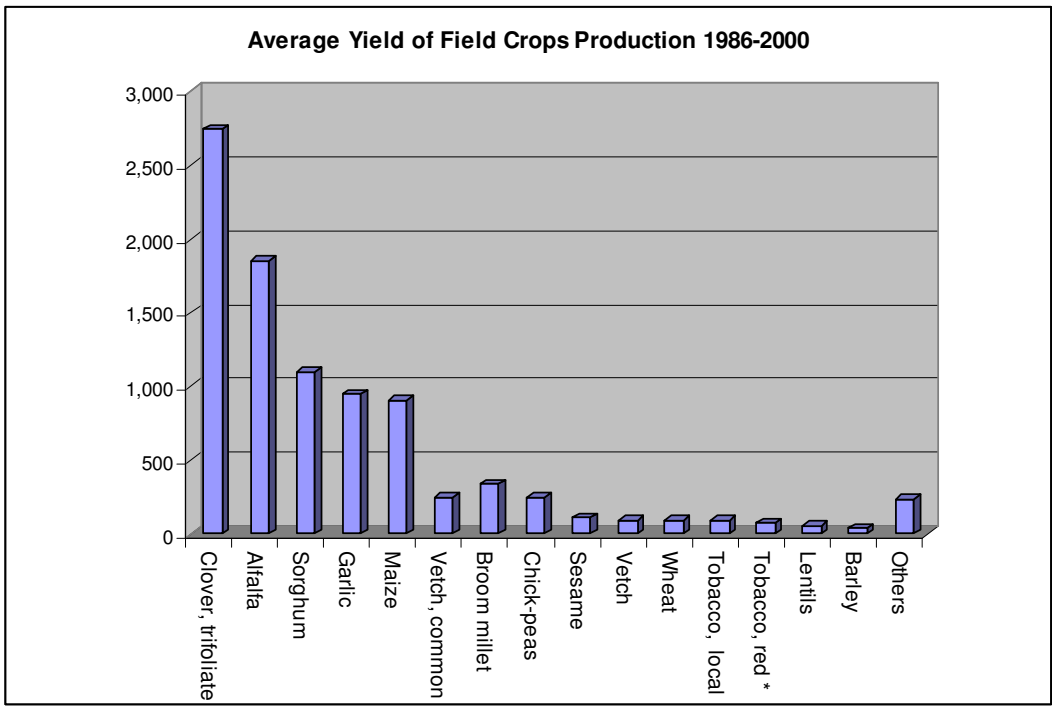

Figure (6): Development of Average field crops productivity for the period 1986-2000 (thousand dunums)

Table (12) summaries the growth rate of output, area and productivity of main field crops in the period 1986-2000. It shows an increasing growth rate of production of barley, maize, sesame and livestock feeds, a negative growth rate for wheat and lentils, vetch and chickpeas. It shows also that there is a growth rate of area planted with wheat, barley, lentils, vetch, chickpeas, maize, sesame and alfalfa, and a negative growth for the area of tobacco, local and red. On the other hand there is a growth rate of yield of barley, chickpeas, maize, tobacco and sesame except for wheat, lentils, vetch and clover. This might be to the expansion for barley cultivation during last decade to the marginal area that is suitable for barley cultivation to provide livestock

with sufficient feed from local resources as a result of feed subsidy and increasing sheep and goat numbers during last decade.

Table (12): Growth rate of production, area and productivity of main field crops during the period 1986-2000

Crop	Production %	Area %	Yield %
Wheat	-1.46	6.83	-1.28
Barley	3.22	8.88	1.97
Lentils	-7.12	4.44	-3.00
Vetch, common vetch	-3.82	0.23	-4.93
Chick-peas	-0.75	10.52	8.41
Maize, Sorghum, Millet	10.54	7.28	17.20
Tobacco, local & Red	0.74	-2.45	3.13
Sesame	4.61	2.38	7.10
Clover, Alfalfa	18.94	2.64	-10.67
Others field crops	-16.04	-17.78	-30.97

Source: own estimate

However, the actual average productivity in the rainfed areas is low compared to what could be attained by applying new technology. This would be determined either by agricultural research in Jordan or by adopting proven technology from comparable agro-ecological environments. In addition, rainfed wheat farmers show high awareness to the effect of improved technology. They have already adopted some of these practices in spite of the limited amount of government effort to increase production through concentrated applied research. The adoption of yield-increasing practices would result in an upward shift of the rainfed cereal production function, meaning more production for a given amount of factor inputs. Results from the agricultural research on wheat and barley at the research stations indicate the following potential yield increase:

For wheat: from 99 kg/dunum, which was the average wheat yield in the rainfed areas in the period 1986-2000, to about 220 kg/dunum, if the technological package were to be adopted

For Barley: from 50 kg/dunum, which was the average barley yield in the period 1986-2000, to about 150 kg/dunum, if the technological package were to be adopted.

In other words, a 50 percent adoption of improved technology by wheat and barley farmers would lead to a production increase equal to cultivations plus 536 thousand dunums of wheat and barley by traditional technology.

3.4.2 Development of Vegetable Productivity

The productivity of vegetables improved and supply of a large number of vegetables was in excess of domestic demand as well as of the available export markets. It became clear during 1986-1990 that supply of certain vegetables like tomatoes, eggplants, cucumber and squash was higher than demand while the domestic demand for some vegetables like potatoes and onions was much higher than supply. Productivity levels of over supplied vegetables were much higher than the under-supplied ones, a factor that made farmers to decide and to risk planting these crops in large areas while expecting higher incomes. The main reason behind the increase of productivity in vegetables was the adoption of plastic houses, new irrigation technology, high yielding varieties and adoption of chemical fertilizers and pesticides.

An increase in area of main vegetables in Jordan during the period 1986-2000 at 0.34 percent, both its production and productivity increased significantly as well at the rate of 3.7 and 3.35 percent per annum, respectively. All vegetable crops shows a significant increase in productivity as displayed in Table (13), except Jew's mallow.Green Onion, Cucumber, sweet melon and watermelons show a high growth rate of productivity during the last period. The yield of cucumber increased from 5.6 kg/du in the period (1986-1993) to 8.2 kg/du in the period (1993-2000), the main

reasons for changing the productivity of cucumber is the adoption of plastic houses, fertilizers, new seed varieties in cucumber production, at present cucumber is planted completely under plastic houses. The yield of watermelons increased form 2.9 kg/du to 3.8 kg/du in the same period. Most of watermelons planted in Jordan at present are planted under drip irrigation in the southern and northern irrigated areas near to desert. Furthermore, in spite of decreased planted area of tomato in Jordan, the tomato production increased with an annual growth rate of 3.21 percent, whereas the tomato productivity increased with an average of 4.03 percent. This is due to the adoption of complete package of technology by farmers in Jordan Valley and highland areas to produce tomato. This package includes, plastic houses, muslins, fertigation, a complete program for fertilization and protection, in addition to new hybrid of seeds.

Table (14) and Table (15) show the development of planted area, average yield and production of winter and summer vegetables, respectively, for the periods (1986-1993) and for (1993-2000) in Jordan. As shown in these tables Tomatoes are the dominant vegetable produced in Jordan followed by potato, cucumber, eggplants, cabbage, squash, cauliflower, and onion.

Table (13): Development of planted area, average yield, production and growth rate of vegetables for the periods (1986-2000) in Jordan

Crop	Average Y86-00			Growth Rate 86-00		
	Area/Dunum	Yield kg/dun	Production kg/du	Area %	Yield %	Production %
Tomatoes	306471.6	3.92	322802.1	-0.79	4.03	3.21
Potato	82772.1	2.25	74183.9	6.04	3.95	-2.51
Water melon	30827.2	3.28	70319.3	-5.54	3.21	10.23
Squash	23407.6	1.56	63771.6	-0.82	2.83	4.96
Eggplants	20951.1	2.75	50246.4	-3.24	0.98	-2.29
Cauliflower	18690.5	1.87	31741.7	0.04	0.06	1.98
Sweet melon	17420.8	1.33	27113.1	-0.83	6.41	0.47
Onion dry	16760.0	1.69	20677.6	0.00	0.00	0.00
String beans	10946.8	1.03	20624.2	-1.45	2.36	5.53
Cucumber	10604.9	7.05	16221.2	-4.41	9.81	-2.10
Broad beans	9675.0	0.59	15356.4	4.85	0.06	8.30
Jew's mallow	8672.0	2.14	10612.4	16.04	-6.67	0.88
Okra	8108.7	0.28	9710.5	2.49	8.83	0.84
Cabbage	6861.8	2.60	9267.6	-2.85	0.77	-1.11
Hot pepper	6707.5	1.89	8779.2	-3.65	2.63	3.16
Lettuce	5198.4	1.62	6889.6	-1.63	4.87	9.32
Sweet pepper	5172.0	2.48	5451.0	-2.68	3.62	0.00
Spinach	4357.0	1.85	4897.2	4.75	4.36	4.91
Onion green	2787.3	1.50	4179.0	8.19	12.45	21.66
Snake cucumber	2568.8	0.60	2069.8	0.00	0.00	11.54
Carrot	2507.1	2.08	1811.0	0.00	0.00	0.00
Peas	2408.0	0.55	1441.9	23.67	5.75	0.00
Cow-peas	1893.0	0.63	1222.3	4.61	0.38	0.00
Parsley	1514.3	1.27	1121.1	0.00	0.00	30.78
Radish	1229.3	1.66	1065.8	0.00	0.00	0.00
Turnip	650.4	1.57	905.8	0.00	0.00	5.01
Others	537.7	1.14	4027.1	6.16	3.35	16.12

Source: DOS, 1986-2002, Annual agricultural statistics.

The average production of tomatoes and potato in winter during the 1993-2000 is 124.5 thousand tons and 48 thousand tons with a growth rate at 7.2 percent and 11.52 percent of the produced vegetables respectively, for the period 1986-2000. Other important crops include watermelon, cucumbers, squash, eggplants and string beans.

The other interesting results in these tables is the shift in production time from winter season to summer season for the following crops: sweet pepper, broad beans, string

beans, peas, cow-peas, and lettuce. On the other hand there is a trend to decrease the production of squash, eggplant and hot pepper. All of these crops provide evidence of increasing of productivity.

Table (14): Development of planted area, average yield and production of winter vegetables for the periods (1986-1993) and (1993-2000) in Jordan

Crop	Development of Winter Vegetable								
	Average 1986-1993			Average 1993-2000			Growth Rate 86-00		
	Area dunums	Yield Kg/du.	Production Ton	Area dunums	Yield Kg/du.	Production Ton	Area %	Yield %	Production %
Tomatoes	34,194	3.2	107,971	35,652	3.51	124,554	2.97	4.12	7.20
Water melon	28	0.7	81	1,666	2.92	5,679	0.00	0.00	0.000
Potato	15,128	2.2	33,504	21,461	2.20	48,286	9.82	1.55	11.52
Cucumber	6,464	5.1	31,339	5,057	8.26	40,375	-5.46	10.06	4.05
Eggplants	10,244	2.7	26,158	8,176	2.86	23,243	-3.33	-0.59	-3.90
Sweet melon	16	0.9	33	185	1.78	454	14.58	4.70	19.96
Squash	12,148	1.4	17,412	10,264	1.47	15,084	-1.50	-0.29	-1.78
Jew's mallow	175	1.2	278	558	1.61	1,072	7.65	5.29	13.34
Cauliflower	5,510	1.9	10,689	9,975	1.96	17,766	0.93	0.97	1.91
Cabbage	5,364	2.5	10,424	5,251	2.49	11,503	-2.01	-0.06	-2.06
Onion dry	5,966	1.2	9,771	11,914	1.98	22,743	0.00	0.00	0.00
String beans	5,199	0.9	4,600	6,007	1.37	7,415	4.63	3.58	8.38
Hot pepper	3,641	1.7	5,761	2,410	2.25	5,283	-3.78	2.83	-1.06
Sweet pepper	3,391	2.5	7,083	1,857	3.15	5,591	-4.21	4.65	0.25
Okra	147	0.2	35	242	0.42	109	27.00	8.05	37.22
Lettuce	3,464	1.5	5,412	4,429	1.68	7,925	1.36	6.03	7.47
Snake cucumber	7	0.1	3	44	0.50	45	0.00	0.00	0.00
Cow-peas	10	0.1	4	34	0.53	20	-0.58	1.56	0.96
Parsley	621	1.2	1,059	1,212	1.32	1,606	0.00	0.00	0.00
Carrot	1,542	1.7	2,912	2,986	2.36	7,030	0.00	0.00	0.00
Broad beans	7,298	0.6	4,295	9,128	0.48	4,475	4.77	-0.71	4.03
Onion green	904	1.3	1,145	3,526	1.65	6,174	9.07	13.72	24.04
Spinach	1,307	1.4	1,868	3,812	2.31	10,772	5.93	4.57	10.77
Radish	438	1.0	530	764	2.27	1,645	0.00	0.00	0.00
Turnip	509	0.8	779	601	2.33	1,304	0.00	0.00	0.00
Peas	681	0.5	310	2,741	0.65	1,736	26.55	5.45	33.44
Others	1,473	1.0	1,407	2,125	1.14	2,503	6.86	7.86	15.26

Source: DOS, 1986-2000, Annual agricultural statistics.

The shift to high-value horticultural crop production was the major contributor to the rapid growth. During this period, vegetable markets, both domestic and regional, were functioning well, and prices were attractive and conducive to further public and private investment

Table (15): Development of planted area, average yield and production of summer vegetables for the periods (1986-1993) and (1993-2000) in Jordan

Crop	Development of Summer Vegetable								
	Average 1986-1993			Average 1993-2000			Growth Rate 86-00		
	Area dunums	Yield Kg/du.	Production Ton	Area dunums	Yield Kg/du.	Production Ton	Area %	Yield %	Production %
Tomatoes	43,825.0	4.5	192,120.8	52,656.3	4.1	222,041.2	-2.8	3.7	0.8
Water melon	21,278.2	3.0	59,030.5	22,476.9	3.8	83,971.3	-6.8	2.5	-4.4
Potato	9,151.3	2.3	21,034.7	16,360.7	2.5	38,721.4	2.7	6.0	8.8
Cucumber	4,214.6	6.6	23,223.9	3,448.2	8.4	30,260.1	-3.6	9.5	5.6
Eggplants	9,511.0	3.0	27,267.3	8,705.8	2.5	21,738.4	-3.2	2.1	-1.1
Sweet melon	19,959.2	1.1	20,947.7	12,847.7	1.6	19,359.5	-1.1	6.4	5.2
Squash	7,390.9	1.7	11,555.2	11,324.6	1.6	17,406.3	-0.2	4.5	4.3
Jew's mallow	5,753.1	2.6	11,987.9	9,569.9	1.8	16,372.8	18.2	-8.8	7.8
Cauliflower	4,654.4	2.1	9,540.7	7,617.9	2.0	14,932.0	-1.0	-0.5	-1.5
Cabbage	1,592.5	2.4	3,824.0	2,477.3	2.5	6,022.9	-4.7	2.6	-2.2
Onion dry	2,563.7	1.6	4,836.7	2,230.8	2.2	5,053.7	0.0	0.0	0.0
String beans	5,390.8	0.9	4,951.1	4,217.7	0.8	3,676.2	-5.5	2.3	-3.3
Hot pepper	2,353.9	1.7	3,755.2	1,847.4	1.8	3,395.2	-3.5	2.4	-1.2
Sweet pepper	1,314.7	2.2	2,622.1	1,820.6	2.2	3,856.9	-0.9	2.7	1.8
Okra	5,731.2	0.2	1,466.1	7,995.6	0.3	2,735.8	2.3	8.6	11.1
Lettuce	1,287.9	1.5	1,688.4	899.9	2.0	1,897.4	-8.5	3.2	-5.5
Snake cucumber	1,942.0	0.4	851.9	2,929.8	0.8	1,924.1	0.0	0.0	0.0
Cow-peas	1,335.4	0.6	710.5	1,859.6	0.7	1,145.2	4.9	0.2	5.2
Parsley	180.9	1.0	220.9	459.8	2.3	921.2	0.0	0.0	0.0
Carrot	110.4	1.6	199.6	478.0	2.8	664.0	0.0	0.0	0.0
Broad beans	276.4	0.7	185.7	214.7	0.7	418.9	5.2	2.6	7.9
Onion green	226.1	1.3	262.9	213.6	1.2	314.6	3.1	5.4	8.7
Spinach	104.4	1.3	129.4	153.9	1.9	320.1	-7.9	7.0	-1.5
Radish	38.3	0.6	44.0	48.3	1.8	142.5	0.0	0.0	0.0
Turnip	13.6	0.5	18.7	30.4	1.5	88.2	0.0	0.0	0.0
Peas	119.8	0.2	35.6	175.4	0.6	76.7	2.1	5.6	7.8
Others	1,247.5	1.0	1,570.2	1,647.0	1.3	2,393.8	5.5	11.0	17.0

Source: DOS, 1986-2000, Annual agricultural statistics.

3.4.3 Development of Fruit Trees Productivity

The expansion of Jordan's production of fruit was mainly due to the extension of irrigation (mainly in the Jordan Valley) and the introduction of improved agricultural technology. Table (16) shows the planted area, average yield and production of fruit trees in 1986 and 2000 in Jordan. The fruit trees area was increased with an average of 3.78 percent annually, whereas the total production of fruit tress increased with 5.63 percent, therefore, the annual increase of fruit tress productivity is about 1.79

percent annually. The yield of one dunum of Olives is increased from 92 kg/du in 1986 to 210 kg/du in 2000 with an annual growth rate of 5.67 percent. The productivity of Citrus fruits is about 1633 kg/du for the year 2000 compared with 1000 and 951 kg/du for Bananas and Apples. Table 16 shows the growth rate in productivity of the main fruit tress in Jordan. There is a high growth rate in productivity of apples and pomegranates exceed 10 percent annually. However, Table 16 shows a decrease in the productivity of banana during the study period in spite of the advances of technology used in banana production such as tissue culture. The reason behind that is the expansion of banana in southern Ghor, where the land salinity in southern region is much higher in northern region and banana is very sensitive to soil and water salinity. Also Banana is a highly water consuming crop, since water is a limited resource in Jordan and it is an expensive commodity so the trend is to reduce the areas planted with Bananas.

Table (16): Development of area, production, and average yield of fruit trees in 1986 -2000 in Jordan

Crop	Area (dunum)			Production (ton)			Yield (kg/dunum)		
	1986	2000	Growth Rate %	1986	2000	Growth Rate	1986	2000	Growth Rate %
Total	498,591.0	869,450.7	3.78	163,263.0	371,286.7	5.63	327.4	427.0	1.79
Olives	344,926.0	637,528.7	4.18	31,781.0	134,285.4	10.08	92.1	210.6	5.67
Citrus fruits	53,941.0	76,271.0	2.34	87,358.0	124,594.9	2.40	1,619.5	1,633.6	0.06
Grapes	55,025.0	37,385.8	-2.54	23,186.0	23,909.6	0.21	421.4	639.5	2.82
Apples	8,447.0	39,378.6	10.81	1,126.0	37,468.3	26.32	133.3	951.5	14.00
Bananas	9,032.0	20,824.3	5.73	13,414.0	20,832.0	2.98	1,485.2	1,000.4	-2.60
Peaches	5,045.0	16,136.7	8.06	725.0	6,908.5	16.22	143.7	428.1	7.55
Figs	5,024.0	5,623.7	0.75	1,449.0	2,501.4	3.71	288.4	444.8	2.93
Plums, prunes	4,296.0	6,507.7	2.81	1,357.0	3,052.9	5.55	315.9	469.1	2.67
Pomegranates	3,031.0	3,959.4	1.80	929.0	4,419.3	10.96	306.5	1,116.2	9.00
Almonds	4,214.0	4,788.1	0.86	504.0	1,658.2	8.26	119.6	346.3	7.35
Apricots	2,376.0	7,837.1	8.28	295.0	4,576.1	20.05	124.2	583.9	10.87
Pears	662.0	2,632.0	9.64	190.0	861.0	10.60	287.0	327.1	0.88
Guava	1,065.0	1,762.8	3.42	495.0	1,643.4	8.33	464.8	932.3	4.75
Dates	0.0	2,641.0	0.00	0.0	1,320.5	0.00	0.0	500.0	0.00
Others	1,507.0	6,173.8	9.86	454.0	3,255.2	14.03	301.3	527.3	3.80

Source: DOS, 1986-2000, Annual agricultural statistics.
Percentage were own estimated

CHAPTER FOUR

Factors Affecting Technological Change

4.1 Technology Adoption in Jordanian Agriculture.

4.1.1 Environmental Factors:

All ecosystems are extremely complex and even the simplified agro-ecosystem is composed of many sub-systems. It is extremely difficult to separate one component of the ecosystem as if it exists separately from the other components and deal with it alone.

Numerous studies conducted world wide on pesticides have indicated their dual effects on the environment and on human health. Large numbers of pesticides have been shown to cause ozone depletion and in addition to other environmental effects. Furthermore, pesticide toxicity is well documented and a yearly report by the International Program on Chemical Safety (IPCS) lists the toxicity of the various pesticides and updates this information periodically. This toxicity is also documented for the pesticide residuals in soil, water, food products and even human body.

In Jordan, the use of modern technology was, and remains, the main objective of most agricultural policies, taking into consideration the limited arable land and water resources. The adoption of chemical technology has been faster in irrigated agriculture. All the farmers in irrigated areas apply fertilizers to vegetables and fruit trees, while in the rainfed area; consumption is still infrequent and low. Modern agriculture requires diverse kinds of chemicals to control weeds, insects, and plant diseases as part of a package of improved technology for high yields. The quantities used are high, and there is over use by many farmers. In the rainfed areas, however, there seems to be a lack of chemicals and

spraying services, and it appears to be difficult to get the private dealers sufficiently interested in such a service.

The intensive use of pesticide has become characteristic of the Jordanian agricultural sector in recent years. The extensive use of herbicides, fungicides and insecticides is considered one of the major problems facing policy makers in Jordan. On the one hand, subsidy and registration policies were made to increase the adoption rate of pesticides in order to increase agricultural production and reduce yield variation in irrigated areas.

Table (17) shows the quantities of pesticides imported during the period (1986-2000). There is an increased of quantities utilized of herbicides and fumigants by time, whereas there is a decrease of the imported quantities of insecticides, acaricides and fumigants. These figures do not indicate that there is a decrease of pesticides usage in Jordan. In fact, the local production of pesticides in 2000 represents 30% of imported pesticides.

Table (17): Development of total quantities of imported pesticides in Jordan during (1986-2000), (1000 liter/ or 1000 kg)

Year	Insecticides	Acaricides	Fungicides	Herbicides	Fumigants	Oil	Rodenti-cides	Total Agr Pesticides*
1986	208.3	58.1	354.2	35.4	248.2	79.1	3.3	986.5
1987	248.6	51.6	591.0	63.3	552.9	64.5	5.5	1,577.4
1988	227.8	52.8	686.8	58.5	113.7	64.5	9.3	1,213.4
1989	252.6	52.3	655.6	23.6	239.7	62.5	0.5	1,286.8
1990	259.3	76.9	369.9	27.6	132.4	20.1	2.0	888.3
1991	38.2	57.3	341.6	70.0	130.2	46.5	13.0	696.9
1992	237.7	57.2	577.8	74.0	257.1	131.5	3.5	1,338.8
1993	208.7	36.1	358.7	49.2	302.0	99.6	10.6	1,064.9
1994	225.6	37.1	325.5	45.0	346.9	44.3	20.0	1,044.4
1995	194.8	38.2	380.1	33.8	322.7	102.9	1.0	1,073.6
1996	126.8	64.8	331.2	56.4	285.4	75.4	14.6	954.6
1997	229.3	26.1	311.1	56.9	153.8	71.9	3.5	852.6
1998	166.6	26.8	336.6	65.5	330.3	119.2	9.5	1054.5
1999	178.9	39.4	369.4	51.2	184.2	80.3	14.6	918.0
2000	198.3	30.8	437.0	58.1	179.7	94.2	8.0	1006.1

* Does not include public health, veterinary, vital and mollusicides
Source: DOS,(1986-2000) Annual agricultural statistics

After the Gulf crises, there was a dramatic reduction of imported pesticides due to political reasons. This situation has encouraged the private investors to invest in pesticides industry. In 2001 there were 14 local firms manufacturing and formulating pesticides for local market and for export purpose in the country. The history of the pesticide industry in Jordan dates back to 1975 when the first formulation plant was established. During 1975-1990 only three other companies were established. All other formulating companies were

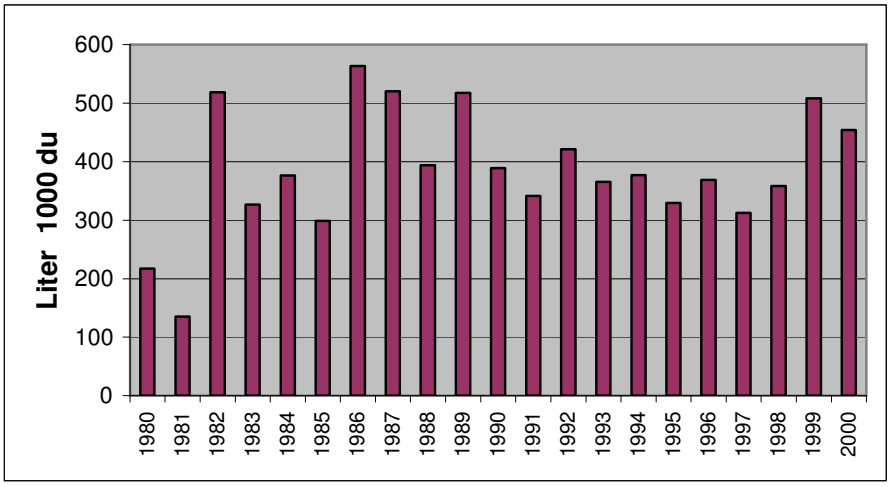

Figure (7): Development of imported quantities of pesticides per 1000 dunums (1980-2000)

established after 1990 and many of them targeted their products to the export market; especially Iraq. Some of these pesticide producers are considered large and have adequate production capacities

while others are just an extension to their original trade business. Figure (7) shows the trends of development for the imported quantities of pesticides per thousand dunums. It clearly indicates the increased amount of pesticides use in Jordan as a result of intensifying the agricultural production.

Furthermore, the quantities of pesticides used in Jordan in 2000 were about 1347 tons, with a value of 12.6 million JD as shown in Table (18). The locally produced quantities

were about 960 tons of which 576 tons were exported to different countries, especially Iraq (DOS, 2002). Pesticide industry is confronted with numerous problems and constraints that hinder its progress. Results of a study on pesticides industry in Jordan indicate that the main constraints are related to insufficient local input requirements, such as active ingredients and containers, plastic, glass, aluminum and others (Karablieh and Nazer, 2002). Results show also that there is inadequate confidence in locally produced pesticides compared with imported ones, and pointed out the weakness of the sector in overcoming marketing difficulties, environmental pollution which take places as a result of using pesticides, and the inactive rules and regulations related to pesticides.

Table (18): Quantity of imported, locally produced and exported pesticides by kind (L& Kg) in 2000

Kind of Pesticides	No. of Recorded Pesticide	Imported	Local Production	
			Local use	Exported
Insecticides	237	198315	62197	295663
Fungicides	200	436994	46607	118431
Acaricides	56	30824	21940	41893
Herbicides	72	58100	55116	47546
Soil & Seed fumigant	22	179695	0	0
Public Health	109	21620	68662	58674
Oil	16	94199	0	0
Rodenticides	22	8000	0	0
Veterinary	28	2505	73649	245137
Vital	8	388	13719	0
Mollusicides	3	0	0	0
Total	773	1030640	341890	807344

Source DOS (2002)

The excessive use of pesticides may have an effect on society welfare and human health, and sometimes lead to diverse economic and ecological effects. This has been shown by a boycott of Jordanian vegetables by the import countries due to the believed that the exported commodities have high pesticide residues. In fact the chemical analysis of pesticide residues shows that Jordanian vegetables do not exceeds the international limits of pesticide residues.

Chemical fertilizer represents one of the important factors for productivity increases of cereal in Jordan. The farmers in the irrigated areas show a high degree of appreciation of chemical fertilizer effect on crop yield. Almost 100 percent of farmers in the irrigated area are adopting chemical fertilizers. The application of fertilizer is greater in higher rainfall zones than in others, because it requires sufficient rainfall to be effective.

Many reasons have been suggested for the slow adoption of new technology, including the reluctance of farmers to invest in risky rainfed farming, the tendency of many small farmers to minimize risk rather than maximizing profit, land fragmentation, and small farm size. It has generally been considered by rainfed farmers that for field crops, such as wheat and barley, available moisture was the limiting factor for yields in rainfed areas and that little could be gained from adding nitrogen.

Table (19) shows the quantities of chemical fertilizers used in Jordanian agriculture during 1983-1997. The quantities of urea, which mainly used in irrigated agriculture does not change during the last 15 years. Quantities of phosphates fertilizers such as TSP and DAP, that could be applied to field crops, are increased from 11 thousand tones in 1983 to 20 thousand tones in 1997. The consumption of nitrogenous fertilizers also increased from 16 thousand tones in 1983 to 27 thousand tones in 1997. This is to an increase of awareness of farmers to the financial benefit of adopting chemical fertilizers and the efforts done by agricultural companies to promote their commodities to farmers in irrigated and rainfed areas.

The open-field cultivation of cereals in rainfed areas has largely been mechanized since 1930, when the first tractor was imported. Although tractors are highly versatile, they

are mainly used for primary tillage and transport. The use of combine harvesters is spreading very rapidly, due to the many direct advantages that they provide over hand harvesting. It is estimated that about 90 per cent of cereal fields are now harvested using them. The rate of growth of combine harvesters (7.6%) has exceeded that of tractors (6.2%) for the period (1983-1997).

Table 19: Quantities of fertilizers consumed in Jordanian agriculture in tones

Year	Urea	Ammonia	Potassium	Phosphate	Compound	Total
1983	12,828	16,095	1,348	11,892	4,090	46,253
1984	5,547	18,979	1,000	2,551	8,589	36,667
1985	11,814	11,935	902	7,900	8,101	40,652
1986	909	7,747	500	11,042	8,025	28,223
1987	13,873	50,835	400	11,173	6,583	82,863
1988	22,811	23,457	1,644	18,814	5,698	72,424
1989	22,760	16,321	400	5,944	5,572	50,997
1990	22,441	6,613	2,282	13,393	5,193	49,923
1991	28,534	13,472	1,800	11,929	5,770	61,505
1992	1,832	73,057	1,707	14,287	4,685	95,568
1993	16,417	27,947	2,287	14,706	5,995	67,352
1994	15,418	9,910	2,079	14,731	5,812	47,950
1995	13,581	18,465	3,699	18,337	6,900	60,982
1996	15,861	13,720	3,600	22,092	5,529	60,802
1997	13,316	27,303	927	20,028	5,452	67,026

Source: DOS, (1983-1997) Annual agricultural statistics

Farm machinery and implements are imported to Jordan duty free. However, the spare parts needed for this machinery are not exempt from duty. Locally assembled or manufactured implements are common in Jordan. Because of high capital investment and small land holdings, owning farm machinery may be unprofitable. Customer service operations are available in Jordan through the private sector. However, few government and semi-governmental agencies are entering this market. They are not trying to compete with the private sector, but to complement its services.

Tillage with draft animals is mostly limited to mountainous regions and small farms. The main reason for using draft animals is the slope of the land, which is not suitable for

mechanization. Sometimes the land is suitable for mechanical tillage, but farmers prefer to use animal tillage. Some feel that animal tillage conserves more soil moisture than mechanical tillage. (Dorling and Multu 1985) argue that small farms favor the use of small tractors, which are not greatly available in Jordan, and that there are insufficient credit facilities to enable farmers to buy large tractors.

The use of combines to harvest and thresh cereal is widespread, but limited in some regions by the lack of suitable machinery because of presence of stony-soils and/or sloping fields, or by the desire of smallholders with livestock to maximize the harvest of straw for feed. In most cases where cereal is hand-harvested, mechanical threshing will follow. On the other hand, the harvesting and processing of legumes is largely manual, due to a lack of suitable machinery. In a study in the Irbid area, the lentil harvest required just one man-day per dunum, but costs farmers 40% of their total crop value. In the same study of wheat and barley, the cost of draft animals and manual harvesting is 65% of the total cost.

Drill machineries and spinners have been introduced in the last 20 years. The disadvantage of these is the high expense of the drills, since they need more careful handling and adjusting than the simple implements used. Especially in stony-soils and where small fields require frequent transporting of the drill along roads. There is no exact number of drill machinery in Jordan. The regional office of the Ministry of Agriculture provides customers' service of drill machinery to farmers in rainfed area upon the request of farmers. Many farmers reported that they couldn't get the drill machine on the appropriate time (Karablieh and Salem, 1990).

However, it is commonly known that mechanization will reduce the demand for labor. This is true in rainfed farming, where mechanization has reduced labor input without much increase in output. In Jordan, capital is invested in rainfed agriculture in the form of machinery such as tractors, combines, sprayers and other small equipment are very low compared what have been invested in irrigated areas. Whether the introduction of machinery and equipment will increase, decrease, or be rescheduled, the labor input depend on the type and nature of technology and agricultural activity. A high degree of mechanization is usually associated with a higher level of wages, as more mechanized technique involves a larger amount of durable equipment, thus generating a more highly integrated production pattern. Therefore, there is a tendency to prefer less mechanized techniques in uncertain conditions. The simple techniques are mostly involved with more current inputs and require more short-run capital and fewer investments. On the other hand, it is well known that mechanical technology increases input productivities.

The farmers' acceptance of the new varieties is conditioned by the extent of productivity and palatability difference from the old familiar varieties. It is well known that the new varieties often yield more output than the traditional varieties only when accompanied by higher utilization of other variable inputs such as fertilizer, capital, etc. This perhaps provides an explanation why the new varieties change the output elasticities ratio between capital and labor. Karablieh (1995) indicated that the productivity of new wheat variety is higher for small farms than large farmers. As the farm output increases, the effect of the new varieties decreases. A possible explanation is that small farms are more efficient in use of inputs than larger farms. New varieties have been widely adopted by producers, irrespective of farm size and tenure status. The result indicate that 15.8 percent of holding in 1983 adopting new seed varieties on 17.5 percent of the holding, whereas in 21 percent of holding in 1997 in 44 percent of the

holding area. The growth rate of adoption by farmers is 3.7 percent annually. Small farmers are more responsive to new varieties than large farmers.

However, most area under irrigation is planted with new seed varieties of vegetables, fruit trees and banana. The old varieties of these crops are almost disappearing. The technological change and decreasing the cost of production per one unit of the product will not allow the traditional farmers who still using old varieties in the market. If the new variety is superior to the old variety at high levels of input use, various input-output price policies might be considered to encourage adoption rate. Seeds represent a very important input for increasing yields. The private sector plays and important role in the diffusion of new seed varieties of vegetables and fruit trees. These new varieties are a kind of private good and cannot be multiplied by farmers. The farmers should purchases these new seed varieties from private sector.

The new seed varieties of field crops such as wheat and barley are considered a public good, and farmers can multiplicities these seed on his farms. Therefore, there is no interest of private sector to diffuse these new seed varieties. However, the seed varieties available so far were not suitable for Jordan's rainfed farming, as they require too much moisture. Experiments on wheat started in the early 1950s in the Deir Alla research station. The studies included experiments on the response of different varieties to fertilizer application, drought and disease resistance. Local wheat varieties, such as Hourani, Sham1, F8, Deir Alla 2 (DA2), DA5, DA7, Stork 'S', ACSAD 65, Maru, Petra and Jubeiha were locally developed. These are high yielding under irrigation and superior to traditional varieties under rainfed conditions. Furthermore, the package of practices on wheat and barley was the result of cooperative research conducted by

FAO, MOA, ICARDA and the University of Jordan. This package identified few cereal varieties such as Rum for barley and different management practices. Many of the farmers who adopted this technology have increased their cereal yields significantly. Farmers have not adopted new technology from demonstration stations as a complete package because of the risk and the insufficient infrastructure for the increased supply of inputs.

Output depends not only on the levels of resources used, but also on the ways in which farmers use their managerial knowledge and technical skills. It is necessary to consider water availability with regard to timing as well as quantity received. Farmers in the rainfed areas traditionally make a greater adjustment in their planted areas of cereal from year to year in accordance with the times of precipitation. For example, if the first heavy rains are in November, planted areas of wheat and barley are relatively large, whereas a late start of the rains correlates with a smaller planted area. There is a clear correlation between total seasonal rainfall and areas planted with wheat and barley. Therefore, the traditional technology in rainfed farming relates more directly to agro-climatic conditions and rainfall variability than any other factor.

The major development in irrigation has started in the 1950s aiming at integrated rural development of the Jordan Valley utilizing Jordan share of the water resources of the River Jordan system. At the present, irrigation is practiced in two main areas: the Jordan Valley and the Upland. In the late sixties and early seventies, the government began developing pilot projects in the desert and the upland of Jordan using groundwater. The expansion in irrigation began in eighties and early nineties by the private sectors through utilizing the groundwater. These activities concentrated on the major basins of

Azraq, Amman-Zarka, upper Yarmouk, and the Dead Sea basins. The uncontrolled pumping from major aquifers has exceeded their safe yield to about 150%. Irrigation activities have also been extended to utilize the non-renewable resources of Dissi and Mudwarah area where about 70 MCM are being pumped annually from the aquifers of this area. However, the development of irrigation technology is very advanced in Jordan, especially drip irrigation technology the change to the new irrigation method has been faster in vegetable cultivation than in fruit tree growing.

The private sector investment in this sector is high. There are many firms produce plastic houses and drip irrigation technology.

In 1994, drip irrigation method covered 85 percent of the area cropped with vegetables compared with only 11 percent of the area planted with fruit trees. Although the change is significant, it only covered 25 percent of the water used for irrigation of which the share for vegetables was 19 percent compared with 9 percent for fruit trees. The share of fruit trees of water consumed in the JV in other words was twice that of vegetables in 1994. The efficiency with which the irrigation system has been used has been reported to be lower than expected. Both the technology used and irrigation schedule require refinement to raise the efficiency from its overall reported level of efficiency of 70 percent to 80 percent or more.

The second change adopted by the farmers was in the introduction of plastic tunnel and mulch culture, plastic house culture, and the fast and efficient method of off-season seedling production and transplanting (seedling). Plastic tunnels are used to protect the plants from the chilling stress of winter nights in JV. They will also lead to a harvesting date of 30 to 45 days earlier than open field planting.

The area planted with plastic houses and plastic tunnels amounted to 6.9 and 19.7 thousand dunums respectively.

Field crops are mainly produced under rainfed conditions; only 6 percent of wheat in Jordan is cultivated under irrigation system, mainly sprinkler irrigation. Only 1.9% of planted area of field crops is irrigated with sprinkler irrigation and 3.8% is irrigated with surface irrigation.

The most common on-farm irrigation system in fruit trees is drip irrigation, which cover about 64 percent of the Jordan Valley area. Very limited number of farms use sprinkler irrigation while the rest, about 35 percent are still using the conventional surface irrigation, which is practiced in citrus and banana farms.

4.2 The Role of Socioeconomic Factors

Farm resources and farmer's characteristics including personal and psychological components play an important role in the adoption decision. Avoiding the risk of crop failure is often more important to farmers than maximizing yields in good years. Farmers in low rainfed areas minimize risk by growing drought-tolerant feed crops, Therefore, the socio-economic characteristics of farmers such as educational level, age, sex and level of endowment play an important component in technology adoption process of new technology. Most of the new agricultural technology is developed for man needed. There are many reasons why the role of women should be explicit analyzed.

First: women play a major role in providing the additional labor required obtaining the benefits from technological change. Failure to consider

gender related differences in labor availability and demand may result in low adoption rates and lower yield impact than expected.

Second: women are found to have a heavy share of the agricultural work and in some cases female input is greater than male (Rassam,1984) and (Rassam and Tully, 1986).

Third: the technological improvements in agriculture focusing on the head of household ignores not only the complexity of the household decision making process, but more importantly the extent of the participation of all household members in rural economic activities.

4.2.1 Farmer's Age:

Elderly farmers seem to be somewhat less inclined to adopt new farm practices than younger ones. The highest adoption was by middle age group (Lionberger, 1968). The adoption behavior of fertilizer use technology, showed a negative significant relationship with the age of the farmers in Syria (ICARDA, 1994). Al-Qudah (1996) found that the age of the farmer shows a significant negative effect on the adoption of new irrigation technology in Jordan, indicating that younger farmers are more progressive and oriented towards the adoption of new innovation.

Table (20) shows a comparison of the percentages distribution of agricultural holders by age and sex according to 1983 and 1997 agricultural census. Female holders increased form 1.5 percent in 1993 to 2.7 percent in 1997. Young females with less than 34 years of age have a minor proportion of these holding. However, 45 percent of holders are in the age of 35-54 years of age. Furthermore, the proportion of the older holders with more than 55 years of age is increased from 35 percent in 1983 to 41

percent. It is well known that older farmers are less interested on adopting of new technology compared with young farmers. Young holders with less than 25 years of age are decreased from 3 percent in 1983 to 2.8 percent in 1997. This means that agriculture in Jordan is becoming more dependent on older people than before.

Table (21) shows the percentage of agricultural labor according to age classes. Similar results were obtained as the age of holders. The agricultural labor is younger than the agricultural holders. Labors with old between 15-34 years of old represent 53 percent

Table (20): comparison of the percentages distribution of agricultural holders by age and sex according to 1983 and 1997 agricultural census.

Age Classes	Male		Female		Total	
Years	**1983**	**1997**	**1983**	**1997**	**1983**	**1997**
< 25	3.05	2.81	0.01	0.04	3.06	2.85
26-34	11.57	9.69	0.12	0.14	11.69	9.83
35-54	49.42	45.01	0.92	1.30	50.34	46.31
55-64	18.93	22.63	0.28	0.80	19.21	23.43
> 65	15.57	17.15	0.13	0.43	15.70	17.58
Total	98.54	97.29	1.46	2.71	100.0	100.0

Source: DOS, agricultural census 1983, 1997

of the total agricultural labors. There is a trend to increase older labors in agricultural labor force. Labors with an old more than 55 years of old increased from 3.2 percent in 1983 to 8.6 percent in 1997.

Table (21) Percentage of agricultural labor according to age classes

Years	1975	1983	1990	1997
< 15 years	1.5	1.3	1.4	1.1
15-34 years	51.1	55.4	55.4	52.7
35-54 years	42.5	40.0	40.0	32
55-64 years	3.9	2.9	2.9	4.2
> 65 years	1.0	0.3	0.3	4.4
Total	100.0	100.0	100.0	100.0

Source: DOS, agricultural census 1975, 1983, 1997 and DOS, 1991

Table 22 shows comparisons between the percentages distribution of holdings management methods by holding size according to 1983 and 1997 census. Holders with

small size of holding are operated the holding by themselves. As the holding size increased there is a tendency to depend on hired managers to operate the holding. In 1997, hired managers operate about 30 percent of the very large holding and 11 percent operated by both holder and hired manager. In conclusion, holder himself operates about 95 percent of holding with less than 100 dunums. By increasing holding size farmers become more dependants on hired managers to operate the holding.

Table (22): Comparisons between the percentages distribution of holdings management methods by size holding according to 1983 and 1997 census.

	Holder himself		Hired manager		Both	
H. Classes	**1983**	**1997**	**1983**	**1997**	**1983**	**1997**
< 5	99.28	99.41	0.72	0.42	0.00	0.17
5-10	99.39	98.98	0.50	0.77	0.11	0.25
10-20	99.54	98.31	0.34	1.19	0.12	0.50
20-30	99.38	98.17	0.35	1.21	0.27	0.62
30-40	99.06	97.93	0.52	1.40	0.42	0.67
40-50	99.30	98.06	0.34	1.26	0.36	0.68
50-100	98.92	97.72	0.56	1.16	0.52	1.12
100-200	98.26	96.81	0.93	1.73	0.81	1.46
200-500	97.55	95.22	1.72	2.36	0.73	2.42
500-1000	97.01	91.93	1.76	4.40	1.23	3.67
1000-2000	93.71	84.77	5.24	7.28	1.05	7.95
>2000	87.06	70.37	10.59	18.52	2.35	11.11
Total	99.04	98.39	0.63	1.02	0.33	0.59

Source: DOS, agricultural census 1983, 1997

4.2.2 Educational Level of Farmers:

The agricultural productivity is directly related with the technology adoption needs no emphasis that the technology adoption by the individual farmers and its diffusion on a large scale are influenced by the education of the individuals and of the society is generally agreed upon but for the qualitative and quantitative break-up of its impact, which remains affected by the type of data and the methodological approaches adopted and is thus keenly debated, both in its effects and in the methodology of measurement, and particularly as a source of future growth of agricultural productivity. There is

increasing evidence and recognition that the capability of people to be effective and productive economic agents, in short, human capital, counts more significantly in the development.

Schooling is presumed to create a favorable attitude toward the use of improved farm practices. The relationship between years of schooling and farm practice adoption rates is likely to be indirect, except in the case where individuals learn specifically about the new practices in school. Here, as with other variables associated with the adoption of farm practices, clear-cut relationships are hard to establish, because years of schooling is related to other factors likely to condition adoption rates, as, for example, income and age of the farm operator (Lionberger, 1968). Watt (1984) reported that the levels of literacy and education affect extension and adoption technology in indirect ways. Illiterate farmers or those with very little education require more simple information that is easily understood. Simple audio-visual, radio and personal contact are mandatory techniques, as is demonstration. Therefore, farmers with more education will adopt earlier than the other farmers (Rogers, 1983). ICARDA (1994) and Al-Qudah (1996) found that increasing a farmer's educational level is expected always to increase the adoption of new technology in Jordan.

Education enhances the farmers' capacity to maximize the perceived profit function by allocating the resources in a more effective cost-efficient manner, by choosing which and how much of each output to produce and in what proportion to use the inputs - allocative effects. The central theme of the allocative effect lies in 'evaluating' and 'adopting' the more profitable new 'technologies'. The worker effect includes the ability to perform agricultural operations more efficiently in the economic sense. It is translating the allocative efficiency into production efficiency. The increased capability to process and apply the information is seen through lowering the marginal costs and

raising the marginal benefits with the given set of inputs. Education also facilitates the more rapid entrepreneurial adjustments to changes in output and input prices, input availabilities/constraints, and new opportunities, etc. The literacy would enable the farmers and agricultural labourers to improve efficiency of farming are obvious for it would enable them to be more scientific in the application of various (new) inputs.

Table (23) shows comparisons of the percentage for educational level of holders by holding classes according to 1983 and 1997 agricultural census. The results indicate that the percentage of illiteracy rate of holders decreased from 45 percent in 1983 to 36 percent in 1997. It also shows that illiteracy rate decreased by increasing holding size. Illiteracy rate among large holders approximately null, while it is 1 percent for holders without land. The group of holders who can read and write also decreased from 18 percent in 1983 to 13 percent in 1997. It has the same trends as illiteracy rate. The holders who receive elementary education are stable during two censuses with an average of 16 percent of the total holders. The holders who have a preparatory education increased from 8 percent in 1993 to 17 percent. The table shows an increase percentage of holders who have secondary and higher educations between during the period of the two censuses. The results indicate that large holders have better educational levels than small holders. This indicates that educational level is correlated on some how with the framers' endowments. Wealth farmers have better attitude-towered education than poor farmers.

Table (23) comparisons of the percentage for educational level of holders by holding classes according to 1983 and 1997 agricultural census

Education	Illiterate		Read & Write		Elementary		Preparatory		Secondary Agr.	
	1983	1997	1983	1997	1983	1997	1983	1997	1983	1997
Without Holding	5.81	11.78	0.91	2.76	0.68	3.31	0.25	2.74	0.00	0.09
< 5	4.90	4.13	2.47	1.82	2.94	2.73	1.92	3.00	0.04	0.12
5 – 10	3.17	2.60	1.53	1.13	1.79	1.88	1.08	1.83	0.02	0.08
10 – 20	6.49	3.80	2.84	1.71	2.61	2.38	1.60	2.25	0.02	0.11
20 – 30	4.60	2.67	2.05	1.10	1.91	1.35	0.87	1.36	0.01	0.06
30 – 40	4.09	1.70	1.66	0.67	1.47	0.79	0.70	0.77	0.02	0.03
40 – 50	2.69	1.22	1.10	0.49	0.96	0.55	0.39	1.01	0.01	0.02
50 – 100	7.00	3.33	2.86	1.26	2.34	1.34	0.92	1.29	0.02	0.06
100 – 200	3.88	1.93	1.66	0.69	1.22	0.78	0.42	0.73	0.01	0.03
200 – 500	2.05	1.16	0.85	0.42	0.53	0.45	0.28	0.42	0.01	0.01
500 – 1000	0.40	0.19	0.17	0.10	0.11	0.11	0.06	0.09	0.00	0.00
1000 - 2000	0.12	0.07	0.07	0.03	0.03	0.04	0.02	0.04	0.00	0.00
> 2000	0.05	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.00	0.00
JV holder		1.82		0.73		0.88		1.01		0.08
Total Holding	45.26	36.42	18.20	12.90	16.58	16.60	8.50	16.56	0.16	0.69

Source: DOS, agricultural census, 1983; 1997.

Continue.. Table (23)

Education	Other Secondary		Agr. Higher Education		Non-Agr Higher Education		Total	
	1983	1997	1983	1997	1983	1997	1983	1997
Without Holding	0.18	1.11	0.03	0.04	0.07	0.64	7.93	22.47
< 5	1.62	1.93	0.06	0.07	1.08	1.59	15.04	15.40
5 – 10	0.77	0.17	0.05	0.06	0.44	0.98	8.83	8.73
10 – 20	1.06	1.60	0.05	0.07	0.61	1.52	15.29	13.45
20 – 30	0.71	0.93	0.04	0.03	0.40	0.76	10.59	8.26
30 – 40	0.57	0.46	0.04	0.02	0.36	0.41	8.92	4.85
40 – 50	0.33	0.31	0.03	0.02	0.18	0.26	5.68	3.89
50 – 100	0.72	0.78	0.05	0.04	0.52	0.62	14.42	8.72
100 - 200	0.42	0.39	0.03	0.03	0.26	0.34	7.90	4.91
200 - 500	0.21	0.26	0.02	0.02	0.17	0.18	4.11	2.92
500 - 1000	0.09	0.07	0.01	0.01	0.04	0.05	0.88	0.62
1000 - 2000	0.03	0.03	0.01	0.00	0.02	0.03	0.29	0.24
> 2000	0.02	0.02	0.00	0.00	0.01	0.01	0.13	0.08
JV holder		0.50		0.06		0.39		5.47
Total Holding	6.72	8.57	0.41	0.48	4.17	7.79	100.0	100.0

Source: DOS, agricultural census, 1983; 1997.

4.2.3 Household Labor:

The population growth was 3.3% in 2001, which doubles the Jordanian population in 22 years. About 25% of the total population and one third of the poor live in rural areas.

Jordanian authorities stated that 21.3% of the Jordanian households are below the absolute poverty line of an annual per capita income of 140 JD in 1995. The rate of poverty in rural areas is higher with almost 30% compared to about 20% of Jordanians living under the poverty line in urban areas. In 2000, the total average annual income per capita was 1,208 JD.

On the other hand, agricultural census in 1997 shows that about 12% of the urban population above 13 years of age is illiterate compared to 20% of the rural population. Especially the educational standard of the poor is low; the illiteracy rate is almost 50% higher than the sample. Unemployment rates among the abject poor reach 38% and 34% among the absolute poor, compared to 17% among the sample.

However, the Jordanian labor force increased from 445 thousand in 1983 to 1229 thousand in 2000. Over the same period, agricultural labor increased from 32.8 thousand to 75 thousand as shown in Table (24). This meant that the contribution of the agricultural sector to employing manpower declined from 7.37 percent to 6.1 percent in the same period (1983-2000). On the other hand, the Jordanian labor market, especially in the agricultural sector, shows an increase in the employment of guest labor.

Table 24: Employment in Jordan and in the Agricultural Sector (1983-2000)

Year	Total Labor forces in Jordan	Agricultural labor forces	Share of Agriculture	Guest labor forces
	(Thousand)	*(Thousand)*	*%*	*(Thousand)*
1983	445.3	32.8	7.37	43.5
1984	458.5	34.9	7.61	46.3
1985	472.3	36.9	7.81	49.1
1986	492.5	37.4	7.59	44.6
1987	509.3	37.8	7.41	41.2
1988	521.8	39.7	7.60	15.1
1989	523.5	37.7	7.20	18.9
1990	524.2	38.3	7.30	20.7
1991	552.0	40.8	7.40	18.8
1992	600.0	44.4	7.40	27.2
1993	859.1	55.0	6.40	25.9
1994	1,140.3	60.0	5.26	35.1
1995	1,077.0	61.8	5.74	52.7
1996	1,093.0	62.5	5.72	47.0
1997	1,150.0	69.0	5.74	48.0
1998	1,188.9	71.3	5.9	47.16
1999	1,195.0	72.9	6.1	44.91
2000	1,229.0	75.0	6.1	50.77

Source: DOS (1983-2000) statistical year book:
CBJ, (1999). Monthly Statistical Bulletin, Central Bank of Jordan, Amman. Jordan

The current agricultural labor market suffers from a shortage of Jordanian labor. Because of the availability of relatively cheap guest labor, the difficult daily mobility of labor to the production regions (mainly Jordan Valley) and the dominance of subsistence agriculture in the rainfed regions, many Jordanian farmers have become more interested in working on a share-cropper basis or leasing their land.

Figure 8 shows the percentage of holdings depends mainly on family labor in performing agricultural operation in Jordan in 1983 and 1997 as a results of two agricultural censuses in these two years. Smallholding with (less than 30 dunums) is becoming more dependent on family labor, where as the holding with (more than 30 dunums) is becoming more dependent on hired labor to perform agricultural tasks. However, using family labor in farm operation between two census shows that farmers with small holding (<40 dunums)

holding is becoming more relying on family labor, where as medium and large farms is becoming more relying on hired labor to perform agricultural operation.

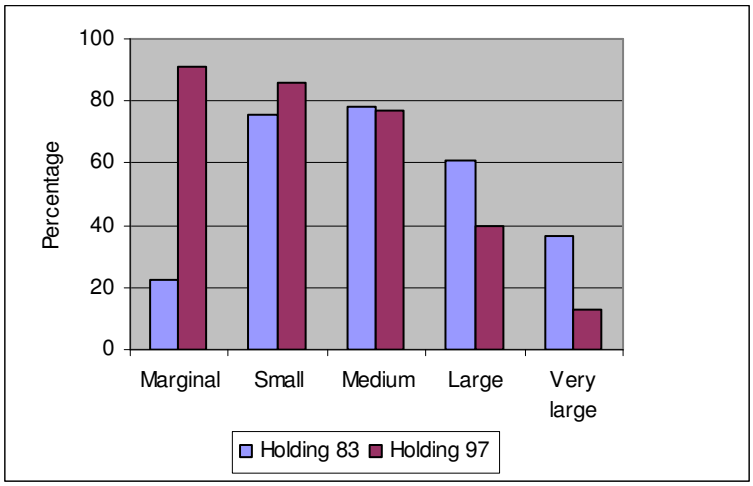

Figure (8): Percentage of holdings depending mainly on family labor to perform agricultural operation[1].

Figure 9 shows the percentage of holdings depends mainly on hired labor in performing agricultural operation in Jordan in 1983 and 1997. Most of small and medium holding is becoming fewer dependants on hired labor. Large holding with more than 500 dunums is becoming more dependent on hired labor, Furthermore, 72% of holding with more than 500 dunums depends mainly on hired labor to perform agricultural operations.

Table (25) shows number and parentage of family and hired labor by level of education in 1997.

The results indicate that 36 percent of agricultural labor is illiterate. Hired agricultural labor is more educated than family labor. However, by increasing educational level of labor decreases their participations in agricultural labor forces. The educated labor force seek an employment opportunities outside agricultural sector. The agricultural labor who bear a secondary education and more represents only 17 percent in the two

[1] Marginal : < 20 dunums , Small : 20-50 dunums, Medium:. 50- 500 dunums, Large : 500-1000 dunums, Very large: >1000 dunums

censuses of the total labor forces. This is due to the believe of the most people that working in agriculture does not require a higher educational level where physical work is required to perform agricultural operations.

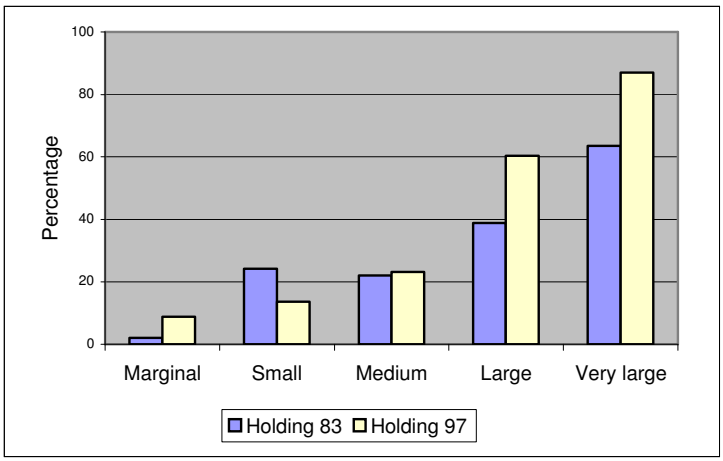

Figure (9): Percentage of holdings depending mainly on hired labor to perform agricultural operation.

Table (26) shows the development of number and percentage of agricultural labor (family & hired) by level of education during the period (1975-1997). It shows an increasing percentage of illiteracy labor and decreasing the higher educated labor that involved in agricultural labor forces. The illiteracy rate between agricultural labors increased from 24 percent in 1975 to 36 percent in 1997. This indicates that the agricultural sector is considered as a buffer of labor for other sector. There is an increase requirement of educational level for involvement and to find a job opportunity in other sector. Therefore, the non-educated labor force seek an employment opportunities in agricultural sector.

Table (25): Number and parentage of family and hired labor by level of education, 1997

	Labor holder	Percent	Hired labor	Percent	Total labor	Percent
Illiterate	34348	36.2	7485	35.2	41833	36.0
Read & Write	12164	12.8	4641	21.8	16805	14.5
Elementary	15658	16.5	2802	13.2	18460	15.9
Preparatory	15165	16.0	2494	11.7	17659	15.2
Secondary	9726	10.3	1720	8.1	11446	9.9
Diploma	2718	2.9	1658	7.8	4376	3.8
University	5087	5.4	444	2.1	5531	4.8
Total	94866	100.0	21244	100.0	116110	100.0

Source: DOS, agricultural census 1997.

Table (26): Number and percentage of agricultural labor (family & hired) by level of education

Educational Level	**1975**		**1983**		**1990**		**1997**	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Illiterate	10897	23.5	13677	18.1	16588	17.9	41833	36.0
Read & Write	88	0.2	183	0.2	222	0.2	16805	14.5
Elementary	9479	20.5	18931	25.1	23952	25.9	18460	15.9
Preparatory	7850	17.0	17407	23.1	21112	22.8	17659	15.2
Secondary	10400	22.5	13089	17.3	15875	17.2	11446	9.9
Diploma	3068	6.6	6392	8.5	7753	8.4	4376	3.8
University	4224	9.1	5301	7.0	6430	7.0	5531	4.8
H. Education	266	0.6	481	0.6	583	0.6	-	-
Total	46272	100.0	75461	100.0	92515	100.0	116110	100.0

Source: DOS, agricultural census 1975, 1983, 1997 and DOS, 1991

4.2.4 Tenure System of Agricultural Land

Land tenure and size of holdings limit the progress of technology. Farm size, number of parcels and patterns of ownership are the most important factors in understanding farmers' behavior toward new technologies. Patterns of ownership, leasing, tenancy of land holding, and sharecropping are among the factors that affect farming practice and farmers' decision, particularly decisions to adopt new technologies.

Table (27) shows that the total land area has been decreased from 3,6 thousand dunums in 1983 to 2,78 thousand dunums in 1997, which can be considered as negative indicator. This happened due to expansion in urban area on the account of agricultural area. On the other hand, number of holdings has been increased from 57 thousand in 1983 to 2.78 thousand in 1997. This reveals the high rate land fragmentation and the reduction in the size of the agricultural holding and the increase in the agricultural holders. Land fragmentation limits the investment and development in the agricultural sector, due to the fact that using of machinery and other fixed assists such as irrigation systems would not be economically feasible in the case of small size of holdings.

Land distribution is highly skewed and land fragmentation is considered to be one of the main causes of low productivity. The 1983 census indicated that 15.8% of farms had less than 5 dunums, 69% of farms had less than 50 dunums, only 2% had between 500 and 5000, and only 0.036% had over 5000. More than 50% of holdings are divided into an average of 3.5 fragments. For a farmer who has a holding of 30 dunums and an average of 3.5 fragments, it means that he owns three pieces of land in three different places. Each piece of land consists of about 8.6 dunums. Most of the land is owner-operated and about 16% of the land holdings are rented. The 1997 census

indicated that 28% of farms had less than 5 dunums, 83% of farms had less than 50 dunums, only 0.08% had between 500 and 5000 as shown in Table 28.

Table (27): Comparison of the number of holding and area between 1983, 1997 census

Agricultural Holding	1983		1997	
	Holding	Area	Holding	Area
< 5	9050	23,721	20207	47,535
5 - 10	5451	3,672	11012	72,502
10 - 20	9655	128,687	14317	185,471
20 - 30	6609	151,281	7416	168,258
30 - 40	5743	185,946	4208	136,833
40 - 50	3547	150,277	2787	118,007
50 - 100	8981	592,127	6532	418,917
100 - 200	4947	631,964	3291	410,323
200 - 500	2610	727,050	1778	487,871
500 - 1000	569	355,635	409	257,340
1000 - 2000	191	238,912	151	188,707
> 2000	85	420,332	54	294,126
Total	57438	3,609,602	72162	2,785,891

Source: DOS, Agricultural census, 1983, 1997

Furthermore, Table 28 shows that in 1983, the area classes with a size of lower than 10 dunums represented about 25% of the total number of holdings in Jordan, while in 1997, the number of holding that belongs to the same area classes increased to about 43%. Urbanization of good agricultural land and speculation has further reduced the cultivated areas. Jordan has a small, high potential agricultural land resource. Small fragmented farms may determine or delay mechanization of some farming activities, due to non-rent ability of its services. These farms also tend to use labor with less efficiency. There is insufficient evidence to determine if tenure structures affect the productivity of technology employed. Land tenure does, however, have important equity implications.

Table (28): comparisons of relative and accumulated distributions of holding and area between 1983, 1997 census

Holding Classes	Relative distribution				Accumulative distribution			
	1983 census		1997 census		1983 census		1997 census	
	Holding	Area	Holding	Area	Holding	Area	Holding	Area
< 5	15.76	0.66	28.00	1.71	15.76	0.66	28.00	1.71
5 – 10	9.49	0.10	15.26	2.60	25.25	0.76	43.26	4.31
10 – 20	16.81	3.57	19.84	6.66	42.06	4.32	63.10	10.97
20 – 30	11.51	4.19	10.28	6.04	53.56	8.52	73.38	17.01
30 – 40	10.00	5.15	5.83	4.91	63.56	13.67	79.21	21.92
40 – 50	6.18	4.16	3.86	4.24	69.74	17.83	83.07	26.15
50-100	15.64	16.40	9.05	15.04	85.37	34.23	92.12	41.19
100-200	8.61	17.51	4.56	14.73	93.98	51.74	96.69	55.92
200-500	4.54	20.14	2.46	17.51	98.53	71.88	99.15	73.43
500-1000	0.99	9.85	0.57	9.24	99.52	81.74	99.72	82.67
1000-2000	0.33	6.62	0.21	6.77	99.85	88.36	99.93	89.44
> 2000	0.15	11.64	0.07	10.56	100	100	100	100
Total	100	100	100	100				

Source: DOS, Agricultural census, 1983, 1997

The problem of the fragmentation of holdings has numerous setbacks, which are well known. The small size of plots does not encourage mechanization in rainfed areas, where income per unit area does not justify their incomes from non-agricultural pursuits. Reviewing the distribution of agricultural lands that are economically and environmentally suited to cereal production, it is readily apparent that there is very little potential for the horizontal expansion of cereal production.

The inheritance law for farmland in Jordan has, over the years, led to a severe fragmentation of land and a severe reduction in the size of holdings. The law of land inheritance cannot be altered easily. The small size of plots does not encourage mechanization in the rainfed areas, where income per unit area does not justify hiring mechanized labor. As a result, a farmer in a small village may own several plots of land scattered around various parts of the village, which are time consuming to deal with. Therefore, Jordan is not only faced with natural constraints, but also with other obstacles in the way of agricultural development such as defects in the land tenure system.

Therefore, most holdings in rainfed areas are too small to generate sufficient income. The message to the policy maker here is that factors such as holding size and production technology, which lead to differences in generated income, can be modified by suitable intervention. If we look at the distribution of holdings by governorate, about 58.9% of holdings are concentrated in Irbid. Land from deceased farmers is divided among sons and daughters, and then each one receives a narrow strip of land. If the original plot is located on a slope, then the strip can only be cultivated up and down the slope. Such tillage is seen throughout the country and its damaging effect in the form of severe erosion is one of the most serious problems effecting rainfed farming in Jordan. This phenomenon led to younger people being less interested in farming as a profession, and also increased the number of part-time farmers.

4.3 Technical Factors.

4.3.1 Mechanical Technological Change and Farm Machinery.

The open-field cultivation of cereals in rainfed areas has largely been mechanized since 1930, when the first tractor was imported. Although tractors are highly versatile, they are mainly used for primary tillage and transport. The use of combine harvesters is spreading very rapidly, due to the many direct advantages that they provide over hand harvesting. It is estimated that about 90 per cent of cereal fields are now harvested using them. The rate of growth of combine harvesters (7.6%) has exceeded that of tractors (6.2%).

Table (29) shows the number and percentage of holder who own tractors. The total number of tractor in agricultural sector is decreasing by time. Machine numbers continue to decrease while custom services are widely available, so mechanization can be efficiently used on small farms as well as large farms. The holder with land who own

tractor are increased from 110 holders to 248 holders. These holders use the tractors to provide custom service to land holders. There is a decrease in the owner of tractors for the smallholding with less than 50 dunums. It is worth to remember that the total area in 1983 census was 3,642 thousand dunums and decreased to 2,786 thousand dunums in 1997. Therefore, in 1983 it was 1,174 dunums per one tractor and in 1997 it was 957 dunums per one tractor. Moreover, in the small holding one tractor served about 600 dunums in 1983 and increased for the similar holding size to serve about 800 dunums as shown in Table (29). It is clearly shown that large holding are more efficient in utilization of tractor than smallholding.

Farm machinery and implements are imported to Jordan duty free. However, the spare parts needed for this machinery are not exempt from duty. Locally assembled or manufactured implements are common in Jordan. Because of high capital investment and small land holdings, owning farm machinery may be unprofitable. Custom service operations are available in Jordan through the private sector. However, few government and semi-government agencies are entering this market. They are not trying to compete with the private sector, but to complement its services.

Table (29): Number and percentage of holders is the owner of tractors in 1983 and 1997 censuses.

Agricultural Holding	1983 census		1997 census		Area/Unit		Owner Growth Rate	Percentage	
	Owner	Area	Owner	Area	1983	1977		Owner 1983	Owner 1997
Without land	110		248					3.5	8.5
< 5	220	23,721	96	47,535	108	495	-5.92	7.1	3.3
5-10	144	36,702	106	72,502	255	684	-2.19	4.6	3.6
10-20	328	128,687	202	185,471	392	918	-3.46	10.6	6.9
20-30	282	151,281	203	168,258	536	829	-2.35	9.1	7.0
30-40	287	185,946	137	136,833	648	999	-5.28	9.2	4.7
40-50	172	150,277	151	118,007	874	782	-0.93	5.5	5.2
50-100	487	592,127	405	418,917	1,216	1,034	-1.32	15.7	13.9
100-200	408	631,964	421	410,323	1,549	975	0.22	13.1	14.5
200-500	390	727,050	408	487,871	1,864	1,196	0.32	12.6	14.0
500-1000	144	355,635	184	257,340	2,470	1,399	1.75	4.6	6.3
1000-2000	75	238,912	79	188,707	3,185	2,389	0.37	2.4	2.7
>2000	56	420,332	50	294,126	7,506	5,883	-0.81	1.8	1.7
JV holders			220					0.0	7.6
Total	**3,103**	**3,642,632**	**2,910**	**2,785,891**	**1,174**	**957**	**-0.46**	**100.0**	**100.0**

Source: DOS, Agricultural census, 1983, 1997

Tillage with draft animals is mostly limited to mountainous regions and small farms. The main reason for using draft animals is the slope of the land, which is not suitable for mechanization. Sometimes the land is suitable for mechanical tillage, but farmers prefer to use animal tillage. Some feel that animal tillage conserves more soil moisture than mechanical tillage. Dorling and Multu (1985) argue that small farms favor the use of small tractors, which are not greatly available in Jordan, and that there are insufficient credit facilities to enable farmers to buy large tractors.

The use of combines to harvest and thresh cereal is widespread, but limited in some regions by the lack of suitable machinery for stony or sloping fields, or by the desire of smallholders with livestock to maximize the harvest of straw for feed. In most cases where cereal is hand-harvested, mechanical threshing will follow. On the other hand, the harvesting and processing of legumes is largely manual, due to a lack of suitable

machinery. In a study in Irbid area, the lentil harvest requires one man-day per dunum, but costs farmers 40% of their total crop value. In the same study of wheat and barley, the cost of draft animals and manual harvesting is 65% of the total cost.

Table (30) shows the number and percentage of holders own the combine harvesters. The figure is misleading due to the different definition of combine harvesters in the two censuses. The table shows that the number of harvesters is decreasing from 8,243 combine harvesters in 1983 to 442 combine in 1997, which is unrealistic. It might be that in 1983 census threshers are aggregated with combine harvesters. Anyway, Jordan has a shortage of combine harvesters; during the harvesting season (June and July) many of combine harvesters come from Syria to perform custom services for farmers in Irbid region.

Table (30): Number and percentage of holders is the owner of combine harvester in 1983 and 1997 censuses.

Agricultural Holding	1983	1997	Area/Unit		Percentage		Owner Growth Rate
	Owner	Owner	1983	1977	Owner 83	Owner 97	
Without land	146	9			1.8	3.4	
< 5	710	15	33	3,169	8.6	5.6	-27.55
5-10	458	9	80	8,056	5.6	3.4	-28.07
10-20	1,048	23	123	8,064	12.7	8.6	-27.28
20-30	795	14	190	12,018	9.6	5.2	-28.85
30-40	918	8	203	17,104	11.1	3.0	-33.88
40-50	496	8	303	14,751	6.0	3.0	-29.48
50-100	1,364	35	434	11,969	16.5	13.1	-26.16
100-200	914	41	691	10,008	11.1	15.4	-22.17
200-500	823	57	883	8,559	10.0	21.3	-19.07
500-1000	353	13	1,007	19,795	4.3	4.9	-23.58
1000-2000	126	15	1,896	12,580	1.5	5.6	-15.20
>2000	92	14	4,569	21,009	1.1	5.2	-13.45
JV holders	0	6		0	0.0	2.2	
Total	8,243	267	442	10,434	100.0	100.0	-24.50

Source: DOS, Agricultural census, 1983, 1997

Drill machineries and spinners have been introduced in the last 20 years. The disadvantage of these is the expense of the drills, since they need more careful handling and adjusting than the simple implements used. Especially where the land is stony and where small fields require frequent transporting of the drill along roads. There is no exact number of drill machinery in Jordan. The regional office of the Ministry of Agriculture provides custom service of drill machinery to farmers in rainfed area upon the request of farmers. Many farmers reported that they couldn't get the drill machine on the appropriate time (Karablieh, 1990).

Table (31) shows the number and percentage of holders who own a plower in 1983 and 1997 censuses. The number of owners increased from 124 owners in 1983 to 2,329 owners in 1997 with an average growth rate of 21 percent. The plower could be manufactured locally and there is a high correlation between the number of tractors and plowers and irrelevant to holding size.

Table (32) shows the number and percentage of holders who own mechanical motors. The number of owners increased from 795 owners in 1983 to 1,649 owners in 1997 with an average growth rate of 5.2 percent. Adopting mechanical motors seem to be irrelevant to holding size.

Table (31): Number and percentage of holders is the owner of plower in 1983 and 1997 censuses.

Agricultural Holding	1983	1997	Area/Unit		Percentage		Owner Growth Rate
	Owner	Owner	1983	1977	Owner 83	Owner 97	
Without land	0	78			0.0	3.3	
< 5	20	104	1,186	457	16.1	4.5	11.78
5-10	1	123	36,702	589	0.8	5.3	34.37
10-20	4	227	32,172	817	3.2	9.7	28.85
20-30	5	230	30,256	732	4.0	9.9	27.35
30-40	5	132	37,189	1,037	4.0	5.7	23.38
40-50	5	122	30,055	967	4.0	5.2	22.82
50-100	15	331	39,475	1,266	12.1	14.2	22.1
100-200	24	309	26,332	1,328	19.4	13.3	18.25
200-500	29	317	25,071	1,539	23.4	13.6	17.08
500-1000	13	122	27,357	2,109	10.5	5.2	15.99
1000-2000	1	61	238,912	3,094	0.8	2.6	29.36
>2000	2	38	210,166	7,740	1.6	1.6	21.03
JV holders		135			0.0	5.8	
Total	124	2,329	29,376	1,196	100.0	100.0	20.95

Source: DOS, Agricultural census, 1983, 1997

Table (32): Number and percentage of holders is the owner of mechanical motors in 1983 and 1997 censuses.

Agricultural Holding	1983	1997	Area/Unit		Percentage		Owner Growth Rate
	Owner	Owner	1983	1977	Owner 83	Owner 97	
Without land	41	221			5.2	13.4	
< 5	20	64	1,186	743	2.5	3.9	8.31
5-10	19	58	1,932	1,250	2.4	3.5	7.97
10-20	41	199	3,139	932	5.2	12.1	11.28
20-30	47	113	3,219	1,489	5.9	6.9	6.27
30-40	70	66	2,656	2,073	8.8	4.0	-0.42
40-50	35	51	4,294	2,314	4.4	3.1	2.69
50-100	118	169	5,018	2,479	14.8	10.2	2.57
100-200	114	128	5,544	3,206	14.3	7.8	0.83
200-500	154	144	4,721	3,388	19.4	8.7	-0.48
500-1000	76	57	4,679	4,515	9.6	3.5	-2.05
1000-2000	33	27	7,240	6,989	4.2	1.6	-1.43
>2000	27	24	15,568	12,255	3.4	1.5	-0.84
JV holders		328			0.0	19.9	
Total	795	1,649	4,582	1,689	100.0	100.0	5.21

Source: DOS, Agricultural census, 1983, 1997

Table (33) shows the number and percentage of holders whose own pumps for irrigation. The number of owners increased from 742 owners in 1983 to 2,758 owners in 1997. This is reflected by increasing area under irrigation. The area under irrigation is increased from 275 thousand dunums in 1983 to 739 thousand dunums in 1997 with an average annual growth rate of 7 percent. The owners of pumps increased with an annual growth rate of 9.4 percent. Therefore, it is possible to conclude that the adoption of irrigation pumps is highly correlated with the increase of area under irrigation.

Table (33): Number and percentage of holders is the owner of pumps in 1983 and 1997 censuses.

Agricultural Holding	1983	1997	Area/Unit		Percentage		Owner Growth Rate
	Owner	Owner	1983	1977	Owner 83	Owner 97	
Without land	22	134			3.0	4.9	
< 5	50	192	474	248	6.7	7.0	9.61
5-10	13	246	2,823	295	1.8	8.9	21
10-20	30	566	4,290	328	4.0	20.5	20.98
20-30	46	298	3,289	565	6.2	10.8	13.35
30-40	68	190	2,734	720	9.2	6.9	7.34
40-50	38	125	3,955	944	5.1	4.5	8.51
50-100	103	327	5,749	1,281	13.9	11.9	8.25
100-200	85	263	7,435	1,560	11.5	9.5	8.07
200-500	139	231	5,231	2,112	18.7	8.4	3.63
500-1000	67	103	5,308	2,498	9.0	3.7	3.07
1000-2000	43	53	5,556	3,561	5.8	1.9	1.49
>2000	38	30	11,061	9,804	5.1	1.1	-1.69
JV holders					0.0	0.0	
Total	742	2,758	4,909	1,010	100.0	100.0	9.38

Source: DOS, Agricultural census, 1983, 1997

Table (34) shows the number and percentage of holders who owns a transport facility. Only 12.5% of total holders have a transport facility. The holders with 200 dunums and more are more probable to have a transport facility. This means that owning a transport facility is highly correlated with holding size. Owner with less than 50 dunums are less probable to have a transport facility. The regional differences show that the holders in Northern are highly probable to have a transport facility than in southern Jordan. This is

probably that the most irrigated area, which generates sufficient income to purchase a transport facilities are in North of Jordan.

Table (34): Number and percentage of holders own transport facilities in 1997.

Agricultural Holding	Number				Percentage				Percentage of total holders
	North	Middle	South	Total	North	Middle	South	Total	
Without land	1158	1641	1048	**3847**	10.1	14.3	9.1	**33.4**	**23.6**
1 – 2	53	83	55	**191**	0.5	0.7	0.5	**1.7**	**2.9**
2 – 5	217	174	88	**479**	1.9	1.5	0.8	**4.2**	**3.5**
5 –10	246	162	83	**491**	2.1	1.4	0.7	**4.3**	**4.5**
10-20	526	252	174	**952**	4.6	2.2	1.5	**8.3**	**6.6**
20-30	323	230	160	**713**	2.8	2.0	1.4	**6.2**	**9.6**
30-40	185	102	100	**387**	1.6	0.9	0.9	**3.4**	**9.2**
40-50	141	119	85	**345**	1.2	1.0	0.7	**3.0**	**12.4**
50-100	416	361	319	**1096**	3.6	3.1	2.8	**9.5**	**16.8**
100-200	324	280	256	**860**	2.8	2.4	2.2	**7.5**	**26.1**
200-500	341	261	219	**821**	3.0	2.3	1.9	**7.1**	**46.2**
500-1000	132	82	62	**276**	1.1	0.7	0.5	**2.4**	**67.5**
1000-2000	81	27	26	**134**	0.7	0.2	0.2	**1.2**	**88.7**
>=2000	40	16	18	**74**	0.3	0.1	0.2	**0.6**	**100.0**
JV Holders	404	381	50	**835**	3.5	3.3	0.4	**7.3**	**21.9**
Total	**4587**	**4171**	**2743**	**11501**	**39.9**	**36.3**	**23.9**	**100.0**	**12.5**

Source: DOS, Agricultural census, 1997

However, it is commonly known that using tractors and mechanization will reduce the demand for labor. This is true in rainfed farming, where mechanization has reduced labor input without much increase in output. In Jordan, capital is invested in rainfed agriculture in the form of machinery such as tractors, combines, sprayers and other small equipment are very low compared what have been invested in irrigated areas. Whether the introduction of machinery and equipment will increase, decrease, or be rescheduled, the labor input depend on the type and nature of technology and agricultural activity. A high degree of mechanization is usually associated with a higher level of wages, as more mechanized technique involves a larger amount of durable equipment, thus generating a more highly integrated production pattern. Therefore, there is a tendency to prefer less mechanized techniques in uncertain conditions. The simple techniques are mostly involved with more current inputs and require more short-

run capital and fewer investments. On the other hand, it is well known that mechanical technology increases input productivities.

4.3 Institutional Factors

4.4.1 Source of Extension:

Agricultural extension is considered as an important element in the development of the agricultural sector. Feder et al. (1984), explained the extension as a source of information to many farmers, either directly through farmers' contact with extension agents and with other extension communication media (radio, leaflets..etc) or indirectly, as farmers who have benefited from direct extension exposure transmit information to other farmers. Although extension is one of the components supporting development, it is also supported and affected by the quality of agricultural research and the degree to which policy and prices support the use of technological adoption.

Realizing that, the Jordanian Government tries to provide farmers with extension services through the formal institutions such as the Ministry of Agriculture and its institutions. also, the private sector provides the Jordanian farmers with such services through its employees who normally have agricultural background are distributed over the Kingdom of Jordan in the form of companies and shops.

The National Center for Research and Technology Transfer (NCARTT) has been given a financial and administrative autonomy under the umbrella of the Ministery of Agriculture. Thus, this center is responsible for providing technical experience and support required by any institution that provides extension service (providing technical advises, issuing bulletins, providing recommendations, training extension people, etc. In addition, this center aiming at organizing this service and to benefit the farmers from a good service by providing them with the results of the research undertaken in the

agricultural sector. The Jordanian Agricultural Policy Charter indicated that the Government will take into consideration a well organized, and related service between the institutions that undertake research and those extend extension services and to make sure that these services are scientific, practical, unbiased and are extended at high efficiency.

In addition the Charter indicated that the Government would make sure that the extension services would be available for all farmers for free so that these farmers can improve their performance in managing their farms towards an efficient, sustainable, and environmentally acceptable agricultural system. According to the Charter, these extension services will be provided particularly for the targeted groups that are in need for such services and cannot have it through private institutions and other extension institutions.

Extension services are provided by a number of institutions, both formally and informally. In the early 1980s some 110 agents were positioned in regional departments, but by 1985 only 62 agents remained. In 1990, out of a total of 255 NCARTT staff, only 80 extension agents were distributed to various parts of the country. Most of these were young graduates holding a B.Sc. degree who had a little, or no experience or no special training in extension. In the late 1980s and early 1990s the extension agents were responsible for enforcing the cropping pattern. Violators of the cropping pattern were given 10 days to uproot the excess planted area and were subject to fines for non-compliance. This enforcement rule not only detracts from the normal duties of the extension agents, but also compromises their integrity as information agents. Therefore, the role of extension agents in promoting information or material inputs appears to be very weak. Qasem (1985) states that only 10% of farms have

contact with extension services. In the rainfed areas farmers benefit from extension services even less than the farmers in irrigated areas and are therefore are extremely reluctant to take risks with unknown inputs.

The private sector, and in particular the institutions selling new technology, has been the most active and successful in convincing farmers to adopt the new technology. This is particularly evident in poultry production, plasticulture, drip irrigation and pesticide technology. There are several reasons for the success of the private sector, including the aggressive promotion of technology coupled with the ability to respond to farmer's questions and problems; the mobility of these salesmen and experts, permitting them to maintain farmer contact over time and the ability to provide technical inputs on credit. A private extension format that has become more prevalent is consultancy. There are 60 commercial companies involved in extensions. They employ highly qualified personnel, are quite popular with farmers and give up-to-date technical assistance. However, because rainfed production does not use many new inputs, private companies show little interest in rainfed farming.

Table (35) shows the percentage source of agricultural extension in Jordan during 1997. Extension agents of the Ministry of Agriculture provide extension services to 39 percent of farmers in Jordan. About 20 percent of smallholders receive extension from this source compared to 50 percent of large holders. Agricultural companies more involved for large holding than smallholdings. Only 10 percent of smallholding receives extension form private firms compared to 30 percent of large holdings. However, 90 percent of holder reported that they depend on their experience in agriculture as a source of extension. Extension from other farmers plays a significant role in the source of extension in Jordan. About 12 percent of farmers rely on this

source for new information. Mass media have a minor role as a source of agricultural information.

Table (35): Percentage source of agricultural extension in Jordan during 1997

Holding Size	Ministry of Agriculture	Official Institutions	Agr. Companies	Other farmers	Own Experience	Public Media	Other sources
Without land	35.4	2.5	16.2	9.6	85.4	3.1	2.1
1 - 2	18.8	1.2	7.9	10.9	91.3	5.4	0.5
2 - 5	20.0	1.4	8.4	10.6	91.9	5.5	0.6
5-10	22.7	1.5	7.7	11.9	91.6	5.7	0.7
10-20	27.3	1.6	9.8	12.5	90.1	6.1	1.2
20-30	31.9	2.0	10.8	12.0	89.3	6.1	1.2
30-40	32.7	2.4	11.6	12.3	89.5	6.4	1.0
40-50	33.8	2.0	12.2	12.7	88.5	6.4	1.4
50-100	36.3	2.3	12.5	12.3	88.4	6.6	1.5
100-200	41.8	3.1	16.4	12.6	86.2	6.5	2.1
200-500	49.0	2.9	22.9	13.4	81.3	7.1	2.9
500-1000	51.3	3.9	27.4	11.7	80.7	5.9	3.2
1000-2000	49.7	7.9	34.4	10.6	76.8	9.3	4.0
> 2000	51.9	5.6	46.3	13.0	74.1	7.4	7.4
Holders in J.V	39.2	2.5	17.4	20.1	85.7	6.0	1.4
Overall	29.5	1.9	11.7	11.8	89.0	5.5	1.3

Source: DOS, agricultural census, 1997.

The public extension is criticized for its insufficient impact, low coverage, and inadequate access to knowledge sources and lack of relevant technology for farmers needs to be extended. This have made it imperative to search for alternative approaches to improve extension delivery, and to cooperate with the multiplicity of institutions offering extension services in joint efforts to achieve their common goals.

Low level of extension coverage of the public extension, lack of relevant technology to be disseminated has allowed the private firms a major role in extending new technologies to farmers. However, this is not to suggest that the private firms are perfect substitutes to the public extension. Transfer of improved technology to the small farmers and women who are less commercialized, and for matters related to the

public interest, is still necessary through the public extension. A complementary working relationship between the private and extension services have to be established.

4.4.2 Source of Finance and Credits:

Agricultural credit has played an important role in the rapid transformation of the Jordanian agriculture from traditional low productivity subsistence agriculture to modern, high productivity and commercialized agriculture, particularly, intensive irrigated agriculture. It would in all likelihood have a greater role to play in future due to the pressing need to assist agriculture in passing safely through the present critical juncture of its development. Furthermore, an efficient and sustainable agricultural credit system is an essential ingredient for effective implementation of the adopted Government policy of economic reforms and structural adjustment of agriculture relating to privatization, more efficient and sustainable use of resources, especially water adoption of optimal cropping pattern that maximizes production, farmers income and foreign exchange earning and realization of more balanced development and equitable distribution of income sources of financing in order to purchase agricultural technology, such as farm machinery and implements, are limited in Jordan. Formal financial institutions and informal sources provide funds. The institutional sources consist of commercial banks and specialized agencies. In addition, suppliers of agricultural inputs commission agents in wholesale markets and other private lenders, who extend credit to farmers. Farmers tend to depend on their own savings when buying farm machinery. This may be due to religious belief, which forbids the payment of interest on borrowed money. Lanzendoerfer (1985) found that out of 197 farmers owning farm machinery, 127 used their own savings to purchase them.

At present, Agricultural Credit Corporation (ACC) is the only specialized agricultural credit institution in the country. Up to 1992, the Cooperative Bank within Jordan Cooperative organization (JCO) and Jordan Valley Farmers' Association (JVFA) were among the specialized credit institutions providing agricultural credit mostly of short-term nature. The total indebtedness of the farming community to specialized credit institutions up to 1989 was estimated as JD 87.4 million, which was distributed among ACC (35.8%), JCO (10.3%), JVFA (1.2%) and commercial banks (52.7%).

In 1992, the government merged the Cooperative Bank, JVFA into ACC to end multiplicity of specialized credit institutions for the purpose of expanding resource base, improve efficiency of operation, spread the risk and reduce overhead costs. Table (36) shows the contributions of formal credit institutions in financing the agricultural sector during the period (1995-1999). It could be inferred from the above figures that contrary to the widely held belief of low involvement of commercial banks in agriculture, the commercial banks remained since 1977 as the highest contributor to formal credit to agricultural sector.

Table (36): The role of formal credit institution in financing agricultural sector

Year	ACC Million JD	Com. Banks Million JD	Total Million JD	ACC Percentage	Com. Banks Percentage
1995	77.1	75.7	152.8	50.46	49.54
1996	84.9	79.5	164.4	51.64	48.36
1997	88.0	93.3	181.3	48.54	51.46
1998	92.7	115.3	208.0	44.57	55.43
1999	104.2	121.1	225.3	46.25	53.75
Average	89.38	96.98	186.36	48.29	51.71

Source: (CBJ, 2000) 'Monthly Statistical Bulletin.

The number and amounts of ACC loans have been increasing since 1980. Total amounts of distributed loans increased more than double the average for the period 1984-1989,

reaching JD 7.4 million in 1990, JD 10.5 million in 1991 and more than JD 16.8 million in 1997 borrowed from 6707 farmers to implement 6174 projects. Of those borrowers, 60% borrowed loans for the first time.

There is great increase in the amounts of loans was due to governmental policies to expand credit facilities to assist in the recovery of agriculture damages caused by rains, snow or drought in the last decade. The outstanding loans are increased from JD 25.8 million in 1985 to JD 56.6 million in 1992 and estimated at JD 121.1 million in 1999. Table (37) shows the development of outstanding loans by ACC and JCO as well as commercial banks. It was estimated that the outstanding credit in agricultural sector at JD 255 million in 1999.

Table (37): The development of total agricultural credits in Jordan

Year	Com. Banks	ACC	JCO	ACC+JCO	Total
1976	5.20	9.70	3.10	12.80	18.00
1980	17.20	14.00	9.30	23.30	40.50
1985	26.30	25.90	22.90	48.80	75.10
1990	53.70	36.60	0.00	36.60	90.30
1995	75.70	77.10	0.00	77.10	152.80
1996	79.50	84.90	0.00	84.90	164.40
1997	93.30	88.00	0.00	88.00	181.30
1998	115.30	92.70	0.00	92.70	208.00
1999	121.10	104.20	0.00	104.20	225.30

Source: ACC (1999) and CBJ (2000)

Table (38) shows a comparison between percentage for the source of finance according to holding size between 1983 and 1997 census. It is clearly shows that 96 percent of holders depends on their own saving for financing agricultural operations. However, there is an increase the role of formal credit institutions in financing agricultural sector. 1.3 percent of holders in 1983 have a credit from formal credit institutions. This percent is increased to 6.7 in 1997. Intermediaries such as commission agent play a minor role in financing agricultural sector. Loan from credit institutions is highly correlated with

holding size. Only 10 percent of holders with holding (50-100) dunums obtain a credit form formal institutions compared with 27 percent of holders with holding size more than 500 dunums. This means that large holders have more access to credit institutions and they can provide guaranties they required for lending.

Table (38): Comparison between percentage for the source of finance according to holding size between 1983 and 1997 census

	Personal Resources		Agr. Credit Institutes		Intermediaries	
Holding classes	**1983**	**1997**	**1983**	**1997**	**1983**	**1997**
< 5	96.35	98.12	0.22	2.02	0.39	0.49
5-10	96.22	96.87	0.40	4.56	1.30	0.62
10-20	95.66	95.77	0.84	7.27	2.43	0.85
20-30	95.63	95.05	1.10	8.87	1.92	1.00
30-40	96.22	95.18	1.65	9.51	3.15	0.81
40-50	96.25	94.62	1.38	10.12	1.61	1.11
50-100	97.14	94.08	1.50	10.79	1.33	1.22
100-200	96.75	93.62	2.45	12.55	1.39	1.58
200-500	97.51	91.96	4.37	16.42	1.38	2.19
500-1000	97.36	90.71	6.33	23.47	1.41	2.69
1000-2000	95.81	88.08	11.52	27.81	0.00	2.65
>2000	94.12	94.44	14.12	27.78	2.35	0.00
Total	96.33	96.05	1.36	6.73	1.64	0.85

Source: DOS, agricultural census 1983, 1997

Table (39) shows that commercial bank lend only 2 percent of holders in 1997. Also other borrowing resources are limited and does not exceeds 1.3 percent of the total lending in 1997. In conclusion, there is an increasing role of formal credit institution in financing technological change in Jordanian agriculture, but their role is still minor.

Table (39): Number and percentage of holder according to source of finance

Source of finance	**Holders in1983 census**	**Holders in1997 census**	**Percentage in 1983 census**	**Percentage in 1997 census**
Personal	59,956	82,275	91.0	88.7
Commercial banks	973	1,887	1.5	2.0
Agr. Credit institutions	3,367	6,183	5.1	6.7
Intermediaries	957	1,205	1.5	1.3
Other resource	631	1,187	1.0	1.3
Total holder	65,884	92,737	100	100

Source: DOS, agricultural census 1983, 1997

4.4 Market Factors:

Jordan's import regime was restrictive and characterized by high tariff and non-tariff barriers in the 1980s. This was a reflection of the import substitution strategy and high protection that led to considerable anti-export bias. Since late 1988, there has been a notable change in the direction of trade liberalization through gradual reduction of tariff and non-tariff import restrictions.

In 1996, the trade balance deficit increased by JD 406.3 million, or 30.2%, as a result of increase in imports, particularly in " food and live animals" group. This group, which was influenced directly by the rise in world prices of basic staples such as wheat and barley, increased the trade balance deficit by 63.6% or JD 266.7 million. Also Imports of "machinery and transport equipment" increased by JD 155.2 million or 24.5%. Overall, total imports increased by 17.5%, with 6 percentage points of the increase caused y a rise in public sector imports. This did not include the imports of the Ministry of Supply (MOS) and crude oil imports, which contributed 4.6 and 0.4 percentage points of the increase respectively. The share of the private sector in the increase in imports was 6.5% or 11.5% if imports of the MOS and crude oil imports were included. In 1998, the trade balance deficit increased to about JD 1439 million, although both, exports and imports decreased from JD 2908 and JD 1301 million to JD 2715 and JD 1275 million respectively.

Jordan joints the World Trade Organization (WTO) in 2000, and as a result Jordan lower its weighted average of tariff to 12 percent over a period of ten years in annual equal cuts. All its non-tariff restrictions should be converted to tariff-based duties within the same period. Of course, the direct impact of this procedure would be the

phasing out of effective protection granted to domestic industries over ten years. However, this will expose these industries to foreign competition, and in turn, will give rise to more efficient allocation of resources. In addition, there would be a possibility for certain imports to increase substantially depending on the price elasticity of import demand. And since the price elasticity of import demand is below one, tariff cuts and associated reduction in domestic prices of imported goods are likely to lead to a rise in import spending and hence to a further increase in trade deficit.

Subsidies on certain consumer goods, especially foodstuff, will have to be eliminated gradually, and domestic prices would be expected to rise gradually as well.

Prior to 1988, there were several quantitative restrictions in Jordan. In the process of reforming the trade regime since late 1988, many non- tariff barriers have been phased out. However, until the beginning of 1995 there were three categories of non-tariff barriers. First, there was a complete ban on the importation of five commodities, namely, tomato paste, fresh milk, certain dairy products, mineral water and table salt. Second, the importation of five major categories, namely, fruits and vegetables, certain chemicals, medicines and many foodstuff, and telecommunication equipment was subject to "permission" from the concerned authorities prior to acquiring an import license from the Ministry of Industry and Trade which is required for all imports. At the beginning of November 1995, prior permission was phased out for most of imports to Jordan. Agricultural products imported from countries, which signed trade protocols with Jordan, still need prior permission. Third, the Government has a monopoly on the import of nine necessary commodities. These are sugar, wheat, rice, flour, dried milk, cigarettes, frozen chicken, lentils and olive oil.

Jordan has applied to join the WTO in order to improve integration with the world economy and realize the benefits of open trade, especially with non-regional markets. In this context, the Government will be required to implement measures to rationalize import and export procedures, investment regulations and to further streamline tariff structures (Hjort, et al, 1998).

To achieve the above policy programs, the Ministry of Agriculture agreed to adopt the following reforms and Policy measures (FAO, 1993):

a. The price of irrigation water would be gradually increased in such a manner that in three years it would fully cover the cost of operation and maintenance of irrigation facilities in the Jordan Valley. At present, irrigation water is sold at 6 fils/M^3 while O&M estimated at about 14-18 fils and annual interest and depreciation costs is estimated at 17 fils. The exact water charges in year three would be decided after a detailed assessment is made on actual cost of O & M in order to alley the farmer fears that the costs might have been inflated by waste, mismanagement and bureaucratic inefficiencies, The water charges were raised to reach an average of 15 fils/M^3.
b. Removal of producer's subsidies for wheat, barley and chickpeas. It was agreed to remove producer subsidies for locally purchased wheat and barley and chickpeas and to base local prices on border prices. However, the subsidies on these products were removed. On the other hand, barley was again subsidized during 1999-2000 because of prevailing drought in these years.

c. Gradual removal of animal feed subsidies within a period of five years. However, it was agreed to continue providing subsidies for specific cases but for a limited period including emergency conditions such as drought, development purposes for remote undeveloped areas, incentives for adoption of improvement measures such as slaughtering in the abattoirs for hygienic purposes, organized range management etc. In these circumstances, subsidies are to be shifted from input to output.

d. Adoption of liberalization policy for agriculture production. The restrictive cropping production pattern policy, which was adopted during 1985-1988 to solve the problem of surpluses of major exported vegetables and latter stopped in 1989, has been irrevocably rescinded.

e. Reorganization of the Ministry of Agriculture in a manner that enables it to perform its duties in an effective way in line with the new direction of development and expected future needs and the streamlining and rehabilitation of public enterprises affiliated to the Ministry. The Ministry would reduce its direct intervention in production and marketing to the minimum. Emphasis would be given to the catalytic role of the Ministry through provision of advisory and supporting services, such as research, extension, education, etc., creation of conducive atmosphere through favorable policy framework and enforcement of needed regulation for orderly and wholesome development.

f. Further emphasis would be given to privatization programs, through drastic reduction of direct intervention of the Government and encouragement of the dominance market oriented economy in agricultural development.

g. Unifying the source of formal agricultural credit by merging the Cooperative Bank into Agricultural Credit Corporation (ACC). This was finalized in 1995.

h. Reorganizing agricultural marketing including stopping the practice of making purchase of fruits and vegetables outside the wholesale markets illegal and introducing measures to prevent commission agents in wholesale markets to involve in direct trading.

The remaining major policy issues, which have not yet been settled, include: the direct Government intervention in production (nurseries) and marketing/processing of fruits and vegetables by Agricultural Marketing and Processing Company.

CHAPTER FIVE

Economic Analysis of Technological Change

5.1 The Impact of Technological Change on Total Agricultural Production

Since the pioneering studies by Solow (1957), Schultz (1958) and Griliches (1964), a large body of literature has been published focusing on the measurements and explanations of technological change and agricultural productivity. The empirical analysis has generally proceeded in four directions. The following approaches are the most representative for measurements of technological change: (1) the accounting approach, which approximates technological change by computation of factor productivity indices, mainly the rate of change of the *total factor productivity* (TFP) indices; (2) the parametric approach, which models the state of technology by including a time trend (or other proxies) in the production, cost, or profit function to obtain parametric measures of the rate of technological change (as measured by a TFP index) and the nature of technological change (*i.e.*, whether technological change is Hick's neutral or biased); (3) the non-parametric approach, which identifies a group of implied linear inequalities that a profit maximizing (or cost minimizing) firm must satisfy and estimate the rate of technological change using linear programming Chavas and Cox (1988,1992); and (4) the structural approach, which is the most recent approach introduced by Gao (1994) and combines the parametric approach and accounting approach in one system, by considering the state of technology as an unobservable latent variable in the aggregate transformation function.

The parametric production function is often postulated to be in the form $y=f(x,t)$, where y and x denote output and input vectors, respectively, and t denotes the state of technology. Thus, on the production function side one can interpret:

$$\tau_t = \frac{\partial f(x,t)}{\partial t} \cdot \frac{1}{f(x,t)}$$

As being a measure of the primal rate of technological change Stevenson (1980) by presuming that production takes place on the isoquant frontier.

Capital and labour are considered as the most important elements in the production in agricultural sector as all other sectors, the agricultural sector is characterized by the abundant of labor since number of labors were increased in this sector from 9,880 laborer in the year 1985 to become 45,089 laborer in the year 2000, on the other hand the agricultural capital was increased from 644.0 million JD to become 799.1 million JD for the same period mentioned above. (DOS, 1985, 2000)

To estimate the production function in the agricultural sector, Cobb-Douglas function was used. Cobb-Douglas function in its classical form was used depending on labor and capital.

5.1.1 Measuring the Role of Labor and Capital on Agricultural Production

Cobb-Douglas Functional form is considered one of the most functions that are used to estimate the production function in general and to estimate the agricultural production function in particular. Cobb-Douglas function depends particularly in this case on the two variables, labor and capital. It has the following general form:

$$Y = A X_1^{\alpha} X_2^{\beta}$$

Where X_1 and X_2 are capital and labor (independent variables) and Y is the output and α and β are the production elasticities of Capital and labor, respectively. It is worthwhile mentioning that land area and water quantity have been used in some cases as independent variables in addition to capital and labor.

The Ordinary Least Square (OLS) method was used to estimate the parameters of production function (α and β). Before presenting the estimated results, it should be noted that the data concerning number of agriculture labors were treated to represent the man-year worker for Jordanian agricultural sector (DOS, 2001). However, the following sections will introduce the results of impact of agricultural inputs on the agricultural gross output and agricultural gross domestic product.

5.2 Results of the analysis of Gross Output with agricultural inputs:

This section of the study demonstrates the different production functions the have been estimated and their anticipated results. In this production functions, elasticities of land, labor, water and area were estimated.

5.2.1 The Impact of Labor and Capital on Gross Output:

The estimated value of labor elasticity that was equal to (0.454) and significant at less than 1% level of significance. The elasticity of labor means that if number of labors increased by 10%, the agricultural production would increase by 4.54%, holding other factors constant. Also the estimated value of capital elasticity was equal to (0.652) at ($P<0.01$). This figure means if the capital increases by 10% the agricultural production would increase by 6.5%, holding other production factors constant, (table 40).

It is obvious that the elasticities for labor and capital is more than one (1.106); this reflects that the agricultural sector is characterized by increasing return to scale. Having this ratio more than one, means that the agricultural production is in the second stage of production. This means that, as the ratio of the proportionate change in agriculture output to the proportionate change in inputs is more than one. For example, as the agricultural input increases by 10% the agricultural output would be increases by 11%, the positive signs of the labor and capital coefficients; indicates their direct positive effect on agriculture production.

When comparing capital and labor coefficients with each other. It can be clearly seen that the response of agricultural production to the change of capital is higher than that of labor. Other regression indicators insures the significance of the production fiction in table 40, where the R^2 is equal to 92%, and this indicates that 92% of the variation in agricultural production explained by capital and labor. Finally the Durbin-Watson test (DW = 2.01) indicating that there is no existence of autocollinearity in the time series data of the production function.

Table (40) Regression results of gross output with labor and capital:

Gross output	Coefficient	Std. Err.	t-test	P<|t|
ln Labor	0.4543285	0.0486336	9.34	0.000
ln Capital	0.6529731	0.1112453	5.87	0.000
Constant	-7.406936	1.459788	-5.07	0.000
F-test (2, 13)		**84.49**		
R-squared		**0.9286**		
Adj R-squared		**0.9176**		
Durbin-Watson-test		**2.01**		

Source: own estimated

5.2.2 The Impact of Labor and Capital with Time on Gross Output:

The time variable was added to the previous model to capture the impact of technological change. The time was used as a proxy variable for technological change. This change can be defined as the expansion of plastic houses, increase use of fertilizers, pesticides and any other new production technologies).

The results shown in table (41) indicates that time parameter is positive at ($p<0.05$) and significant, this is clearly indicate the positive response of agricultural production to agricultural development, these results indicate to the development that Jordan has achieved in agricultural production by using fertilizers, new irrigation systems, using of mechanization and pesticide and others. It can be noticed that after adding time to the model the ratio of the proportionate change in agriculture output to the proportionate change in inputs is less than one, this means that we still need to adopt more technology and to increase efficiency use of the agricultural inputs to move from the first stage of production the rational stage. However, the model in Table 41 was highly significant.

Table (41) Regression results of Gross Output, Labor, Capital and Time

Output	**Coef.**	**Std. Err.**	**t**	**P<|t|**
ln Labor	0.1497315	0.2025848	0.74	0.474
ln Capital	0.6442074	0.1060768	6.07	0.000
Time	0.0337146	0.0215681	1.56	0.05
Constant	2.372777	2.318801	1.02	0.326
F-test (3, 12)		**63.55**		
R-squared		**0.9408**		
Adj R-squared		**0.9260**		
Durbin-Watson-test		**1.99**		

Source: own estimated

5.3 Results of the Analysis of Agricultural Gross Domestic Product (AGDP) with Agricultural Inputs:

5.3.1 The Impact of Labor and Capital on Agricultural Gross Domestic Product (AGDP)

In this party of the study, Agricultural Gross Domestic product was used as a dependent variable instead of gross output to measure the impact of agricultural inputs (Table 42). Results indicated that the elasticity of capital is positive (1.14) and it is significant as expected. However, labor coefficient is negative, which is not expected according to the model. The results indicate that if we increase labor input by 10%, this will decrease the AGDP by 0.7%, the negative singe of labor is referred to a decrease of labor productivity in the agricultural sector and this can be explained by:

1. Increase the number of Jordanian family labors in agriculture production since most of agricultural labors is a family labors for a fixed area and this leads to a increase labor input productivity.
2. The Jordanian agriculture is distinguished by being traditional agriculture and it is described by the intensive use of unskilled labor, also the dependency on unskilled immigrant labor which affects negatively on agricultural labor efficiency, this pushes the agriculture to the concept of capital agriculture and this does not agree with the size of agricultural holdings since (5-50) dunums is contributing around 70% of the total agricultural holdings size (Arabiat, 1996). Also the negative singe for labor is related to superabundant of labour resulted from vertical expansion of agriculture.

Table (42) Regression results of Agricultural Gross Domestic Product, Labor Capital

AGDP	Coefficient	Std. Err.	t-test	P<|t|
Ln Labor	-0.077135	0.0584778	-1.32	0.210
Ln Capital	1.146802	0.1337631	8.57	0.000
Constant	-9.955379	1.755271	-5.67	0.000
F-test (2, 13)		**37.56**		
R-squared		**0.8525**		
Adj R-squared		**0.8298**		
Durbin-Watson-test		**2.130**		

Source: own estimated

5.3.2 The Impact of Labor, Capital with Time on Agricultural Gross Domestic Product

The estimated results indicate the positive effect of time that explains the positive impact on technological change on agricultural gross domestic product, while labor coefficient remains negative and time coefficient has a positive impact.

R^2 = 0.85 which indicates that the variations used explain around 85% of change in the amount of the agricultural production. The F-test was used to test the whole significance of the model. However, the Durbin-Watson test indicates that there is a slight incidence of first order autocollinearity. This explains the insignificance of labor and time independent variables, which is irrevocable in this case.

Table (43) Regression results of Agricultural Gross Domestic Product, Labor Capital with Time

AGDP	Coefficient	Std. Err.	t-test	P<|t|
ln Labor	-0.11064	0.266027	-0.42	0.685
ln Capital	1.145917	0.139296	8.23	0.00
Time	0.003664	0.028322	0.13	0.899
constant	-9.64014	3.044962	-3.17	0.008
F(3, 12)		**23.15**		
R-squared		**0.8527**		
Adj R-squared		**0.8159**		
Durbin-Watson-test		**1.790**		

Source: own estimated

5.3.3 The Impact of Labor, Capital, Area and Water on Agricultural Gross Domestic Product

It is clear from the results estimated in table 44 that the coefficients of labor and area were negative this can be attributed to the following factors: (1) Low contribution of labor in the total cost of intermediate labor in the agricultural sector (2) Low the quality of agricultural land that were used for planting and the (3) Low productivity of field crops especially in the new land invested for producing field crops in the marginal land with rainfall of less than 200 mm.

The results indicated that if we increase the labor by 10% the AGDP will be decreased by 0.4%, the negative sign of labor is referred to a decrease of labor productivity in the agricultural sector. It is noticed also that area coefficient was negative ($-4.7 * 10^{-7}$) and approximate to zero. This is referred to the reduction in the area of agricultural land. The negative value of land elasticity can explain the increased deterioration of land quality in Jordan especially in the marginal area.

It is obvious that capital and water coefficient were positive, this can be explained by their direct effect on agricultural production. We can explain 90.0% of total variation in aggregate real output by the explanatory variables, labor, capital, area and water, in addition most of models' t-values were significant.

Table (44) Regression results of Agricultural GDP with Labor, Capital, Area and Water

AGDP	Coefficients	Std. Err.	t-test	P<|t|
ln Labor	-0.04261	0.054674	-0.78	0.452
ln Capital	0.758975	0.24186	3.14	0.009
ln Area	-4.76E-07	2.56E-07	-1.86	0.09
ln Water	0.001531	0.000758	2.02	0.069
Constant	-5.54935	2.806084	-1.98	0.074
F-test (4,11)		**24.97**		
R-squared		**0.9008**		
Adj R-squared		**0.8647**		
Durbin-Watson-test		**2.20**		

Source: own estimated

CHAPTER SIX

Conclusions and Recommendations

Conclusions:

The agriculture's direct contribution to GDP has been declining since 1992 where it was 11% of GDP and dropped to 2.4% in 2000. The decline in the agricultural sector began in the late eighties due to 1989 economic crises; it began with a major devaluation of the Jordanian Dinar. The decline was aggravated in 1994 when the government imposed trade liberalization policy and was directly influenced by accession to World Trade Organization (WTO). As a result of that, protection of the local or national agricultural products has stopped and the direct support to farmers and animal growers has been decreased. With its limited water resources, Jordan is a net food importing country. The most important imported commodities are raw foodstuffs and feeds. Imports of wheat, the staple food grain, averaged about 500 thousand tons in the mid-1990s, costing an average of US$80 million. Imports of major feed products, including maize, barley, soybean meal, and compound feeds, amounted to about 970 thousand tons during the same period with an average cost of US$144 million.

The missing elements in the dissemination of new production technologies in the rainfed and irrigated areas are failing to consider the socio-economic factors for farmers, where the producer skill in receiving and decoding information, farm-level endowments (land quality and type and agro-climatic conditions) are among the important factors influencing the demand for new technology. Increasing agriculture productivity by raising crop yields is

the surest way to increase food production. But improving productivity has a direct impact on the natural environment because changes in crop, soils, and water management are needed to achieve these increases in productivity.

The research efforts should address the socio-economic dimensions of the structural change in the rainfed and irrigated agriculture. Interest in the social and economic aspect of technology development and transfer has increased considerably in the recent years. These constraints reduce the farmer's profit and affect his/her plans for the next season. Because of capital scarcity, especially for small farmers, and risk consideration farmers are rarely in a position to adopt a complete package

The growth of agricultural output can be explained by increasing inputs used in the production process, by the adoption of new technology, or by improving the technical efficiencies of producers. Therefore, analysis of growth of capital investment in agriculture, land improvements, buildings, machinery and equipments, wells, and irrigation tanks is essential to measure the impact of capital accumulation in agriculture. New and improved varieties responsive to improved management and the use of manufactured inputs are also essential to understand the impact of technology on outputs.

The total production in Jordan of the three major groups of crops averaged 1.1 million tons per year equivalent to 37 percent of total agricultural income for the period 1986-2000. The production rate of field crops has an annual increase of 4.73% during the study period. This is due to the growing drought-resistant varieties of field crops such as wheat and barley. However, the planted area of field crops has an annual increase of 6.85 percent during the period 1986-1993 then it has an annual decrease of 6.14 percent during the

period 1993-2000. The total production of field crops increased with an average 7.8 percent during the first period and increased by 1.36 percent annually. This is due to the increase of wheat production under irrigation. This was represented by the leasing of the southern desert region near Al-Mudawara to commercial companies, which use highly mechanized technology with a central pivot irrigation system.

The planted area with vegetables decreased with an annual rate of 1.67 percent during the first period then it is increased with an annual rate of 2.7 percent, whereas the total vegetables production increased by 2.4 percent during the period (1986-2000). This is due to the substitutions of vegetables with fruit tress in the first period as the price of fruit trees products is increased and marketing bottleneck in vegetables due to export difficulties. At the same time, productivity of vegetables improved and supply of a large number of vegetables was in excess of domestic demand as well as of the available export markets. It became clear during 1986-1988 that supply of certain vegetables like tomatoes, eggplants, cucumber and squash was higher than demand while the domestic demand for some vegetables like potatoes and onions was much higher than supply. Productivity levels of over supplied vegetables were much higher than the under-supplied ones, a factor that made farmers to decide and to risk planting these crops in large areas while expecting higher incomes.

The area of fruit trees increased from 498 thousand dunums in 1986 to 869 thousand dunums in 2000 with an annual growth rate of 4 percent, whereas the production is increased from 128 thousand tones to 371 thousand tones with an annual growth rate of 6 percent for the same period. The expansion of Jordan's production of fruits was mainly due

to the extension of irrigation (mainly in the Jordan Valley) and the introduction of improved agricultural technology. One of the major reasons for increasing agricultural production is the increasing of cultivated area and expansion of irrigated area in Jordan. There is a pressure to expand the total area of cultivated land and to enhance the productivity of that land in order to provide a secure food supply for the growing population. The drastic change in Jordan occurred in fruit production (olive tress). This area increased continuously to reach 40% of irrigated areas in Jordan in 1997. The irrigated area of fruit trees increased from 452 thousand dunums in1986 to 761 thousand dunums in 1993 with an annual average growth rate of 6.7 percent and increased the irrigated area to 883 thousand dunums with annual growth rate of 2.1 percent. While the production of fruit trees has an annual increase of 5.63% during the period 1986-2000, this is due to the increase of water supply particularly in Jordan Valley. The production of vegetables had an annual increase rate of 3.70% during the same period this increase was due to the increase of irrigation in highland and in Jordan.

Chemical fertilizer represents one of the important factors for productivity increases of cereal in Jordan. The farmers in the irrigated areas show a high degree of appreciation of chemical fertilizer effect on crop yield. Almost 100 percent of farmers in the irrigated area are adopting chemical fertilizers. The application of fertilizer is greater in higher rainfall zones than in others, since it requires sufficient rainfall to be effective. Many reasons have been suggested for the slow adoption of new technology, including the reluctance of farmers to invest in risky rainfed farming, the tendency of many small farmers to minimize risk rather than maximizing profit, land fragmentation, and small farm size. It has generally been considered by rainfed

farmers of field crops, such as wheat and barley, available moisture was the limiting factor for yields and that little could be gained from adding nitrogen.

Farm machinery and implements are imported to Jordan duty free. However, the spare parts needed for this machinery are not exempt from duty. Locally assembled or manufactured implements are common in Jordan. Because of high capital investment and small land holdings, owning farm machinery may be unprofitable. Customer service operations are available in Jordan through the private sector. However, few government and semi-governmental agencies are entering this market. They are not trying to compete with the private sector, but to complement its services. The use of combines to harvest and thresh cereal is widespread, but limited in some regions by the lack of suitable machinery because of presence of stony-soils and/or sloping fields, or by the desire of smallholders with livestock to maximize the harvest of straw for feed. The farmers' acceptance of the new varieties is conditioned by the extent of productivity and palatability difference from the old familiar varieties. It is well known that the new varieties often yield more output than the traditional varieties only when accompanied by higher utilization of other variable inputs such as fertilizer, capital, etc. This perhaps provides an explanation why the new varieties change the output elasticities ratio between capital and labor. Drip irrigation method covered 85 percent of the area cropped with vegetables compared with only 11 percent of the area planted with fruit trees. Although the change is significant, it only covered 25 percent of the water used for irrigation of which the share for vegetables was 19 percent compared with 9 percent for fruit trees. The share of fruit trees of water consumed in the JV in other words was twice that of vegetables in 1994. The efficiency with which the irrigation system has been used has been reported to be lower than expected. The second

change adopted by the farmers was in the introduction of plastic tunnel and mulch culture, plastic house culture, and the fast and efficient method of off-season seedling production and transplanting. Plastic tunnels are used to protect the plants from the chilling stress of winter nights in JV. They will also lead to a harvesting date of 30 to 45 days earlier than open field planting. The area planted with plastic houses and plastic tunnels amounted to 6.9 and 19.7 thousand dunums respectively.

Education enhances the farmers' capacity to maximize the perceived profit function by allocating the resources in a more effective cost-efficient manner. The results indicate that the percentage of illiteracy rate of holders decreased from 45 percent in 1983 to 36 percent in 1997. It also shows that illiteracy rate decreased by increasing holding size. Illiteracy rate among large holders approximately null, while it is 1 percent for holders without land. The group of holders who can read and write also decreased from 18 percent in 1983 to 13 percent in 1997.

Land tenure and size of holdings limit the progress of technology. Farm size, number of parcels and patterns of ownership are the most important factors in understanding farmers' behavior toward new technologies. The total land area has been decreased from 3.6 thousand dunums in 1983 to 2.78 thousand dunums in 1997, which can be considered as negative indicator. This happened due to expansion in urban area on the account of agricultural area. On the other hand, number of holdings has been increased from 57 thousand in 1983 to 2.78 thousand in 1997. This reveals the high rate land fragmentation and the reduction in the size of the agricultural holding and the increase in the agricultural

holders. Land fragmentation limits the investment and development in the agricultural sector.

Land distribution is highly skewed and land fragmentation is considered to be one of the main causes of low productivity. The 1983 census indicated that 15.8% of farms had less than 5 dunums, 69% of farms had less than 50 dunums, only 2% had between 500 and 5000, and only 0.036% had over 5000. The 1997 census indicated that 28% of farms had less than 5 dunums, 83% of farms had less than 50 dunums, only 0.08% had between 500 and 5000 dunums.

Agricultural extension is considered as an important element in the development of the agricultural sector. Extension services are provided by a number of institutions, both formally and informally. In the early 1980s some 110 agents were positioned in regional departments, but by 1985 only 62 agents remained. In 1990, out of a total of 255 NCARTT staff, only 80 extension agents were distributed to various parts of the country. Most of these were young graduates holding a B.Sc. degree who had a little or no experience or no special training in extension. Extension agents of the Ministry of Agriculture provide extension services to 39 percent of farmers in Jordan. About 20 percent of smallholders receive extension from this source compared to 50 percent of large holders. The public extension is criticized for its insufficient impact, low coverage, and inadequate access to knowledge sources and lack of relevant technology for farmers needs to be extended. This have made it imperative to search for alternative approaches to improve extension delivery, and to cooperate with the multiplicity of institutions offering extension services in joint efforts to achieve their common goals.

The ordinary least square method was used in estimating the parameters of production function. Results of the analysis of gross output with agricultural inputs shows that the estimated value of labor elasticity was equal to (0.454), and capital elasticity was equal to (0.652). It is obvious that the elasticities for labor and capital is more than one (1.106); this reflects that the agricultural sector is characterized by increasing return to scale. This means that, as the ratio of the proportionate change in agriculture output to the proportionate change in inputs, as the agricultural input increases by 10% the agricultural output would be increased by 11%. It is obvious that labor and capital coefficients are positive; this illustrates their direct effect on agriculture production. It is clear that capital elasticity of production was greater than labor elasticity, this means that the response of agricultural production to the change of capital is more important than its response to the change of the number of labors in the agricultural sector.

Instead of gross output, AGDP was used to measure the impact of these variables. The estimated results indicated that the capital is positive and it is significant as expected, and the capital elasticity for production was 1.14, but the labor coefficient is negative which is not expected according to the model, this can be explained by the low contribution of labor in the total cost of intermediate good in agricultural sector. The time variable was added to the previous model to capture the impact of technological change. The results indicate that the rate of technological change in the case of gross output was 3% while it is 0.3% in the case of agricultural gross domestic product.

The quantity of fertilizer, pesticide, and water allocated to agriculture was used directly in the model to measure the combination of these variables in increasing output in addition to the primary input variables (labor, capital and time).

The results indicate the positive impact of labor, capital, water, pesticide and technology on agricultural gross output and AGDP. The elasticity of land was approximate to zero; this could be explained by the expansion of low quality of agricultural land. The new land bought into the production process was the marginal land with less than 200 mm rainfall, especially the expansion of field crops in Mafraq area and the desert; therefore, the partial elasticity of lands was approximate to zero in both cases.

Recommendations:

(1) There is still a need for technology transfer in order to modernize irrigated agriculture. Particularly the aspects of a large-scale introduction of modern irrigation technology, the establishments of on-demand water supply.

(2) Government policies in this area are intended to produce substantial savings and to reduce the current shortages of irrigation water. This will require the joint effort and investment of both the Government and the farmers involved, particularly in the developing suitable water storage structures both on and off-farm in order to minimize evaporation and seepage losses.

(3) Improved and new technologies are expected to increase food production, increase income, and the improved well-being of farmers. The benefits, however, will depend mainly on the speed of transfer and on how the technology is actually transferred. The introduction of high yield and high pest resistance crop varieties

should be taken to avoid excessive soil deterioration. Special attention should be given to the efficient use of scarce resources in traditional farming systems, particularly in the semi-arid regions.

(4) Widen the coverage of formal credit institutions in terms of number of farmers and range of activities. Expansion programs should cover more farmers; particularly, small scale farmers, farmers in areas of priority for development, women and young starting farmers. The range of activities should be extended to include supporting activities such as marketing, input supply, etc.

(5) Low level of extension coverage of the public extension, lack of relevant technology to be disseminated has allowed the private firms a major role in extending new technologies to farmers. However, this is not to suggest that the private firms are perfect substitutes to the public extension. Transfer of improved technology to the small farmers and women who are less commercialized, and for matters related to the public interest, is still necessary through the public extension. A complementary working relationship between the private and extension services have to be established.

(6) Mechanization alone is insufficient to increase yields. Policies to increase production through the introduction of improved seed varieties, insecticides, and other new inputs have not been very successful in the rainfed areas of Jordan.

(7) Agricultural productivity, in terms of returns to both water and labor, is relatively low but can be improved. There is scope for further improvement in irrigation efficiencies in the Jordan Valley. Achieving higher productivity would require improving farmers' technology. This could be achieved by investment in farmer education and training and by improving the focus and delivery of research, extension and other producer services. A particular need is to make such services more demand-driven and farmer-focused.

(8) There is a lack of detailed technical and economic information on varieties and/or kinds of products that are in demand, both in local and export markets. Excessive and/or improper use of pesticides results in a high level of chemical residues, affecting the quality of produce as well as wasting chemicals of costly prices.

(9) Fertilizer applications are not usually based on soil analysis and crop requirements. Product quality is affected by the type and quantity of fertilizers used. The availability, quality and quantities of irrigation water are another factor that has to be addressed. The poor quality of water in the Jordan Valley has resulted in major losses in fruit and vegetable production owing to increased salinity of the irrigation water, especially in the Middle Ghor.

References

ACC, (1999). Annual Report, Agricultural Credit Cooperation. Amman. Jordan.

AL-Qudah, H. 1996. Optimal irrigation management under conditions of limited water supply in the Jordan Valley. Ph.D. Thesis, University of London, London, UK.

Arabiat, S. and Snober B. (1984). Mechanization of agriculture and socio-economic development in Jordan. Dirasat. 11 (7):129-200.

Binswanger, H. P. (1986). Agricultural Mechanization: Issues and Policies. Washington, D.C.: World Bank.

Byerlee, D. and Hesse de Polanco, E. (1986). Stepwise adoption of technological packages: Evidence from the Mexican Altiplano. *American Journal of Agricultural Economics*, 68 (3): 519 - 527.

CBJ. (1999). Monthly statistical bulletin. Central Bank of Jordan. Amman, Jordan.

CBJ. (2000). Monthly statistical bulletin. Central Bank of Jordan. Amman, Jordan.

CBJ. (2002). Monthly statistical bulletin. Central Bank of Jordan. Amman, Jordan.

Chavas, J. P. and T. L. Cox (1988). A Nonparametric Analysis of Agricultural Technology. *American Journal of Agricultural Economics.* 70 (2): 303-310.

Chavas, J. P. and T. L. Cox (1992). A Nonparametric Analysis of the Influence of Research on Agricultural Productivity. *American Journal of Agricultural Economics.* 74 (3): 583-591.

Dorling, M. J. and S. Mutlu (1985). Commercialization of New Indigenous Technology in Jordanian Agriculture. Geneva: International Labor Office.

DOS. (1977). General results of the agricultural census 1975. Department of Statistics, Amman, Jordan.

DOS. (1985). General results of the agricultural census 1983. Department of Statistics, Amman, Jordan.

DOS. (1985-2000). Annual Agricultural Statistics. Department of Statistics, Amman, Jordan.

DOS. (1999). General results of the agricultural census 1997. Department of Statistics, Amman, Jordan.

DOS. (2001). Statistical Yearbook 2001. Department of Statistics, Amman. Jordan

DOS. (2002). Statistical Yearbook 2002. Department of Statistics, Amman. Jordan

El-Naser, H. (1999). Water resources management policy reforms for the Hashemite Kingdom of Jordan, Ministry of Water and Irrigation, Amman- Jordan.

FAO (1993). Programming Mission to Agricultural Sector. The Hashemite Kingdom of Jordan. Technical Support Services at Program level, UNDP/FAO Work Program. pp11-12

Feder, G. and Slade, R. (1984). The Acquisition of information and the adoption of new technology, *American Journal of Agricultural Economics*, 66(3), 312-320.

Gao, X. M. (1994). Measuring Technological change Using a Latent Variable Approach. *Euro. Rev. Agr. Econ*. 21: 113-129.

Griffin, R. C.,Montgomery, J. M. and Rister, M. E. (1987). "Selecting functional form in production function analysis." Western Journal of Agricultural Economics. 12 (2): 216-277.

Griliches, Z. (1964). Research Expenditures, Education, and the Aggregate Agricultural Production Function. *Amer. Econ. Rev*. 54 (6): 961-74.

Haddad, N. 1991. Field crops in Jordan-actual, constraints and suggested solutions. The Higher Council for Science and Technology. Amman, Jordan. p. 18.

Haddad, N., Karablieh, E. K. and Bailey, E. (1997). Development and transfer of improved technologies for integrated crop-livestock production in low-rainfall zones. Achievements of the Mashreq project. International Center for Agricultural Research in the Dry Area (ICARDA). Aleppo, Syria.

Hjort, Kim, C., Zakaria, Majed and Salah, Falah I. (1998). An Introduction to Jordan's Agriculture Sector and Agricultural Policies, Access to Microfinance & Improved Implementation of Policy Reform (AMIR Program), Amman Jordan

ICARDA (International Center for Agricultural Research in the Dry Areas). (1985). Annual Report. Aleppo (Syria). ICARAD

International Center for Agricultural Research in Dry Areas (ICARDA). (1994). Annual report of farm resource management program, Aleppo, Syria, 1994.

Jaradat, A. A. (1988). An assessment of research needs and priorities for rainfed agriculture in Jordan. Al-Hurria P. Press, Jordan. pp. 62-73.

Johnson, S. H. and Kellogg, E. D. (1984). Extension's role in adapting and evaluating new technology for farmers. In: Swanson, B. E. Agricultural extension, 2nd

edition, Food and Agriculture Organization of the United Nations, Rome, p.40-55.

Jordan Valley Authority. (1997). Annual report. Ministry of Water and irrigation, Amman.

Karablieh, E. (1995). An assessment of the impact of agricultural technology on output in the rainfed farming areas in Jordan. Wissenschaftliche Verlag, Kiel University, Germany.

Karablieh, E. K. and M. Salem (1990). "The Impact of Technology on Employment in the Rainfed Farming Areas of Irbid District, Jordan." in "*Labor, Employment and Agriculture Development in West Asia and North Africa*".(Dennis Tully, ed,.),ICARDA. Kluwer Academic Publishers. London. p. 7-30

Katkhuda, N. and Yassin, A. 1997.Wheat research and technology transfer in Jordan. ICARDA, West Asia Regional Program. Amman, Jordan. p.18.

Khader, B. and A. Badran, The economic development of Jordan. Crown helm, London .Sydney. Wolfeboro. New Hampshire. P.1-10.

Lanzendrfer, M. (1985). Agricultural Mechanization in Jordan. A Study on its Processes in a Socioeconomic Context. Sozialkonomische Schriften zur Ruralen Entwicklung. Band 62. Herodot GmbH, Gttingen

Lee, Linda K. and Stewart, William H. 1983. Land ownership and the Adoption of minimum tillage. *American Journal of Agricultural Economics*, 65 (2): 256-263

Lionberger, H. F. (1968). Adoption of new ideas and practices, fifth edition. The Iowa State University Press, U.S.A

Maddala, G. S. (1992). Introduction to econometrics. 2nd edition. MacMillan Publishing Company, New York. p. 497.

Ministry of Planning (MOP). 1999. Socioeconomic Development plan (1999-2003). Ministry of Planning, Amman, Jordan.

MWI. (1999). Annual report. Jordan valley Authority. Ministry of water and irrigation. Amman. Jordan

MWI. (2000). Annual report. Jordan valley Authority. Ministry of water and irrigation. Amman. Jordan

Norton, R. D. (1988). "Policy analysis for food and agricultural development -basic series and their uses-." Report prepared for the office of international cooperation and development. USDA.

Qsaem, S. (1985). “Agricultural research and extension.” in Agricultural Sector of Jordan: Policy and System Studies (Zahlan, A.B., ed.). London: Ithaca Press. p. 343-411.

Rassam, A. M. (1984). Syrian farm household: women's labor and impact of technologies. M.A. thesis, University of Western, Ontario. London, Canada.

Rassam, A. M. and D. Tully. (1986). Economic of wheat production in north-west Syria". ICARDA, Annual Report 1986. Aleppo, Syria. p. 80-87.

Rogers, E. M. (1983). Diffusion of innovations, 4th. edition. The Free Press, New York

Roling, N. (1982). Alternatives approaches in extension. Vol. 1. John Willey, Chichester, United Kingdom.

Schultz, T. W. (1958). *Economic Organization of Agriculture*. New York. McGraw-Hill.

Sofranko, A. J. 1984. Introducing technological change. In: Swanson, B. E. *Agricultural extension*, 2nd edition, Food and Agriculture Organization of the United Nations, Rome, p. 21-39.

Solow, R. M. (1957). Technical Change and the Aggregate Production Function. *Review Economics and Statistics*. 39: 312-320.

Stevenson, R. (1980). Measuring Technological Bias. *Amer. Econ. Rev*. 70 (1): 162-173.

Watts, L. H. (1984). The organizational setting for agricultural extension. In: Swanson, B.E. Agricultural extension, 2nd edition, Food and Agriculture Organization of the United Nations, Rome, p. 20-39.

World Bank. (1989). Jordan towards an agriculture sector strategy” Report No. 7547-JO. Agricultural Operation Division, Europe, Middle East and North Africa.

World Bank. (2001). Jordan Rift Valley Improvement Project. Unpublished report. Ministry of Water and Irrigation, Amman.

References in Arabic

أبو فودة، عمر،١٩٩٧، دور القطاع الزراعي في التنمية الاقتصادية في الأردن، رسالة ماجستير، الجامعة الأردنية، عمان، الأردن.

استيتية، رشا، ١٩٩٩، تمويل القطاع الزراعي في الأردن، رسالة ماجستير، الجامعة الأردنية، عمان، الأردن.

الجالودي، جميل،١٩٩٥، القطاع الزراعي في الأردن، دالة الانتاج ومصادر النمو (١٩٦٨-١٩٩٣)، مجلة دراسات، العلوم الإدارية، المجلد ٢٤، العدد ١،١٩٩٧.

الحلاق، سعيد ونسيم رحاحلة، ١٩٩٧، النمو الاقتصادي للقطاع الزراعي في الأردن (١٩٦٨-١٩٩٣)، أبحاث اليرموك، المجلد ١٥، العدد ٢، ص ٩-٣٠.

الدويس، عبد العزيز، عصام أبو الوفا ومصطفى منصور، ١٩٩٢، تحليل اقتصادي قياسي لأهم العوامل المؤثرة على قيمة الناتج المحلي الزراعي السعودي، مجلة الإسكندرية للبحوث الزراعية. مجلد ٣٧، العدد ٣، ص١-٢٦.

عبد الرزاق، بشير، ١٩٩٨، دالة الإنتاج الزراعي في الأردن (١٩٦٨-١٩٩٨)، مجلة جامعة دمشق، المجلد ١٤، العدد ٢، ١٩٩٨.

عربيات، سليمان، ١٩٩٦، تعقيب على ورقة عمل اقتصاديات الزراعة الاردنية والتحديات المستقبلية، مؤتمر الاقتصاد الاردني في اطاره الاقليمي والدولي، مركز الاردن الجديد، ص(١٨٦-١٨٧).

أثر التقدم التكنولوجي على الإنتاج الزراعي للمحاصيل الحقلية والخضروات والفواكه في القطاع الزراعي في الأردن

إعداد

ناهدة يوسف السايس

المشرف

د. عامر زاهي سلمان

ملخص

تهدف هذه الرسالة إلى تحليل ودراسة أثر التقدم التكنولوجي على الإنتاج الزراعي للمحاصيل الحقلية والفاكهة والخضراوات في القطاع الزراعي الأردني خلال الفترة الزمنية (١٩٨٦-٢٠٠٠). وكذلك تهدف إلى دراسة العوامل المؤثرة في حجم الإنتاج الزراعي في الاقتصاد الأردني ولتحقيق هذا الهدف تم استخدام أسلوبين للتحليل

التحليل الوصفي: تم بيان تطور حجم الإنتاج الزراعي من خلال البيانات الإحصائية الرسمية المنشورة في نشرات البنك المركزي الأردني والنشرات الإحصائية السنوية لدائرة الإحصاءات العامة ووزارة الزراعة خلال الفترة (١٩٨٦-٢٠٠٠) فيما يلي أهم نتائج التحليل الوصفي. حقق القطاع الزراعي في عقد الثمانينات نسب نمو مرتفعة نتيجة لتوسع الأراضي المروية، واستخدام تقنيات الإنتاج الحديثة وتوفير بيئة مناسبة للإستثمار في هذا القطاع وغياب العقبات الرئيسية للصادرات الأردنية للأسواق الخارجية. في بداية التسعينيات إنخفض مؤشر نمو القطاع الزراعي بسبب الأزمة الإقتصادية في الأردن والتطورات السياسية في المنطقة والعالم وحرب الخليج وما لها من تبعات إقتصادية..إن مساهمة القطاع الزراعي في الناتج المحلي الإجمالي ارتفع من ٨٣ مليون دينار عام ١٩٨٠ إلى ١١٤,٦ مليون دينار عام ٢٠٠٠. وسبب إرتفاع معدل النمو بقطاع الزراعة خلال الثمانينات كان نتيجة تطوير الأراضي والمياه في وادي الأردن؛ من خلال استثمارات القطاع العام بالإضافة إلى الاستثمارات الخاصة بتقنيات جديدة كالري بالتنقيط، البيوت البلاستيكية والتحول إلى إنتاج المحاصيل العالية القيمة، أما من حيث مساحة الأراضي القابلة للزراعة فقد تراجعت من ٢,٧ ألف دونم عام ١٩٨٠ إلى ٢,٤٩ ألف دونم عام ٢٠٠٠ ويعتبر هذا مؤشر سلبياً على أداء القطاع الزراعي، فقد تراجعت المساحة القابلة للزراعة نتيجة التوسع العمراني في المدن والأرياف على حساب الأراضي الزراعية. وفي المقابل إزداد عدد الحائزين الزراعيين من ٥٧ ألف حائز عام ١٩٨٣ إلى ٧٢,٨ ألف حائز عام ٢٠٠٠، وهذا مؤشر آخر على مشكلة التفتت للحيازات وانخفاض حجم الحيازة الزراعية. انخفضت المساحة المزروعة بالخضراوات بمعدل سنوي يساوي ١,٦% خلال الفترة الأولى ثم بدأت بالارتفاع بمعدل سنوي يساوي ٣,٧%. بينما إرتفع إجمالي قيمة إنتاج الخضراوات ٠,٣٤% خلال الفترة ١٩٨٦-٢٠٠٠. والسبب الرئيسي لهذا الارتفاع هو زيادة المورد المائي لهذه المزروعات في المناطق المرتفعة ووادي الأردن. ارتفعت مساحة أراضي الأشجار المثمرة من

٤٩٨ ألف دونم عام ١٩٨٦ إلى ٨٦٩ ألف دونم عام ٢٠٠٠، بمعدل زيادة سنوية ٣,٧٨%، بينما إرتفع الإنتاج من ١٦٣ ألف طن إلى ٣٧١ ألف طن بمعدل إرتفاع سنوي ٥,٦% للفترة نفسها. كذلك فإن قيمة انتاج الفواكة ارتفعت من ٢٩,٩ مليون دينار أردني إلى ٨٥,٣ مليون دينار أردني بزيادة سنوية مقدارها ٧,٢%.

التحليل الكمي: تم بناء نموذج اقتصادي لبيان أثر التقدم التكنولوجي في الحجم والعوامل التي تؤثر في الإنتاج الزراعي وذلك باستخدام دالة (كوب – دوغلاس) العامة للإنتاج لتحقيق هذه الغاية. فقد تم استخدام نموذج الدالة الخطية اللوغاريثمية للمربعات العادية الصغرى (OLS) لتقدير قيم المعلمات لدالة الإنتاج. وأظهرت نتائج التحليل أن دالة الإنتاج تخضع لظاهرة الغلة المتزايدة في حالة استخدام عنصر العمل ورأس المال في دالة الإنتاج. وأن مساحة الأرض الزراعية لها دورا إيجابيا في حجم الإنتاج الزراعي. وكذلك بينت النتائج استجابة القطاع الزراعي للتقدم التكنولوجي وتحيز التكنولوجيا لرأس المال.