IMPACT OF GOVERNMENT POLICIES AND TECHNOLOGY ON THE PRODUCTION OF SELECTED FIELD CROPS UNDER RAIN-FED CONDITIONS IN NORTHERN JORDAN

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CHAPTER I

INTRODUCTION

From 1964 to 1987, the value of Jordanian agricultural sector output increased in nominal terms from JD 25.2 million to JD 127.2 million (Central Bank of Jordan). The bulk of the growth in output has been attributable to increased production of fruits and vegetables most of which was grown under irrigation in the Jordan valley. Growth rates in the production of field crops, specifically, wheat, barley, lentils, and chickpeas, which are produced in the rain-fed regions of the country, have not kept pace.

Problem Statement

Rain-fed field crop production and acreage varied considerably during the time period between 1980 and 1988 (Ministry of Agriculture). For example, the production of wheat ranged from a low of 60,000 metric tons in 1980 to a high of 137,000 metric tons in 1988. Over this time period, Jordanian consumption of wheat and other products of field crops has increased. Imports have also increased.

In 1980, 60,000 metric tons of wheat were produced domestically and 163,000 metric tons were imported. The supported price paid to producers for wheat was $285 (US) per ton. By 1987, the supported price had increased to $342 (US). Wheat imports increased to 542,000 metric tons, and domestic production was 137,000 metric tons.

The production of field crops in Jordan is affected by several government policies. Direct policies include subsidizing prices paid to producers, monopolizing importation of certain commodities, and providing credit to agricultural producers at subsidized interest rates. Policies that affect the exchange rate and international trade indirectly affect the production of field crops. Because the majority of inputs used in agricultural production are imported, exchange rates play an important role in determining the domestic prices of agricultural production inputs. Trade policies that include collecting duties on imports also play an important role in determining domestic prices of inputs.

The stated purpose of subsidizing prices paid to producers and providing agricultural credit at subsidized rates is to provide incentives for farmers to increase the output of major field crops in the rain-fed region of the country. It is not clear if the policies have been successful. Output of the major field crops has been variable over the last decade and when averaged over time, has not increased (Table 1). However in the absence of the government policies, production may have declined.

The 1985-1990 Five-Year Development Plan for Jordan included a goal to increase the productivity of wheat and lentils through the introduction of alternative production systems. The proposed systems included the use of fertilizer and increased mechanization in addition to other production practices. Several researchers and specialized organizations recommended the use of improved technology to achieve the above goal.

Over time as land has passed from generation to generation, the number of owners of the fixed amount of arable land has increased such that the average size of a land holding continues to decrease. The result of this process has been termed land fragmentation. Several researchers have hypothesized that land fragmentation is a serious problem in Jordan (Arabiat and Al-Kadi; Qasem). However, the effect of fragmentation on production costs has not been determined.

Objective

This dissertation includes four essays. The first includes a description of the rain-fed sector and policies which affect production. In the second essay, the land fragmentation issue is addressed. Consequences of land fragmentation on the cost of producing wheat in the rain-fed region of Jordan are estimated. In the third essay, econometric models and enterprise budgets are used to evaluate the economics of alternative production systems for wheat and lentils. The fourth essay contains the results of an evaluation of the impacts of selected government policies on production of the field crops.

Each essay contains specific objectives. For example, the overall objective of the analysis presented in the second essay is to determine if field size influences production costs. One measure of economic efficiency is average per unit production costs. The first specific objective is to estimate the average variable costs of producing wheat in the rain-fed region of Northern Jordan and to determine if land fragmentation as measured by average field size is beneficial, costly, or an insignificant factor. The second objective is to determine if wheat yield is a function of field size.

For the third essay, the overall objective is to determine if several of the recommended practices for producing wheat and lentils in the region are economically viable alternatives to traditional practices. The first specific objective is to determine if a wheat production system which includes combine harvesting is more economical than the traditional system based upon a stationary thresher. The second objective is to determine if mechanical seeding of lentils with a grain drill is more economical than the traditional method of hand seeding. The third objective is to determine the economically optimal rate of fertilization for wheat and lentils. The fourth objective is to determine which of the four alternative production systems for wheat and lentils can be expected to generate the most income for farmers in the region. The fifth objective is to determine if subsidization of fertilizer or machinery would be an appropriate policy for the government to implement to provide incentives for farmers to increase the production of wheat and lentils.

The overall objective of the fourth essay is to determine the impact of existing government policies including price and credit subsidies on the efficiency of producing wheat and lentils. The first specific objective is to determine the most efficient wheat production system in terms of social profits from among a group of twelve systems currently used by wheat producers in the region. The second objective is to determine the most efficient lentils production system from among seven systems currently used in the region. The third objective is to determine the impact of price subsidies on the economics of the defined production systems. The fourth objective is to determine if exchange rate and price policy interact to enhance the efficiency of producing the two crops.

Sources of Data

The data used in this study were obtained from primary and secondary sources. The primary data were collected by personal interviews of sixty-three farmers in the northern part of Jordan. The survey was conducted in July 1992. Secondary data were abstracted from various issues of published and unpublished materials from the Ministry of Agriculture, Department of Statistics, Central Bank of Jordan, and the International Center for Agricultural Research in the Dry Areas.

Organization of the Study

Chapter II contains a description of the Jordanian agricultural sector and a description of the major factors that may affect the economy. In Chapter III, the impact of land fragmentation on the cost of producing wheat is investigated. Chapter IV, includes an analysis of the economics of alternative production systems for wheat and lentils. Chapter V includes the results of an analysis of the impact of government policies on wheat and lentil production. The final chapter includes a summary of findings and suggestions for further research.

Table 1. Production of Wheat, Barley, Lentils, and Chickpeas, 1981-1988.

Crop	1981	1982	1983	1984	1985	1986	1987	1988
	Metric tons (1,000)							
Wheat	60	29	116	25	63	40	109	137
Barley	18	7	34	5	20	15	41	50
Lentils	7	3	8	2	4	3	8	10
Chickpeas	1	1	2	1	2	0	1	2

Source: Ministry of Agriculture

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CHAPTER II

THE AGRICULTURAL SECTOR IN THE JORDANIAN ECONOMY

INTRODUCTION

This chapter includes a description of the Jordanian economy and a brief description of the major factors that have affected the economy in general and specifically the agricultural sector since independence was achieved in 1946. Many political events such as the Arab-Israeli wars, the Lebanese crises, the Iraqi-Iranian war, and most recently the Gulf war have affected the Jordanian economy. The consecutive development plans and several government policies have influenced the economy since the early sixties. The purpose of this chapter is to provide a brief description of Jordan and to describe various public policies and plans which may have influenced the country's agricultural sector.

The Hashmite Kingdom of Jordan has an area of 92,600 square kilometers (36,592.8 square miles). It is bordered on the North by Syria, on the East by Iraq and Saudia Arabia, on the South by Saudia Arabia and the Red Sea and on the West by Israel (Figure 1). There are major topographical regions in Jordan. These are: 1) The Highlands, which is a fairly high region, divided by some valleys, and several mountainous areas; (2) the Jordan River-Dead Sea depression, a result of the great geological crack that extends into Africa; and (3) the extension of the Syrian desert.

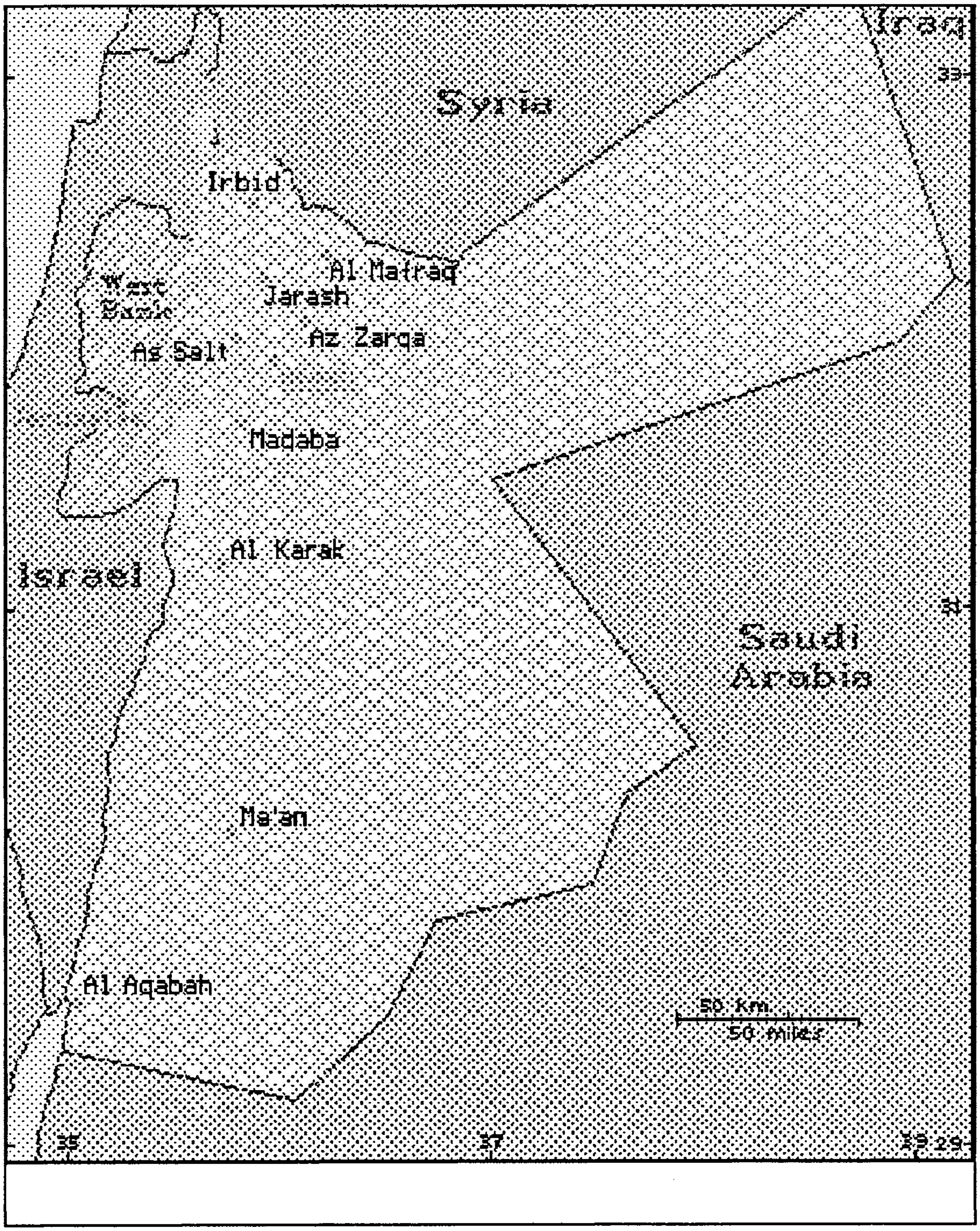

Figure 1. Map of Jordan.

To the west, the Jordan River flows through the Jordan River-Dead sea depression. The river is formed from the Yarmouk river which flows from Syria and the Az Zarqa river, whose headwaters arise entirely within the East Bank of Jordan. At the southern end, the Jordan River empties into the Dead Sea, which is considered as the deepest depression on the earth's land surface at 265 meters below the sea level.

The Jordanian Highlands extend from the Jordan Valley. The Highlands rise to an average elevation of 900 meters. Some summits reach 1,200 meters in the north and 1,500 meters in the south. Most of the cereal grains are produced in the Highlands. The great Syrian Desert lies east and south of the Highlands. It occupies most of Jordan. This desert forms approximately 90 percent of the Kingdom's land area.

The climate includes a rainy season which extends from November to April. Very dry conditions prevail during the rest of the year (no rainfall at all). Agricultural zones as described in Table 1, have been established based on the rainfall pattern, which is influenced by the topography. Agricultural activities are varied. They include intensive irrigated agriculture in the Jordan Valley, extensive dryland farming systems in the Highlands, and nomadic livestock systems in the very low rainfall areas.

The Jordanian population is characterized by a relatively high rate of growth. Population growth of 3.6 percent in 1988 compares with 1.7 and 2.4 percent for the rest of the world and developing countries, respectively (World Bank). The relatively high rate of growth has resulted in a large proportion of the population below the age of 18. The country has witnessed large flows of people into Jordan from Palestine and the West Bank of Jordan during the last 30 years, the outflow of Jordanian workers to the Gulf states, and the inflow of workers from Arab and non-Arab countries.

Table 1. Agricultural Zones Based on Rainfall Pattern.

Zone	Average Annual Rainfall (Millimeters)	Area (Million Dunums)[a]	Relative Proportion of Country (percent)
Arid desert	100	75.0	81.1
Desert	100-200	9.6	10.3
Marginal	200-300	5.3	5.7
Semi-arid	300-500	1.7	1.8
Semi-humid	500	1.0	1.1
TOTAL		92.6	100.0

Source: Duwayri, p.126

[a] 1 dunum = 0.1 hectare.

The last national population and housing census was conducted by the Department of Statistics in 1979. The population of the East Bank of Jordan was found to be 2,152,000. Jordanians abroad for purposes of education, tourism and medical treatment, were included. However expatriate Jordanians in Saudia Arabia and the Gulf states were not included. In 1988, the Department of Statistics estimated the population of the East Bank to be 2,824,000.

The population was classified into rural and urban which at the time was 878,000 and 1,946,000, respectively. The total labor force was 509,000 of which 61,100 were agricultural laborers. If the annual growth rate of 3.6 percent continues, the population is expected to reach 4.5 million in year 2000 (Department of Statistics).

Agriculture in the Development Plans

In 1990, Jordan completed twenty-three years under formal development plans. The stated objectives of the development plans were to improve the well being of the citizens by improving the efficiency of the utilization of the available scarce resources such as water and limited arable land. During this period the country examined an adoption of different planning policies.

The first (1963-1967) Five-Year Plan for Economic and Social Development was instituted in 1962. Later it was changed to the 1964-1970 Seven-Year Plan. One goal of the plan was to increase the Gross Domestic Product (GDP) by 7 percent annually. Other goals were to reduce the deficit, reduce the dependence on foreign assistance for budget support, and reduce the level of unemployment. A stated goal for the agricultural sector was to achieve greater stability in the value added contribution of agriculture to GDP. Completion of irrigation projects, specifically the East Ghor Canal was a stated means for achieving a reduction in variability of agricultural output (Ministry of Planning).

The 1967 Arab-Israeli war disrupted the plan and resulted in new economic and social obstacles. The Plan was halted due to the Israeli occupation of the West Bank of Jordan which resulted in a serious loss of Jordan's natural and economic resources. The war era forced the government to shift funds originally budgeted for development projects into military expenditure. An additional consequence of the 1967 war was the interruption of the planning process until 1973.

The second development plan was established in 1973. The Three-Year (1973-1975) Development Plan was designed to address problems which resulted from the occupation of the West-Bank. The plan concentrated on re-stimulating the economy and creating about 70 thousand new jobs. The annual average growth rate of the Gross Domestic Product (GDP) reached 5.9 percent during the plan while the targeted rate was 8 percent (Ministry of Planning). The agricultural sector share of GDP during the plan decreased while the share of the mining and manufacturing sector was substantially increased.

The third development plan was formulated in 1975. The Five-Year (1976-1980) Development Plan was designed to meet the significant changes in the Middle East mainly due to the boom in oil prices and the huge inflow of assistance and loans from the Arab countries. The immense development in the Gulf countries resulted in an increase in the demand for Jordanian technicians, teachers, engineers, and laborers. This outflow of Jordanian workers towards the oil countries significantly increased the flow of remittances and increased the country's hard currency. During the plan the Gross Domestic Product increased at an average rate of 12.1 percent per year. Despite the increase in the value of agricultural products due to the use of modern technologies and the expansion in irrigation, the relative importance of the agricultural sector decreased from 12.1 percent during 1973-1974 to 7.1 percent during 1979-1981 (Ministry of Planning).

The fourth development plan was formulated in 1980. The Five-Year (1981-1985) Development Plan was devised in a way to continue the same pattern of development of the previous plan. The plan presumed the continuation of financial aid, loans, and remittances from the Arab countries. The dependence of the Jordanian economy on the economies of the Gulf countries resulted in a decrease in the performance of the Jordanian economy due to the reduction in economic activity of the Gulf states. The real average growth rate of Gross Domestic Product (GDP) was 4.2 percent which was far below the targeted rate of 11.1 percent. The agricultural sector experienced an annual growth rate of 7 percent during this plan. Net income from agriculture increased in real terms from JD 69.4 million in 1980 to JD 97.5 million in 1985, an increase of 40.5 percent. The overall increase was 2.5 percent below the planned rate (Ministry of Planning).

The last development plan was the Five-Year (1986-1990) Development Plan. The overall targets of the plan included achieving a GDP growth rate of 5 percent per annum, creation of new employment opportunities, reducing the deficit in the balance of trade of goods and services, and ensuring regional distribution of development benefits (Ministry of Planning).

The Plan achieved an increase of 45.5 percent in agricultural income in real terms at an annual average growth rate of 7.8 percent. The targeted annual increase in agricultural income was planned to be achieved by expanding irrigated areas in the Jordan Valley and the highlands, and increasing the productivity of the rain-fed areas by introducing advanced agricultural techniques.

The Role of Agriculture in the Jordanian Economy

The agricultural sector occupies an important place in the Jordanian economy, but unlike typical developing countries, agriculture contributes a relatively small share of income to the national economy. The Jordanian economy is dominated by the services sector, which generates about 61 percent of the Gross Domestic Product (GDP) and employs two-thirds of the labor force. The first major increase in the services sector was realized after the Lebanese crises took place. A number of banking and transit services were shifted from Beirut to Amman immediately following the crises which started in late 1974. The second major increase in the services sector was in the early eighties following the Iraqi-Iranian war. Transportation and importation business showed a significant increase during the war to fulfill Iraq's war demands.

Figure 2 shows the development in the Gross Domestic Product (GDP) and the contribution of the agricultural sector in the economy during the period 1977-1987. During this period the GDP was growing at an increasing rate. However, the agricultural production fluctuated from year to year. The highest production was achieved in 1987 while the lowest was in 1977. Although agricultural production was increasing in real terms, it's relative contribution to Gross Domestic Product was decreasing. The decrease in agricultural contribution could be explained by the increase in contribution of other sectors mainly the construction and services sector. The inflow of remittances from Jordanians working in the Gulf states, boosted construction of new homes and in turn increased the demand for public services such as water and sewer projects, electricity, roads, and telecommunication services.

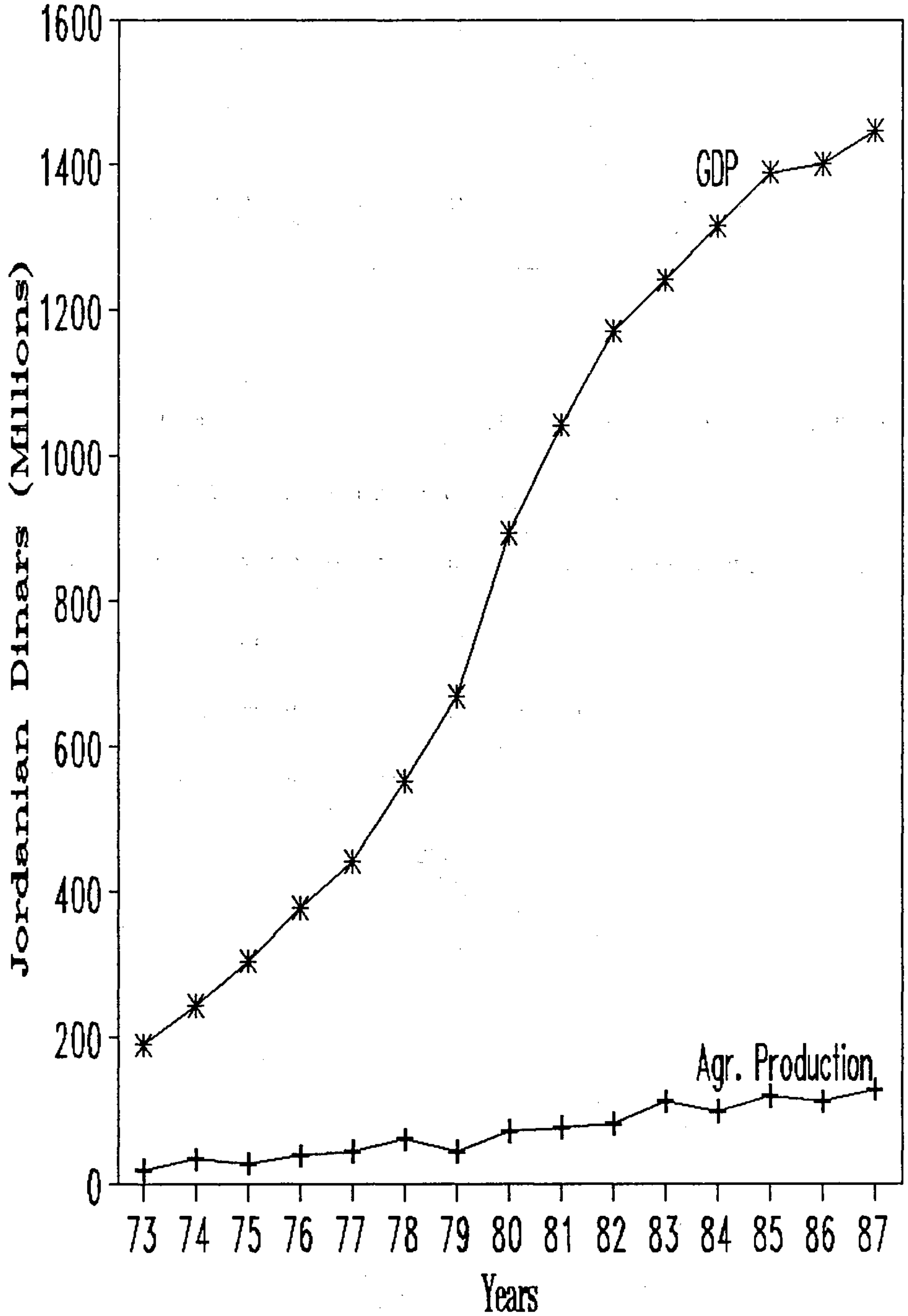

Figure 2. Gross Domestic Product (GDP) and Agricultural Production during 1987 at Nominal Prices.

Fruits, vegetables, cereal grains, meats, dairy products and tobacco are produced in Jordan. Table 2 includes the planted areas by groups of crops during 1981-1988.

Table 2. Planted Areas of Different Crop Groups 1981-1988 (in thousand dunums).

Group of Crops	1981	1982	1983	1984	1985	1986	1987	1988
Winter Field Crops	1668.7	1172.5	1715.7	687.5	1448.6	767.9	2022.7	1970.7
Summer Field Crops	31.8	29.9	40.0	21.7	39.4	23.9	19.0	39.4
Tobacco	67.6	81.5	84.0	69.5	55.5	25.0	32.1	35.9
Irrigated Winter Vegetables	172.5	198.1	216.0	151.9	134.4	157.1	119.3	94.5
Irrigated Summer Vegetables	154.5	207.8	247.7	267.9	272.3	156.1	158.9	164.4
Rain-fed Summer Vegetables	101.6	75.5	107.7	91.4	96.7	48.8	59.3	114.8
Fruit Trees	405.9	432.2	442.5	452.7	502.8	582.9	617.8	660.8
Total	2606.6	2197.5	2854.3	1742.3	2549.7	1761.7	3029.0	3080.5

Source: Ministry of Agriculture

Table 2 shows the enormous fluctuation in the area planted to winter field crops which included wheat, barley, lentils, broadbeans, and vetch. This fluctuation is due to the variation in rainfall from year to year. Rainfall influences planting. The standard practice of the Jordanian farmers in the rain-fed region is to delay the start of planting until onset of rainfall is clearly manifest, and finish planting as late as January or February when it is rather clear how much rainfall is expected (Stewart). Summer field crops include chickpeas, sesame, and corn. Field crops are produced primarily in the rain-fed region of the country. Wheat, barley, and forage are also produced under irrigation in the southern desert by some commercial companies, and sometimes they are produced in the Jordan Valley as a part of the crop rotation. Although cultivated area varies from year to year, the area planted to field crops remains the largest. In 1987 about two thirds of the total cropland was in field crops. Table 3 includes the cultivated area and the production of the four major crops produced in the rain-fed region of Jordan. The table shows that wheat occupies the highest share in cultivated area and production.

Irrigated agriculture is another important component of the agricultural sector. Fruits and vegetables are mainly produced under irrigation in the highlands, eastern desert, and in the Jordan Valley. Fruits and vegetables are harvested in the Valley from October to May. The higher elevations produce a wide range of horticultural crops from May to November. Producers of horticultural products have invested heavily in greenhouses for winter production. In 1989, the Ministry of Agriculture estimated the number of greenhouses at 7,754 in the Jordan Valley and 8,106 in the irrigated areas of the highlands (Harrison and Jabarin).

A wide variety of vegetable crops are produced in Jordan. However, the major vegetables are tomato, eggplant, squash, cucumber, cabbage, cauliflower and potato. These crops are also considered as the major agricultural exports of Jordan. They are exported to Saudia Arabia and the other Gulf States. Smaller quantities are also exported to some European countries during the winter season.

Table 3. Cultivated Area and Production of Wheat, Barley, Lentils and Chickpeas in Jordan 1981-1988. Area in Thousand Dunums and Production in Thousand Metric Tons.

	Wheat		Barley		Lentils		Chickpeas	
Year	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.
1981	1060.7	60.0	448.5	18.0	104.3	6.5	20.6	1.3
1982	759.9	29.0	318.3	7	54.7	2.6	23.1	0.9
1983	1106.6	115.0	450.0	34.0	92.9	8.1	31.6	1.5
1984	430.0	25.0	190.0	4.8	3.5	1.7	15.6	0.6
1985	943.0	62.0	399.2	19.7	57.8	4.1	28.9	1.6
1986	506.5	40.0	181.9	14.5	43.0	2.6	18.1	0.9
1987	1245.4	109.0	600.6	41.0	112.1	7.6	17.1	1.00
1988	1182.7	137.0	633.0	50.0	128.0	9.8	33.6	2.1

Source: Ministry of Agriculture

Land planted to fruit trees increased continuously during the period 1981-1988 as shown in Table 3. The major increase in fruit trees was olives in the highlands. This increase may be attributable in part to a government support program implemented in the highlands for land with slopes between 8 and 25 percent. The program provides farmers with fruit tree seedlings, free food supplies (donated by some international agencies as an incentive for participation in this program), and material needed for terracing (Qasem).

Exports are a vital source of hard currency to the Jordanian economy. The major exports of Jordan are phosphates and potash, chemicals and agricultural products. During the eighties Jordanian exports showed a continuous increase as depicted in Figure 3 (Central Bank of Jordan).

Fruits and vegetables make up about 85 percent of the value of Jordan's agricultural exports. In 1982, exports to Saudia Arabia and the Gulf States exceeded 800,000 metric tons. With declining oil price and an overvalued Jordanian dinar and heavy subsidization of fruit and vegetable production in Saudia Arabia, Jordan's agricultural exports declined in 1983, 1986 and 1987 as shown in Figure 3.

The major Jordanian imports are crude oil, manufactured goods, machinery and transport equipment, and food items (Central Bank of Jordan). Although agricultural products make up a major portion of Jordan's exports, agricultural imports also constitute a large share of Jordan's imports especially meat, and wheat grain and wheat flour. Agricultural imports were about eighteen percent of total imports in 1987. Meat and wheat constituted the largest share of imported agricultural products in 1987. The two

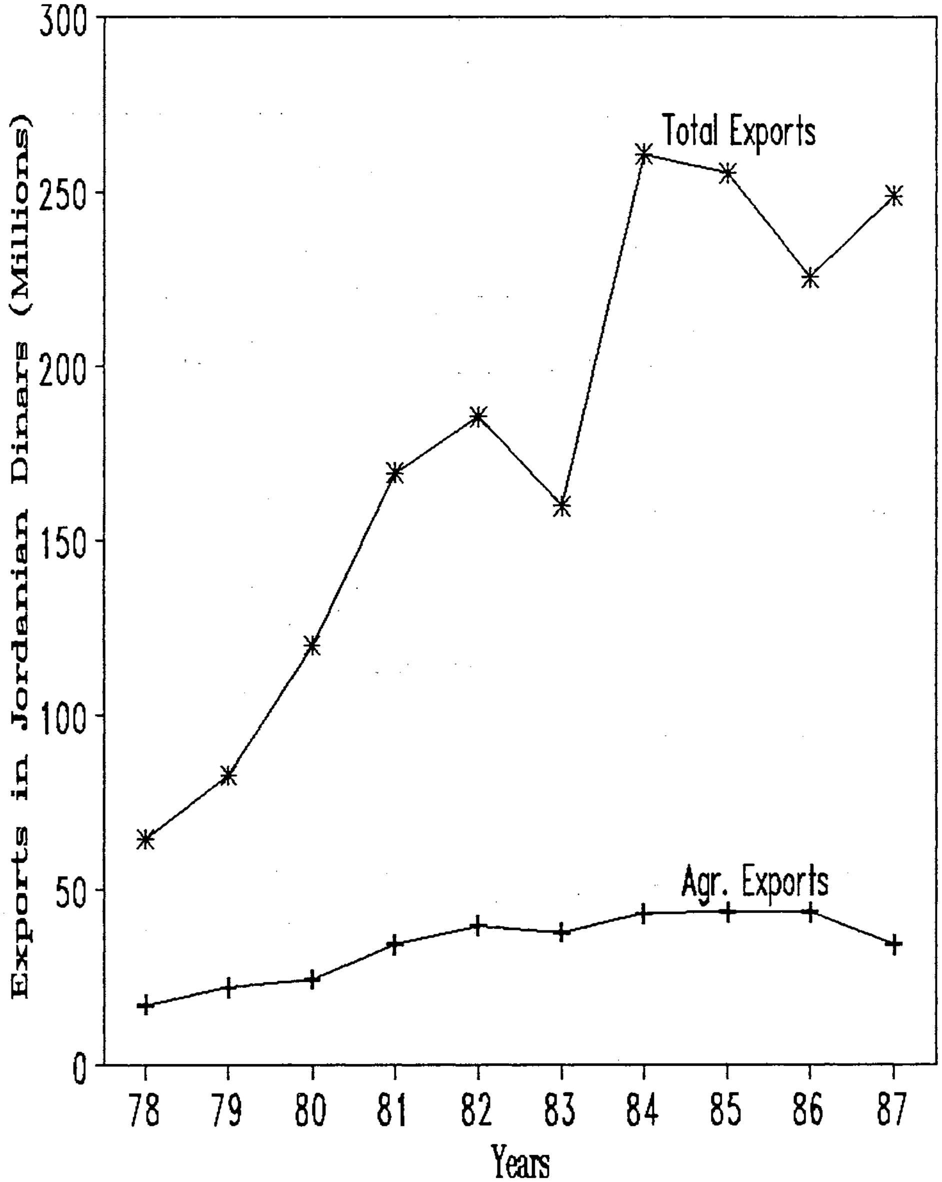

Figure 3. Total Exports and Agricultural Exports during 1978-1987 at Nominal Prices.

commodities composed respectively, 17 and 18 percent of the total agricultural imports in 1987.

Figure 4 shows the domestic imports and the agricultural imports. Agricultural imports increased continuously until 1984 and then declined in the following years.

The Jordanian economy has been affected by public policies. Some of these policies were design to influence the whole economy and others where design to influence specific sectors. Several public policies were implemented to affect the agricultural sector in Jordan. Some of these policies were implemented to improve the overall performance of the agricultural sector such as marketing policies of agricultural products, agricultural credit policy, and land use policies. Other policies were specified to affect certain sub-sectors in the agricultural sector such as retail pricing of fruits and vegetables, procurement prices of field crops, water policies in the Jordan Valley, and so on. The following section includes a discussion of public polices that affect production of selected field crops in Jordan.

Public Policies Affecting the Production of Wheat, Barley, Lentils, and Chickpeas

Since 1968 the government of Jordan has implemented several policies to influence basic food supplies and to achieve certain goals. Some of the stated goals were to: 1) increase the production of food commodities; 2) improve the efficiency of utilization of resources in the production of food; and 3) reduce the disparity in income distribution between the agricultural sector producers and the producers in other sectors (Al-Zobi and Al-Fanek). Since the late sixties different government intervention polices

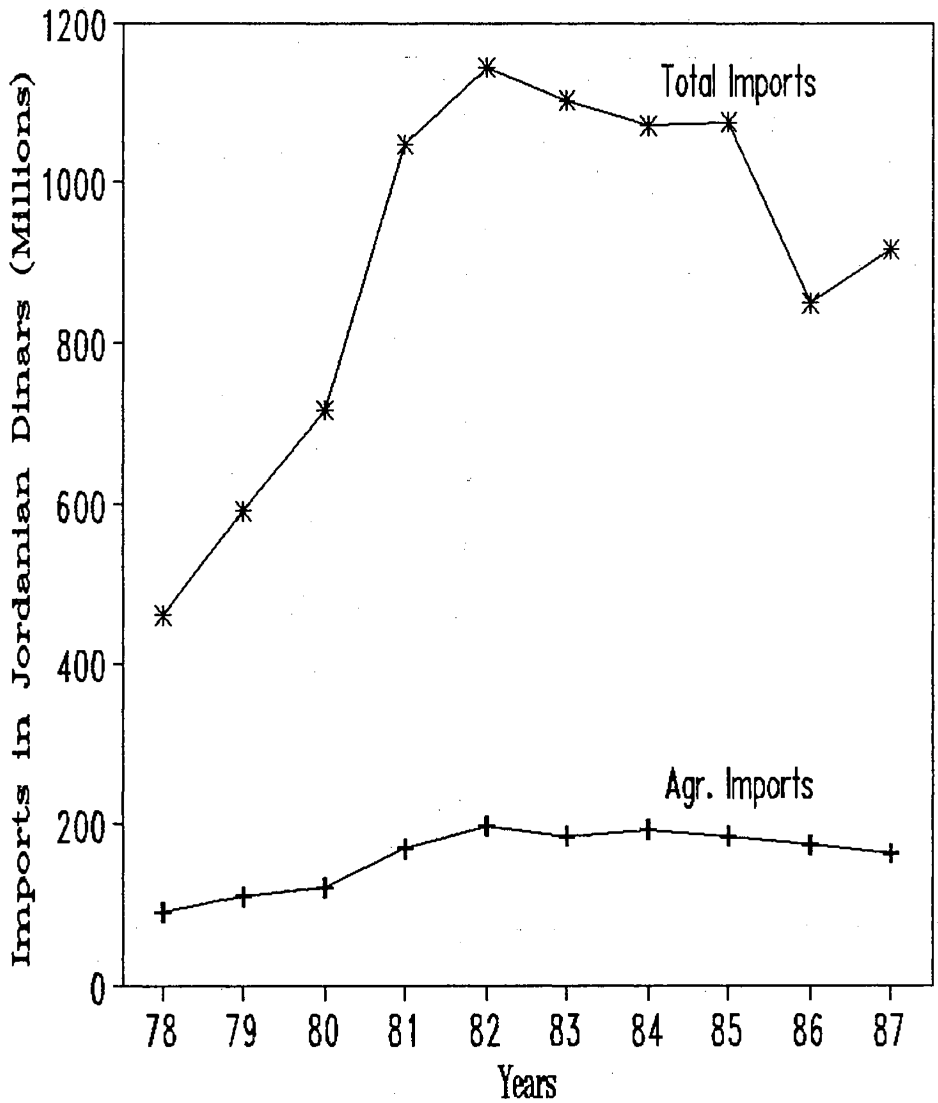

Figure 4. Total Imports and Agricultural Imports during 1978-1987 at Nominal Prices.

were implemented. These include: 1) subsidization of retail prices; 2) subsidization of producer prices; 3) subsidization of agricultural credit; and 4) specific subsidies to encourage planting of fruit trees.

Subsidization of Retail Prices

Retail prices are subsidized for wheat flour, lentils, chickpeas, and barley. The objective of this policy is to provide these commodities to all consumers at prices below world market prices. The policy was to benefit low income consumers, but every consumer either rich or poor benefits.

The government purchases these commodities from local producers or by importation at prices which are usually higher than the subsidized price at which they are sold in retail. Tables 4-6, include price data for wheat, lentils, and chickpeas. The data contain the annual commodity's procurement prices from local and imported sources, quantities of local purchases and imports, retail prices, and the amount of government subsidy at the retail level. Wheat sold to millers receives a real subsidy, while lentils and chickpeas were taxed or received a trivial subsidy in some years. In other words, the selling price of wheat sold to millers was much lower than the procurement prices of both locally purchased or imported wheat. However, retail prices of lentils and chickpeas were in many years much higher than the imported prices.

Table 4. Nominal Prices, Quantities and Consumer's Subsidies of Local and Imported Wheat During 1979-1990.

Year	Procurement Prices Local (Farmers) (JD/Ton)	Procurement Prices Imported (World) (JD/Ton)	Selling Price to Millers (JD/Ton)	Purchased Quantities Local (Ton)	Purchased Quantities Imported (Ton)	Amount of Subsidy Local (Million JD)	Amount of Subsidy Imported (Million JD)
1979	95	65	40	25,508	211,185	1.403	5.280
1980	97	86	39	19,412	162,913	1.126	7.657
1981	104	51	37	3,393	348,129	0.227	4.874
1982	109	91	37	34,758	209,210	2.503	11.297
1983	109	99	37	474	318,678	0.034	19.758
1984	120	84	37	35,412	450,534	2.939	21.175
1985	119	72	34	15,406	376,908	1.310	14.323
1986	120	55	31	61,576	270,877	5.480	6.501
1987	120	48	31	59,220	543,409	5.271	9.238
1988	132	60	35	42,796	399,816	4.151	9.995
1989	142	98	35	51,328	172,410	5.492	10.862
1990	147	120	35	32,378	610,985	3.626	5.193

Source: Al-Zobi and Al-Fanek

Table 5. Nominal Prices, Quantities and Consumer's Subsidies of Local and Imported Lentils During 1979-1990.

Year	Procurement Prices Local Farmers (JD/Ton)	Procurement Prices Imported World (JD/Ton)	Retail Selling Price (JD/Ton)	Purchased Quantities Local (Ton)	Purchased Quantities Imported (Ton)	Amount of Subsidy Local (Thousand JD)	Amount of Subsidy Imported (Thousand JD)
1979	174	129	140	178	640	(6,000)	7,040
1980	170	119	130	655	16	(26,000)	176
1981	172	227	180	16	1,232	N/A	(57,904)
1982	171	164	200	4,188	1,427	121,000	51,372
1983	174	195	200	1,978	2,703	51,000	13,515
1984	177	138	200	3,664	82	84,000	5,084
1985	174	163	180	66	585	N/A	9,945
1986	177	181	300	3,731	1,017	459,000	121,023
1987	179	167	200	6,866	1,589	144,000	52,437
1988	198	130	200	52	484	N/A	33,880
1989	250	129	200	4,260	11,391	(213,000)	808,761
1990	N/A	365	250	N/A	428	0	(3,280)

Source : Al-Zobi and Al-Fanek

Table 6. Nominal Prices, Quantities and Consumer's Subsidies of Local and Imported Chickpeas During 1979-1990.

Year	Procurement Prices (JD/Ton) Local Farmers	Procurement Prices (JD/Ton) Imported World	Retail Selling Price (JD/Ton)	Purchased Quantities Local Ton	Purchased Quantities Imported Ton	Amount of Subsidy (JD) Local	Amount of Subsidy (JD) Imported
1979	N/A	233	N/A	N/A	7,768	N/A	N/A
1980	N/A	123	N/A	N/A	58	N/A	N/A
1981	166	133	170	91	6,624	364	245,088
1982	164	181	164	219	6,962	88	(115,569)
1983	N/A	179	N/A	N/A	9,827	N/A	N/A
1984	166	189	166	170	8,447	N/A	(194,281)
1985	169	204	180	297	10,384	3,267	(249,216)
1986	169	168	180	993	9,972	10,923	119,664
1987	169	135	175	1,850	18,114	11,100	724,560
1988	181	131	185	7	7,516	28	405,864
1989	370	265	300	26	13,112	(1,820)	458,920
1990	N/A	383	N/A	N/A	10,843	N/A	N/A

Source : Al-Zobi and Al-Fanek

Subsidization of Producer Prices

The objective of this policy is to increase the production of wheat, barley, lentils and chickpeas (Al-Zobi and Al-Fanek). Domestic prices are set higher than world prices to encourage producers to expand the cultivated areas and improve production techniques to achieve higher yields. In 1979 the government started subsidizing the procurement prices of wheat, barley, lentils, and chickpeas. Tables 7 through 10, include the procurement prices, local quantities purchased by the government from producers and the amount of subsidies paid to the producers for the four crops.

Farmers are free to sell their produce either to the government or to any other party. A recent study by Mukatsh, showed that wheat, barley, lentils, and chickpeas are marketed through different marketing channels. Table 11 contains the percentage of total production marketed through various means in 1989.

Importation Policy

The government is the sole importer for each of the four crops. The policy enables the government to control the subsidy provided to producers, control the subsidy provided to consumers, and protect local production from competition with foreign producers (Al-Zobi and Al-Fanek). The Ministry of Supply imports the commodities for distribution through wholesalers in major cities. Retail prices are monitored by the Ministry of Supply inspectors and price policy violators are subjected to penalties.

Table 7. Nominal Procurement Prices, Local Purchased Quantities and Producer's Subsidy of Wheat Producers during 1979-1990.

Year	Procurement Price Imported (JD/Ton)	Procurement Price Local (JD/Ton)	Local Purchased Quantity (Tons)	Total Subsidy (JD)
1979	65	95.2	25,508	770,342
1980	86	96.5	19,412	203,826
1981	51	104.1	3,393	180,270
1982	91	108.5	34,758	608,265
1983	99	108.5	474	4,503
1984	84	119.5	35,412	1,257,126
1985	72	119.4	15,406	730,244
1986	55	119.6	61,576	3,977,810
1987	48	119.5	59,220	4,234,230
1988	60	131.8	42,796	3,072,753
1989	98	143.0	51,328	2,258,432
1990	120	147.0	32,378	874,306

Source : Al-Zobi and Al-Fanek

Table 8. Nominal Procurement Prices, Local Purchased Quantities and Total Producer's Subsidy of Lentils Producers during 1979-1990.

Year	Procurement Price Imported (JD/Ton)	Procurement Price Local (JD/Ton)	Local Purchased Quantity (Tons)	Total Subsidy (JD)
1979	129	174.0	178	8,010
1980	118	170.0	655	33,405
1981	227	171.9	26	(1,433)
1982	164	171.2	4,188	30,154
1983	195	174.4	1,978	(40,747)
1984	138	177.0	3,664	142,896
1985	163	174.0	66	726
1986	181	177.0	3,731	(14,924)
1987	167	179.0	6,866	82,392
1988	130	198.0	52	3,536
1989	129	250.0	4,260	515,460
1990	365	N/A	N/A	N/A

Source : Al-Zobi and Al-Fanek

Table 9. Nominal Procurement Prices, Local Purchased Quantities and Total Producer's Subsidy of Chickpeas Producers during 1979-1990.

	Procurement Price		Local Purchased	Total Subsidy
	Imported	Local	Quantity	
Year	(JD/Ton)		(Tons)	(JD)
1979	233.0	N/A	N/A	N/A
1980	123.4	N/A	N/A	N/A
1981	133.2	166.0	91	2,986
1982	181.1	164.4	219	(3,662)
1983	179.4	N/A	N/A	N/A
1984	189.1	166.0	170	(3,927)
1985	204.5	169.0	297	(10,533)
1986	168.1	169.2	993	1,047
1987	134.9	168.9	1,850	62,812
1988	131.4	181.0	7	247
1989	264.8	370.0	26	2,683
1990	385	N/A	N/A	N/A

Source : Al-Zobi and Al-Fanek

Table 10. Nominal Procurement Prices, Local Purchased Quantities and Total Producer's Subsidy of Barley Producers during 1979-1990.

Year	Procurement Price Imported (JD/Ton)	Procurement Price Local (JD/Ton)	Local Purchased Quantity (Tons)	Total Subsidy (JD)
1979	46	53	90	630
1980	60	69	16	144
1981	57	N/A	N/A	N/A
1982	51	N/A	N/A	N/A
1983	65	N/A	N/A	N/A
1984	57	76	2,923	54,076
1985	42	71	2,363	68,527
1986	53	74	12,116	256,859
1987	29	75	26,746	1,222,292
1988	48	83	466	16,077
1989	67	100	6,169	203,577
1990	96	N/A	9,350	N/A

Source : Al-Zobi and Al-Fanek

Agricultural Credit Policy

Financing for agricultural production is available from institutional specialized sources and non-institutional or private sources. The institutional sources include the Agricultural Credit Corporation (ACC), the Jordan Cooperative Organization (JCO), and the Jordan Valley Farmers Association (JVFA). The ACC and JCO provide credit for

Table 11. Marketing Channels of Wheat, Barley, Lentils and Chickpeas in 1989.

Marketing Channel	Percentage of Total Production			
	Wheat	Barley	Lentils	Chickpeas
Sold to Ministry of Supply	72.5%	3.8%	10.9%	0.1%
Family Consumption	12.6%	8.2%	2.6%	3.5%
Kept as Seeds	5.7%	5.4%	5.3%	2.7%
Sold to Merchants	9.2%	82.6%	81.2%	93.7%

Source: Mukatsh

both irrigated and rain-fed agriculture while the JVFA serves only the specialized irrigated producers in the Jordan Valley.

The use of credit by rain-fed farmers from institutional sources is limited, amounting to 5 to 10 percent of the total granted loans. Traditional production techniques do not require significant financing and farmers have been reluctant to obligate themselves with credit to finance more technology (ESCWA).

The ACC provides producers with subsidized loans at interest rates that range between six and nine percent which is approximately three percent less than that charged by commercial banks.

The JCO provides field crop producers with seed, fertilizer, plowing, and combine harvesting at prices lower than market prices. Plowing and combine harvesting is provided first to those who are co-operative members and secondly to the rest of the farmers at subsidized prices.

of field crops is affected by land use policies. Government intervention to encourage land utilization practices was adopted in two ways ectives of this government intervention were to increase planted area erosion in the highland by terracing.

hich affected agricultural land use in the rain-fed region was the age fruit tree planting on rain-fed areas with a slope between 9 and 25 icy was implemented by the Ministry of Agriculture in the form of e seedlings, free food supplies (wheat flour, cooking oil and preserved aterials needed for terracing. This action encouraged traditional wheat producers in these areas to plant fruit trees on some of their land. Qasem (p.17) stated that "Although the land use program administered by the Ministry of Agriculture has not succeeded in promoting wheat cultivation, it has been successful in promoting the sound utilization of hilly land".

Another factor that negatively affects field crop production in the rain-fed areas, is the law that allows partitioning of land into a small single landholding. This kind of action has resulted in severe land fragmentation. Qasem stated (p.21) "The number and size of landholdings have changed drastically over the years. In 1975 there were 50,791 landholdings with a total area of 3,904 thousand dunums of agricultural land, whilst by 1983 the number has increased to 57,436 with a total area of 3,642 dunums. This means that an area of 292 thousand dunums has been lost from agriculture to other usages". Other usages include home building, industrial uses, and commercial uses.

The Higher Council of Regional Planning (HCRP) decided in 1982 that, the minimum size of a landholding for farmland and nonfarmland usage outside the Jordan Valley, can be divided into a separate holding of ten dunums (one hectare) outside the city or village limits. Several exemptions by the Council for certain regions of the country next to a city or town limits, allowed for dividing landholdings into pieces even lower than four dunums. The law also permits for common ownership of one single piece of land (in some areas as small as one tenth of a hectare). Common ownership is a routine consequence of inheritance under Islamic law or purchase. Land owned by an individual passes to heirs after death.

Financial Costs of Government Policies

Tables 4 through 10 contains the annual subsidy or tax paid or received by the government as a result of the policies to subsidize retail and producer prices of wheat, barley, lentils, and chickpeas. The tables indicate that wheat takes the major share of the policies cost.

Table 12 contains a summary of the previous seven tables in addition to government's total expenditure during the period 1979 to 1988 (Central Bank of Jordan). The last column shows that during the ten year period the annual total costs of the different policies for the four crop was very little compared to the total government expenditure.

Survey Results

The data used in this dissertation were obtained by personal interviews conducted in July 1992. The interviewed farmers were located in eleven villages across three rainfall zones in Northern Jordan. The villages are denoted in Figure 5.

For the rainfall zone of 250-350 mm, three villages which include Boyda, Naymah, and Tura were arbitrarily selected. For the rainfall zone of 350-400, mm, five villages were selected including Thenyba, Sareh, Shajarah, Houra, and Magyer. The three villages of Hakama, Maro, and Jayez were selected from the rainfall zone of 400-450 mm. The villages were arbitrarily selected to represent the major areas of wheat and lentil production in the rain-fed region of Northern Jordan. Due to the lack of records for wheat and lentil producers in the area, the sample of farmers to be interviewed was obtained with the help of social chiefs in each village. The chiefs arranged the appointments for the interviews with the farmers. Thus, the observations are not strictly random in that the likelihood of selection was not equal across all farmers in the region. The procedure used to obtain farmers from which information was obtained could be

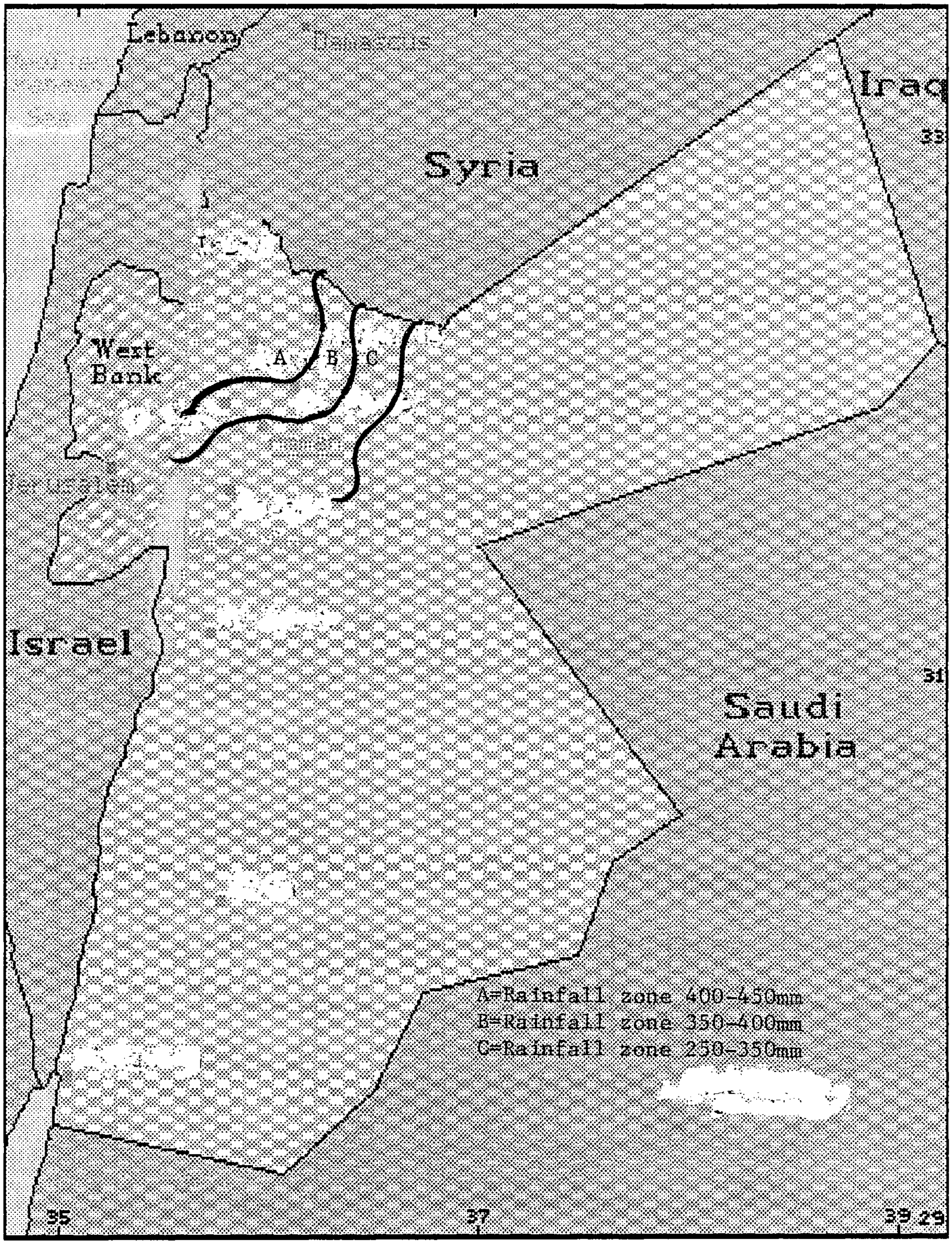

Figure 5. Map of Jordan with area of survey denoted.

described as purposive. However, for analysis conducted for this dissertation each observation is considered to be equally likely. Randomness of the sample was assumed to the extent that interviews were limited to those producing wheat and lentils in the study area.

A total of 63 farmers were interviewed in the eleven villages. The number of farmers in each village and other related information is summarized in Tables 1 through 3 for wheat farmers and in Tables 4 through 6 for lentils farmers (See Appendix A).

Table 12. The Subsidy Cost for Wheat, Barley and Lentils in the Government Budget (1979-1988).

	---------Retail Price Policy--------			---------------Producer Price Policy-------------						
Year	Wheat Subsidy (JD) (000,000)	Lentils Subsidy (JD)	Chickpeas Subsidy (JD)	Wheat Subsidy (JD)	Lentils Subsidy (JD)	Chickpeas Subsidy (JD)	Barley[a] Subsidy (JD)	Total Subsidy (JD) (000,000)	Government Expenditure (JD) (000,000)	Subsidy Percent of Gov. Expend.
1979	6.683	(1,040)[b]	0	770,342	8,010	0	630	7.460	515.660	1.5[c]
1980	8.917	25,824	0	203,826	33,405	0	144	9.182	563.150	1.6
1981	5.101	57,776	245,452	180,270	(1,433)	2,986	0	5.586	647.100	0.9
1982	13.800	(172,372)	(115,481)	608,265	30,154	(3,662)	0	14.147	693.550	2.1
1983	19.792	(64,515)	0	4,503	(40,747)	0	0	19.691	705.270	2.8
1984	24.114	(89,084)	(194,281)	1,257,126	142,896	(3,927)	54,076	25.280	720.800	3.5
1985	15.633	(10,341)	(245,949)	730,244	726	(10,533)	68,527	16.166	805.680	2.0
1986	11.981	(580,023)	130,587	3,977,810	(14,924)	1,047	256,859	15.752	981.340	1.6
1987	14.509	(196,437)	735,660	4,234,230	82,392	62,812	1,222,292	20.650	965.810	2.1
1988	14.146	(33,880)	405,892	3,072,753	3,536	247	16,077	17.610	1045.700	1.7

[a] Barley producers receives a subsidy in some years. However, barley consumption was not subsidized.

[b] Value in parenthesis indicate earnings or taxes instead off the subsidy.

[c] Subsidies for these crops as a percent of total government expenditure.

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CHAPTER III

MANUSCRIPT I

IMPACTS OF LAND FRAGMENTATION AND FARM SIZE ON THE COST OF PRODUCING WHEAT IN THE RAIN-FED REGION OF NORTHERN JORDAN

IMPACTS OF LAND FRAGMENTATION AND FARM SIZE ON THE COST OF PRODUCING WHEAT IN THE RAIN-FED REGION OF NORTHERN JORDAN

ABSTRACT

In some cultures inheritance customs results in land fragmentation such that over time operating farms become composed of a collection of spatially dispersed fields rather than a contiguous land unit. This study was conducted to determine the impact of land fragmentation as measured by average field size on the average cost of producing wheat in the rain-fed region of Northern Jordan. Primary data were collected from farmers in the region. Maximum likelihood and estimated generalized least squares methods were used to estimate the average variable cost of producing wheat. It was determined that the average variable cost of producing wheat is a decreasing function of field size as well as farm size. Land fragmentation increases the cost of producing wheat. Continued land fragmentation, will lead to decreasing efficiency and is problematic when it results in small fields.

INTRODUCTION

Small farm size and land fragmentation have been hypothesized to be impediments to economical wheat production in Jordan. They are believed to be a principal cause of Jordan's low productivity and major obstacles to the development of the rain-fed agricultural region (El-Hurani and Duwayri, 1986).

In some cultures the desire to leave each heir an equal portion of the farm leads farmers to divide each field in each generation (Binns, 1950). Partial inheritance leads to ever-diminishing field size (Clout, 1972; Moore, 1972; Burton and King, 1983; Brettell, 1977). Operating farms are often composed of a collection of spatially dispersed fields rather than a contiguous land unit.

Land fragmentation is defined as the division of a single farm into several separate, distinct parcels (Binns, 1950). Many developed and developing countries encounter a land fragmentation problem. Some consider land fragmentation to be a major impediment to efficient field crop production (Binns, 1950; Dovering, 1965; Grigg, 1983; Jacoby, 1971; Karouzis, 1971; King and Burton, 1982). Small and irregular fields increase the costs of moving workers and equipment and reduces the field efficiency of machines relative to that obtainable in large, rectangular fields (Buller and Bruning, 1979).

While there are costs associated with land fragmentation, under some circumstances spatial dispersion may be beneficial. An individual farmer who manages several dispersed parcels may exploit differences in elevation or soil type by scheduling plantings to reduce risk and distribute labor requirements over time (Bentley, 1987). In addition, fields in different zones may permit a farmer to produce a more diversified portfolio of crops (Cole and Wolf, 1974; Forbes, 1976; Friedl, 1974; Weinberg, 1972). In mountain regions, crops at lower elevations mature before those at higher elevations. A farm family may exploit differences in elevation to synchronize harvest with available family labor, reduce requirements for hired labor and spread out fresh food supplies over time (Netting, 1972; Forbes, 1976; Friedl, 1974; Galt, 1979).

Land fragmentation may facilitate risk management through diversification even in relatively homogeneous environments such as that found in the Great Plains of the USA. For example, hail storms are often localized such that the probability of a total loss is less for a farmer with spatially dispersed land tracts. Similarly, rain from thunderstorms is often localized such that some fields may produce well in certain years, while others do well in other years (Carlyle, 1983; Heston and Kumar, 1983).

Land Fragmentation in Jordan

One factor which influences land fragmentation in Jordan is the law which governs the partitioning of land into a single landholding. Outside the city or village limits, the minimum size of a landholding which can be divided into a separate holding is one hectare. However, the law permits for common ownership of one single piece of land (in some areas as small as one tenth hectare). Common ownership is a routine consequence of inheritance under Islamic law or purchase. Land owned by an individual passes to heirs after death.

Available data indicate that the average farm size in the rain-fed regions of Jordan is eight hectares (Agricultural Statistics, 1988). However, most farms are composed of dispersed parcels. The average landholding is divided into 2.5 pieces such that the average contiguous field size in one location is 32 dunums (3.2 hectares).

Arabiat and Al-Kadi (1988), concluded that the degree of agricultural land fragmentation as measured by an index they developed, is very high in northern Jordan. Qasem (1985) has reported that land fragmentation is a continuous process. The number of individuals who acquired ownership rights increased every year from 1976 to 1981. The data in Table 1 show that in 1976, for example, 2,657 individually owned land parcels changed ownership in Jordan. The ownership of these parcels was transferred to 7,033 individuals. During the period from 1976-1981, a total of 17,668 individually owned parcels were transferred to 59,070 individuals. The number of owners of the transferred land almost tripled.

Data are not available to directly measure the impact of decreasing parcel size on farm size or the size of fields farmed. For example, a single farmer may acquire the rights to farm a number of contiguous but independently owned parcels through various tenancy arrangements. However, for a given size of farm, the transactions costs of renting could be expected to be an increasing function of the number of landlords. For example, a farmer with 100 units of land and two landlords is likely to incur less transactions cost than a farmer with 100 units of land and twenty landlords. An underlying assumption of the analysis presented in this paper is that the average field size available for farming decreases as the number of individual land owners increases.

Arabiat and Al-Kadi (1988) have determined that land fragmentation is a serious problem in Jordan. The analysis presented by Qasem (1985) indicates that the degree of land fragmentation has increased. However, it remains to be determined if this fragmentation reduces economic efficiency or alternatively, if the benefits of fragmentation exceed the costs. No research has been conducted to measure the impact of fragmentation on production costs.

The objective of the research reported in this paper is to determine if field size influences production costs. One measure of economic efficiency is average per unit production costs. Hence, the specific objective is to estimate the average variable costs of producing wheat in the rain-fed region of Northern Jordan and to determine if land fragmentation as measured by average field size is beneficial, costly, or an insignificant factor.

The results are expected to be of use to those Jordanian farmers who have flexibility regarding field size. In addition, the results may be of value to those responsible for setting and modifying Jordanian public policies which influence land fragmentation.

Model

Ten models are fitted to estimate average variable cost as a function of the three rainfall eco-climatical zones, fertilizer applied, use of combine harvester, land seeded to wheat on the farm, and average wheat field size. The full model is represented in Equation 1. The models are estimated to determine if production efficiency as measured by the average variable cost of producing wheat is influenced by field size. Land seeded to wheat on the farm is included as a variable in the models since, prior studies have shown that production costs are a function of farm size (Madden, 1967; Moore and Carter, 1984).

$$AVC_i = F(LR_i, MR_i, FERT_i, CTEC_i, WACR_i, AFS_i) \tag{1}$$

ROMA ACR ACR/PCS

Where :

LR_i = 1 if the farm i is located in rainfall zone of 250-350 mm and 0 otherwise;

MR_i = 1 if the farm i is located in rainfall zone of 250-400 mm and 0 otherwise;

$FERT_i$ = fertilizer level in kilograms per dunum used on farm i;

$CTEC_i$ = 1 if the wheat on farm i was harvested with a combine and 0 otherwise;

$WACR_i$ = land area (dunums) seeded to wheat on farm i, and

AFS_i = average wheat field size (dunums) on farm i.

Several functional forms were used to estimate the average variable cost to produce a unit of wheat on the farm. These functional forms are shown in Table 2.

Data and Statistical Methods

Primary data were collected by personal interviews of sixty-three farmers in the northern part of Jordan. The survey was conducted in July 1992. Questions were designed to obtain detailed data which could be used to prepare wheat enterprise costs and returns budgets for each farm. The average variable cost of producing wheat on each farm was generated with these budgets by dividing the total variable costs of producing wheat by yield. The average variable cost is expressed in terms of Jordanian dinar per kilogram of wheat produced.

All farmers who were surveyed and who reported the use of fertilizer indicated that they used ammonium sulfate (21 percent nitrogen). The fertilizer levels are expressed in kilograms of fertilizer used per dunum. Wheat grain yield is expressed in kilograms per dunum.

The Glejser test confirmed the presence of heteroskedasticity which is a common problem with cross-sectional data (Kennedy, 1989; Berndt, 1991; Judge et al., 1985; Salvatore, 1982). Heteroskedasticity is the term used to describe the violation of the ordinary least squares assumption that all the disturbance (error) terms have the same variance. In these instances ordinary least squares generates inefficient estimates of the standard errors and thus incorrect statistical tests.

Alternative approaches for obtaining unbiased and efficient parameter estimates when heteroskedasticity occurs include Estimated Generalized Least Squares (EGLS) and Maximum Likelihood Estimation (MLE) (Judge et al., 1985; White et al., 1993). If the distribution of the error term is normal, the estimators derived by both EGLS and MLE will be equal. However, when the distribution of the error term is not normal the MLE is a superior method. MLE and EGLS were used in this study.

Results

Statistical results for Models 1 and 2 are presented in Table 2. The F-statistics for all models are significant at a ten percent level. Model 8 was used to represent the relationship between average variable cost and the different variables in the full model of Equation 1. The results indicate that there is a significant relationship between the average variable cost and the fertilizer level, the use of the combine harvester and the average field size on the farm.

The model confirms that average variable cost is a decreasing function of fertilizer level, the use of the combine harvester, average field size and farm size. Average variable cost of producing wheat on the farms included in the survey is greater with small fields. That is, the average field size is important.

Figure 1 shows the relationship between average variable costs and land area seeded to wheat for three field sizes using the results from Model 8.

Table 3 includes estimated values of the AVC of producing wheat for alternative farm and field sizes based on parameter estimates of Model 8. Over the relevant range as farm size increases the average variable cost decreases. A further decrease in the average variable cost occurs as the field size increases. For a given field size (AFS), say 20 dunums, the AVC decreases from JD 0.111 to JD 0.099, when the farm size increases from 40 dunums to 160 dunums. Similarly, for a given farm size, say 120 dunums, the AVC decreases from JD 0.103 to JD 0.087, when the field size increases from 20 to 60 dunums. In other words the AVC curve shifts up, indicating an increase in the AVC when the field size decreases and it shifts down, indicating a decrease in the AVC when the farm size increases.

The values in Table 4 show the AVC of producing wheat in Jordan for selected alternative farm and field sizes as a percent of the average cost of importing wheat into Jordan from 1979-1989. The average cost of importing wheat was computed by adjusting the F.O.B. Gulf of Mexico price for shipping costs, exchange rates, and local transportation. Values in excess of 100% indicate that the AVC of producing wheat in Jordan exceeds the cost of importing wheat. Similarly, for a given farm size, fragmentation as reflected in the average field size, reduces the ability of the Jordanian farmers to compete with producers in other countries.

Conclusions

Upon death of the owner, it is common for agricultural land in the rain-fed region of northern Jordan to be divided among heirs. Over time the size of an average land holding has decreased. This process of land fragmentation has been cited as a major impediment to efficient production of field crops. However, the consequences of land fragmentation on the ability of Jordanian farmers to compete in the world wheat market has not been determined.

For the research reported in this paper average wheat field size was used as a proxy for land fragmentation. The specific objectives were to compute the average variable cost of producing wheat as a function of average field size and farm size and to determine if average field size is an important factor in determining wheat yield.

Primary data were obtained from a sample of 63 Jordanian farmers. Maximum likelihood and estimated least squares estimation were used to derive parameter estimates. Land fragmentation was found to be significant. The average variable costs of producing wheat in the region increases as the average field size decreases.

The modelling effort leads to several implications. Land fragmentation is indeed an impediment to efficient wheat production in the region. Individual farmers may have limited options to increase average field size and thus reduce average variable cost of production. The question remains as to what type of public policies may be put into place to reduce the degree of land fragmentation or to mitigate the cost imposed by land fragmentation. If the land market in the region is well developed, there may be some possibility for individual farmers to increase average field size by acquiring the rights to farm contiguous units. The transactions costs of working with numerous landlords has not been addressed. It is not clear if government policy can contribute to this process. However, it is clear that continued land fragmentation, will lead to decreasing efficiency and is problematic when it results in small fields.

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TABLE 1

Number of individually owned land parcels which changed ownership in Jordan (1976 -1981) and number of individuals acquiring ownership

Year	Number of individually owned land parcels which changed ownership	Number of individuals acquiring ownership of the transferred land
1976	2,657	7,033
1977	2,445	8,313
1978	2,898	9,853
1979	3,028	10,295
1980	3,160	10,744
1981	3,480	11,832
Total	17,668	59,070

Source: Qasem, 1985.

Table 2.

Statistical estimates of the average variable costs of producing wheat in Jordan as a function of the three rainfall eco-climatical zones, fertilizer applied, the use of combine harvester, land area seeded to wheat on the farm and the average wheat field size.[a]

Variable	Model 1[b]	2	3	4	5	6	7	8	9	10
Intercept	-1.84 (-6.222)*	-1.2 (-5.6)*	-1.5 (-5.3)*	-1.2 (-7.1)*	0.21 (11.98)*	0.19 (15.68)*	0.22 (13.4)*	0.189 (14.8)*	0.18 (14.7)*	0.19 (14.7)*
Low rainfall eco-climatical zone	-.33[c] (-2.7)*	-25 (-1.6)*	-.28 (-1.8)*	-.24 (-1.6)	-.023 (-1.48)	-.03 (-1.6)	-.02 (-1.3)	-.002 (-.87)	-.0034 (-.2)	-.028 (-2.0)*
Median rainfall eco-climatical zone	-.17 (-.19)	0.03 (.28)	-.03 (.04)	-.03 (.34)	0.007 (0.58)	.013 (1.26)	.002 (.2)	.006 (.57)	.0097 (.89)	0.0031 (.29)
Fertilizer applied (kg/dunum)					-0.005 (-1.62)	-.006 (-2.1)*	-.005 (-1.8)*	-.006 (-2.1)*	-.007 (-2.5)*	-.005 (-1.75)*
Fertilizer applied squared					0.0002 (0.75)	.003 (1.4)	.0001 (.6)	.0002 (.98)	.0003 (1.5)	.0001 (.6)
Log of fertilizer applied	-.033 (-3.7)*	-.028 (-2.7)*	-.029 (-2.7)*	-.03 (-2.8)*						
Combine harvester	-.96 (-9.9)*	-.97 (-10.6)	-.92 (-10.22)	-1.2 (-7.0)*	-.089 (-8.97)	-.09 (-9.7)*	-.08 (-9.2)*	-.084 (-8.7)*	-.086 (-8.6)*	-.086 (-8.8)
Land seeded to wheat					-0.004 (-1.11)	-.0007 (-3.9)*		-.0001 (-1.23)	-0.0002 -(2.9)*	
Land seeded to wheat squared					0.000001 (.19)	0.000002 (2.9)*				
Log of land seeded to wheat		-.18 (-1.9)*		-.21 (-4.4)*						
Average size of wheat field					-.0013 (-1.43)		-.002 (-3.4)	-.0004 (-2.1)*		-.0051 (-3.5)*
Average size of wheat field squared					0.000008 (1.38)		.00001 (2.3)*			
Log of average size of wheat field	-.24 (-4.0)*	-.04 (-.27)	-.25 (-3.9)*							
R^2	0.75	0.80	0.78	0.79	0.76	0.75	0.75	0.73	0.71	0.72
F		31.5	35.4	38.5	16.7	21.1	21.4	18.8	19.9	21.5

[a] The dependent variable is the average variable cost of producing a kilogram of wheat on the farm.

[b] Model 1 was estimated using the maximum likelihood procedure. All other models were estimated with estimated generalized least squares.

[c] The value in parentheses are t-values. One asterisk denotes significance at the 1 percent level.

TABLE 3

Estimated average variable cost of producing wheat in Jordan (dinar/kilogram) for selected farm and field sizes[a]

	Farm Size (dunums)						
Field size (dunums)	40	80	120	160	200	240	280
20	0.111	0.107	0.103	0.099	0.095	0.091	0.087
40	0.103	0.099	0.095	0.091	0.087	0.083	0.079
60	0.095	0.091	0.087	0.083	0.079	0.075	0.071

[a] Predicted values derived from the full regression model.

TABLE 4

Average variable costs of producing wheat in Jordan as a percent of the average cost of importing wheat for selected farm and field sizes

	Farm Size (dunums)						
Field size (dunums)	40	80	120	160	200	240	280
20	139%	134%	129%	124%	119%	114%	109%
40	129%	124%	119%	114%	109%	104%	99%
60	119%	114%	109%	104%	99%	99%	89%

[a] The average variable cost of producing a kilogram of wheat on a farm with 30 dunums seeded to wheat and three fields is estimated to be 145% of the cost of importing a kilogram of wheat.

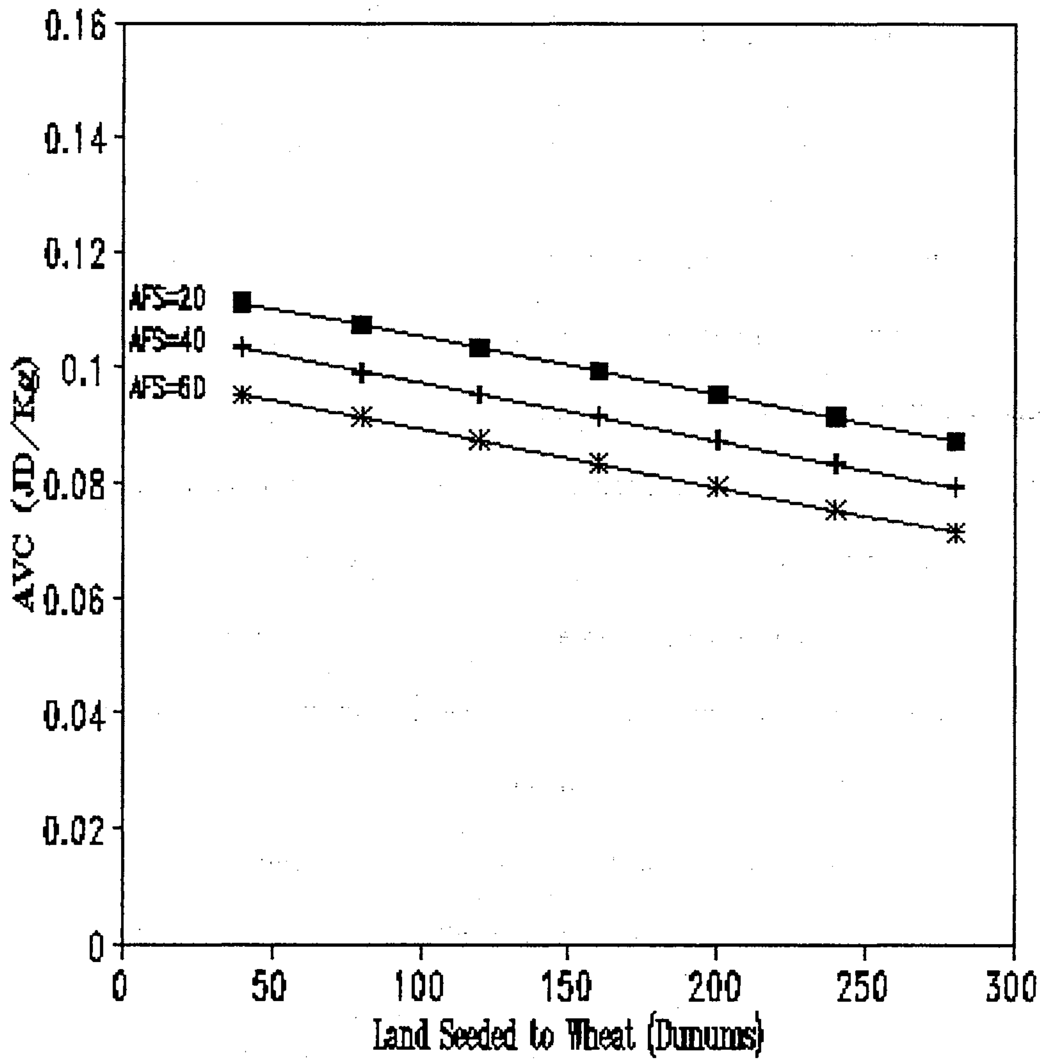

Figure 1. Average variable cost (Jordanian dinar/kg) of producing wheat in the rain-fed region of Northern Jordan as a function of the land area seeded to wheat on the farm (dunum) for average field sizes (AFS) of 20, 40, and 60 dunums.

CHAPTER IV

MANUSCRIPT II

ECONOMICS OF ALTERNATIVE SYSTEMS FOR PRODUCING WHEAT AND LENTILS IN THE RAIN-FED REGION OF NORTHERN JORDAN

ECONOMICS OF ALTERNATIVE SYSTEMS FOR PRODUCING WHEAT AND LENTILS IN THE RAIN-FED REGION OF NORTHERN JORDAN

ABSTRACT

The government of Jordan has expressed a goal of increasing the productivity of wheat and lentils in the rain-fed region of the country. Several policies have been suggested to provide incentives for farmers to adopt and implement alternative production systems. This study was conducted to determine if production systems using commercial fertilizer and increased levels of mechanization are economically viable alternatives to the traditional systems. Personal interviews of farmers in the region who used traditional as well as alternative production practices were conducted. Maximum likelihood methods were used to estimate response functions and enterprise budgeting methods were used to conduct economic analysis. Optimal levels of fertilization were determined for wheat. It was also determined that both wheat grain and wheat straw and lentils as well as lentil vines are all economically important products. Alternative production systems which do not preserve the value of the straw and vines are not likely to be economically viable.

INTRODUCTION

The land area in Jordan seeded to field crops in the last decade has declined. Figures 1 and 2 show the production and the area seeded to wheat and lentils during the period 1978-1990. The 1985-1990 Five-Year Development Plan for Jordan included a goal to increase the productivity of wheat and lentils through the introduction of alternative production systems. The proposed systems included the use of fertilizer and increased mechanization in addition to other production practices.

Several researchers have recommended that the Jordanian government implement policies designed to provide incentives for farmers to improve the production of field crops in the rain-fed regions of Jordan (Gotsch; El-Hurani; ICARDA). The recommended policies include subsidization of the price of fertilizer and subsidization of certain farm machinery including combines for harvesting wheat and grain drills for seeding lentils.

Gotsch has recommended that the government provide a direct subsidy for purchased inputs to encourage farmers to adopt technologies which could increase the production of wheat and lentils in the rain-fed regions. However, the Jordanian government does not currently provide a direct subsidy for agricultural inputs.

Research conducted on experiment stations has shown that some technologies have the potential to increase yields of wheat and lentils (NCART; ICARDA). However, farm level data have not been available to conduct an economic analysis of the recommended alternatives. Hence, the impact of the proposed practices on farm yields and on the realized net income of farmers in the region has not been established. In addition, fertilizer recommendations have not been based upon economic analysis of farm level data.

The overall objective of the research reported in this paper is to determine if several of the recommended practices for producing wheat and lentils in the rain-fed region of Jordan are economically viable alternatives to traditional practices. A specific objective is to determine if a wheat production system which includes combine harvesting is more economical than the traditional system based upon a stationary thresher. A second objective is to determine if mechanical seeding of lentils with a grain drill is more economical than the traditional method of hand seeding. A third objective is to determine the economically optimal rate of fertilization for wheat and lentils. The fourth objective is to determine which of the four alternative production systems for wheat and lentils can be expected to generate the most income for farmers in the region. A final objective is to determine if subsidization of fertilizer or machinery would be an appropriate policy for the government to implement to provide incentives for farmers to increase the production of wheat and lentils in the region.

The information generated in the analysis should be of value to policy makers in Jordan. The information should also be useful for farmers in the region who produce wheat and lentils.

Data

Primary data were collected by personal interviews of 63 farmers in the northern part of Jordan. The survey was conducted in July 1992. Questions were designed to obtain information which could be used to estimate yield response functions and to determine the economic consequences of producing wheat and lentils with the traditional and the alternative technologies.

Of the 63 farmers, 57 produced wheat and 48 produced lentils. A total of 38 of the 57 wheat producers (67 percent) reported the use of fertilizer on wheat. Those who used fertilizer reported an average use of 10.26 kg/dunum of ammonium sulfate (21 percent nitrogen). (A dunum is one tenth of a hectare.) No other formulation of fertilizer was reported. Thirty-one (54 percent) of the wheat producers indicated that they used the traditional harvest system in which the wheat is cut and shocked into bundles. After drying, the bundles are collected and transported to a stationary thresher where the grain is threshed. The wheat straw is bagged for use on the farm or for sale as feed for sheep and goats.

The remaining 26 (46 percent) farmers who produced wheat reported the use of a combine harvester. Combines are typically rented from either the Jordanian Cooperative Organization or individuals. One reported disadvantage of the combine technology is that the straw is returned to the field and not collected for storage and use as feed. There is a market for renting the wheat stubble including the straw for grazing. All farmers who used a combine reported renting the stubble for grazing. However, the reported average gross return from grazing of 2.30 JD/dunum is substantially less than the average gross return from the straw collected with the conventional system of 18.04 JD/dunum. (Prices are reported in Jordanian dinars, with 1 JD = $1.47 US in 1992.)

A total of 19 of the 48 (40 percent) farmers who reported growing lentils indicated that they used fertilizer on the land seeded to lentils. Those who used fertilizer reported using 9.55 kg/dunum of ammonium sulfate. The traditional hand seeding method was used by 43 (90 percent) of the farmers. The remaining 5 (13 percent) used a grain drill rented from local individuals to seed the lentils. Those using the traditional seeding method reported an average seeding rate of 11.7 kg/dunum whereas those using a grain drill reported an average seeding rate of 10.6 kg/dunum. Some of the farmers who rented a grain drill indicated dissatisfaction with the seeding rate.

All farmers who were included in the survey reported that mature lentil vines were collected and that the lentils were hand harvested. After the seeds were separated the vines were bagged for storage and use as hay for livestock, primarily sheep and goats.

Statistical Modelling

The data obtained from the survey were used to estimate wheat yield response as a function of fertilizer and harvesting method, and lentil yield response as a function of fertilizer and seeding method. The full model for estimating wheat yield is portrayed in Equation 1. The yield is estimated as a function of rainfall eco-climatical zones, fertilizer applied, the use of combine harvester, land area seeded to wheat and acreage field size.

$$WYLD_i = F(LR_i, MR_i, FERT_i, CTEC_i, WACR_i, AFS_i) \quad (1)$$

Where:

$WYLD_i$ = Wheat yield (kg/dunum) for farm i;

LR_i = 1 if the farm i is located in rainfall zone of 250-350 mm, and 0 otherwise;

MR_i = 1 if the farm is located in rainfall zone of 350-400 mm, and 0 otherwise;

$FERT_i$ = Quantity of ammonium sulphate fertilizer (kg/dunum) for farm i;

$CTEC_i$ = 1 if the wheat on farm i was harvested with combine and 0 otherwise;

$WACR_i$ = land area (dunums) seeded to wheat on farm i, and

AFS_i = average wheat field size (dunums) on farm i.

The full model used to estimate lentil response was similar to but different from the model used to estimate wheat response. The technology of concern for the lentils is grain drill versus conventional seeding. Hence, a dummy variable was included to allow for differences across seeding method. Additionally, since the seeding rate differed by method of seeding it was included as a continuous variable. A dummy variable for harvest method was not included since all lentils were hand harvested. For the full model the yield of lentils was estimated as a function of rainfall eco-climatical zones, fertilizer applied, seeding method, seeding rate, and land seeded to lentils on the farm.

$$LYLD_i = F(LR_i, MR_i, FERT_i, STEC_i, SEED_i, LACR_i) \qquad (2)$$

Where:

$LYLD_i$ = Lentil yield (kg/dunum) for farm i;

LR_i = 1 if the farm is located Quantity of ammonium sulphate fertilizer (kg/dunum) for farm i;

MR_i = 1 if the farm is located in rainfall zone of 350-400 mm and 0 otherwise;

$FERT_i$ = Quantity of ammonium sulphate fertilizer (kg/dunum) for farm i;

$STEC_i$ = 1 if a grain drill was used to seed lentils on farm i and 0 otherwise;

$SEED_i$ = Seeding rate (kg/dunum) for farm i, and

$LACR_i$ = Land area (dunums) seeded to lentils on farm i.

The Glejser test confirmed the presence of heteroskedasticity which is a common problem with cross-sectional data (Kennedy, 1989; Berndt, 1991; Judge et al., 1985; Salvatore, 1982). Heteroskedasticity is the term used to describe the violation of the ordinary least squares assumption that all the disturbance (error) terms have the same variance. In these instances ordinary least squares generates inefficient estimates of the standard errors and thus incorrect statistical tests.

Alternative approaches for obtaining unbiased and efficient parameter estimates when heteroskedasticity occurs include Estimated Generalized Least Squares (EGLS) and Maximum Likelihood Estimation (MLE) (Judge et al., 1985; White et al., 1993). If the distribution of the error term is normal, the estimators derived by both EGLS and MLE will be equal. However, when the distribution of the error term is not normal the MLE is a superior method. Hence, MLE is preferred in general and was used in this study.

Results for Wheat

Statistical estimates of wheat yield response are presented in Table 1. The results of all models indicate that there is a significant relationship between the wheat yield and the fertilizer level. The combine harvester dummy variable is also significant for models. Use of a combine rather than a stationary thresher was found to decrease marketable grain yield.

The Wald Chi-Square statistic confirmed that Model 2 explains significantly more of the variability in yield of wheat than the full model and Model 3. That is, it is appropriate to drop the average field size variables (AFS_i and AFS_i^2). Thus, Model 2 was selected to represent wheat yield response to rainfall eco-climatical zones, fertilization, method of harvest, and farm size.

The parameter estimates of Model 2 were used along with current prices of 0.14 JD/kg for fertilizer and 0.15 JD/kg for wheat to determine the optimal quantity of fertilizer. For these prices the economically optimal amount of fertilizer is 10.1 kg/dunum.

Table 2 includes estimated values of economically optimal levels of fertilizer for alternative wheat and fertilizer prices. The analysis included in Table 2 has several implications. First, the results suggest that the economically optimal quantity of fertilizer is relatively insensitive to the prices of both fertilizer and wheat. A second finding is that those farmers who use fertilizer and who on the average reported an application of 10.3 kg/dunum, are applying an appropriate rate. A third finding is that the physically optimal quantity of fertilizer, the application rate which is expected to resulted in the maximum yield, is 11.5 kg/dunum. This rate is near most of the economically optimal quantities. Hence, for those farmers who currently fertilize, subsidizing the price of fertilizer is not likely to result in a substantial increase in the use of fertilizer or production of wheat. An appropriate policy instrument would be one that induced those 33 percent of the farmers who do not currently apply fertilizer on wheat to begin doing so.

For the economically optimal level of fertilizer, the expected wheat yields were found to be 222 and 211 kg/dunum for wheat produced using the traditional threshing and combine harvester system, respectively. The estimated economically optimal amount of fertilizer and the estimated yields were used to prepare the budgets presented in Table 3.

Table 3 contains estimates of costs and returns for wheat produced in the rain-fed region of northern Jordan. Estimates for the traditional (stationary thresher) production system and for the alternative (combine harvest) system are included. Yields included in the budgets were calculated from the statistically estimated response function. The quantity of fertilizer included in the budgets is based upon the economically optimal level for the budgeted prices of wheat and fertilizer. The area seeded to wheat was based on the mean of the farm size of the sample.

The estimated cost of the traditional stationary thresher system (15.67 JD/dunum) is more than two times greater than the cost of the combine harvester system (7.70 JD/dunum). Most of the difference in cost is a result of higher labor cost of traditional harvesting. But, the revenue generated by the traditional stationary thresher system is greater (51.7 JD/dunum) than the revenue from the combine harvester system (33.95 JD/dunum). The difference in revenue results primarily from the value of the straw produced with the traditional system (18.04 JD/dunum) relative to the value of the grazing available with the combine system (2.30 JD/dunum). In addition, the marketable grain is estimated to be about 6 percent greater for the traditional system.

The net returns to family labor, land, overhead, management, and risk from the traditional thresher system (36.03 JD/dunum) is almost 50 percent greater than the net returns from the combine system (26.25 JD/dunum). The combine system as budgeted is not economically competitive with the traditional system. Several factors contribute to this conclusion. In the region of the study, more than a third of the value of the wheat crop is in the harvested straw. Much of this value was lost on those farms on which a combine was used. From a public policy perspective, the data suggest that programs to promote combine harvesting technology should also include provisions for straw collection. The combine in the absence of some means of collecting the straw is not economically efficient.

It is not clear from the available data why six percent more wheat per dunum was harvested on those farms which did not use the combine. Evidently field losses were greater with the combine system. It may be that the combines were not adjusted properly, or that grain was not harvested in a timely fashion. Based upon the survey, the farmers paid a standard rate per dunum to the custom combine operators. However, owners of the stationary threshers were paid based upon the volume of grain harvested. While there was an incentive for the thresher operators to maximize yield, there was apparently no economic incentive for the combine operators to do so. A payment structure which provides an economic incentive to the combine operators to reduce field losses may be appropriate.

Results for Lentils

Statistical estimates of lentil grain yield response are presented in Table 4. Based upon a series of Wald tests Model 3 which includes rainfall eco-climatical zones, fertilizer, seeding rate, and area seeded to lentils as continuous variables was selected to represent lentil yield response. Half of the farmers reported that they did not use fertilizer for lentils. However, the other half reporting an average application of 9.6 kg/dunum. For Model 2, the estimated coefficient for the fertilizer variable was 6.02. Hence, the application of 9.6 kg/dunum at a seeding rate of 11.25 kg/dunum on an average farm size could be expected to increase the yield of lentils by 58 kg/dunum.

The use of a mechanical seeder did not significantly change grain yield. However, the seeding rate variable was found to be significant. On the average, the seeding rate was found to be lower for those five farms on which a mechanical seeder was used. One conclusion that can be drawn is that calibration of mechanical seeders to achieve seeding rates consistent with those obtained with the traditional hand seeding method is important.

All farmers who produced lentils reported that after separation the vines were stored for use as livestock feed. Table 5 includes estimates of lentil hay response functions. The same functional forms as those used to estimate lentil grain yield were fitted. Results are very similar. This is not surprising since the simple correlation coefficient between lentil grain yield and vine yield is 0.82. Model 3 of Table 5 which includes linear terms for fertilizer and seeding rate was selected to estimate lentil hay yield response for economic analysis.

Table 6 includes four enterprise budgets prepared to compare the relative economics of hand seeding versus mechanical seeding and fertilization versus no fertilization. A fertilizer rate of 9.6 kg/dunum which was the average amount applied on those farms which used fertilizer was included on two of the budgets and no fertilizer was included on the other two. Two of the budgets reflect the costs and returns from mechanical seeding and two from hand seeding.

Estimated costs as reflected in the budgets are similar across the systems. The budgeted costs of the fertilizer was 1.34 JD/dunum. Seeding with a grain drill was budgeted to cost 0.50 JD/dunum more than hand seeding.

Estimated revenues are substantially different. Based upon the estimated response functions, fertilizer is expected to increase lentil yield by 73 percent and vine yield by 56 percent. The marginal value of the fertilizer which is in excess of 20 JD/dunum greatly exceeds its marginal cost of 1.34 JD/dunum.

Summary and Conclusions

The government of Jordan has expressed a goal of increasing the productivity of wheat and lentils in the rain-fed region of the country. Several policies have been suggested to provide incentives for farmers to adopt and implement alternative production systems. Recommended policy prescriptions include subsidization of the price of fertilizer and subsidization of certain farm machinery including combines and grain drills.

The overall objective of the research reported in this paper was to determine if several of the recommended practices for producing wheat and lentils in the rain-fed region of Jordan are economically viable alternatives to traditional practices. A specific objective was to determine if a wheat production system which includes combine harvesting is more economical than the traditional system based upon a stationary thresher. A second objective was to determine if mechanical seeding of lentils with a grain drill is more economical than the traditional method of hand seeding. A third objective was to determine the economically optimal rate of fertilization for wheat and lentils. The fourth objective was to determine which of the four alternative production systems for wheat and lentils can be expected to generate the most income for farmers in the region. A final objective was to determine if subsidization of fertilizer or machinery would be an appropriate policy for the government to implement to provide incentives for farmers to increase the production of wheat and lentils in the region.

Primary data were obtained from a sample of 63 Jordanian farmers. Maximum likelihood estimation was used to derive parameter estimates of wheat grain yield, lentil grain yield, and lentil vine yield response functions. Estimated response function parameters were used to estimate expected yields and fertilizer requirements for enterprise budgets. The budgets were used to compare the economics of the evaluated alternatives.

1. The wheat production system which includes combine harvesting was found to be less economical that the traditional stationary thresher system. In the region of the study, more than a third of the value of the wheat crop is in the harvested straw. Much of this value was lost on those farms on which a combine was used. The data suggest that programs to promote combine

harvesting technology should also include provisions for straw collection. The combine in the absence of some means of collecting the straw is not economically efficient. An additional finding was that grain losses in the field were greater with the combine system. Based upon the survey, the farmers paid a standard rate per dunum to the custom combine operators. A payment structure which provides an economic incentive to the combine operators to reduce field losses may be appropriate.

2. The use of a mechanical seeder did not significantly change lentil yield. However, the seeding rate was found to be lower on those farms which used a grain drill. The lower seeding rate resulted in lower yields. One conclusion that can be drawn is that mechanical seeders should be calibrated to achieve seeding rates consistent with those obtained with the traditional hand seeding method.

3. The economically optimal quantity of fertilizer for wheat is relatively insensitive to the prices of both fertilizer and wheat. Farmers who responded that they used fertilizer on wheat are applied an appropriate rate. Hence, for those farmers who currently fertilize, subsidizing the price of fertilizer is not likely to result in a substantial increase in the use of fertilizer or production of wheat. An appropriate policy instrument would be one that induced those 33 percent of the wheat farmers and 38 percent of the lentil producers who do not currently apply fertilizer to do so.

4. Net returns from the traditional stationary thresher wheat production system with 10.42 kg/dunum of fertilizer were estimated to be 36 JD/dunum. The

fields hand seeded to lentils with 9.6 kg/dunum of fertilizer were estimated to generate net returns of 31 JD/dunum. These estimated net returns for the most economical wheat production and the most economical lentil production systems are nearly equivalent. This suggest that farmers in the region have opportunities to diversify by producing a combination of the two crops.

5. Subsidizing the price of fertilizer is not likely to result in a substantial increase in the use of fertilizer or production of wheat. An appropriate policy instrument would be one that induced those 33 percent of the wheat farmers and 50 percent of the lentil producers who do not currently apply fertilizer to begin doing so.

A major limitation of the study is that the data used in the analysis were based upon a single survey. Observations over several years would provide additional information regarding the riskiness of the two crops. However, surveys such as the one conducted for this analysis, reinforce the importance of a good understanding of the traditional production system and how in the case of wheat and lentils the straw and vines are economically important products. Hence, a comprehensive economic evaluation of alternative production systems must include provisions for valuing the straw and vines as well as for the primary products, wheat grain and lentils.

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TABLE 1

Statistical Estimates of Wheat Response Functions

for the Rain-fed Region of Jordan.[1]

Variable	Model 1	Model 2	Model 3
Intercept	86.1[2] (14.4)*	94.01 (8.89)*	85.99 (6.24)*
Low rainfall eco-climatical zone	19.9 (1.13)	22.6 (1.26)	7.6 (0.48)
Medium rainfall eco-climatical zone	-16.13 (-1.4)	-16.29 (-1.5)	-10.5 (-.92)
Fertilizer applied (kg/dunum)[3]	16.3 (4.99)*	16.3 (5.2)*	16.5 (5.25)*
Fertilizer applied Squared	-0.77 (-2.9)*	-0.76 (-3.1)*	-0.73 (-2.98)*
Combine harvester[4]	-10.0 (-0.87)	-10.8 (-1.00)	-21.5 (-1.96)*
Land seeded to wheat	0.817 (1.64)*	0.79 (3.1)*	
Land seeded to wheat squared	-0.0024 (-1.93)*	-0.002 (-3.1)*	
Average size of wheat field	0.61 (0.54)		1.78 (2.5)*
Average size of wheat field square	-0.008 (-1.05)		-0.014 (-2.124)*
R^2	0.43	0.43	0.41

[1] The dependent variable is wheat grain yield in kilograms per dunum.

[2] The values in parentheses are t-values. One asterisk denotes significance at the 5 percent level.

[3] The fertilizer source was ammonium sulfate. All farmers in the survey who reported the use of fertilizer indicated that they applied ammonium sulfate.

[4] A dummy variable with a value of one for those farms on which a combine was used and zero otherwise.

TABLE 2

Economically Optimal Levels of Fertilizer for Alternative Wheat and Fertilizer Prices for the Rain-fed Region of Jordan.[1]

Wheat price	Fertilizer price (JD/kg)				
(JD/kg)	0.070	0.105	0.140	0.175	0.210
0.0750	10.1	9.8	9.5	9.2	8.9
0.1125	10.3	10.1	9.9	9.7	9.5
0.1500	10.4	10.3	10.1	9.9	9.8
0.1875	10.5	10.3	10.2	10.1	10.0
0.2250	10.5	10.4	10.3	10.3	10.1

[1] The fertilizer is in terms of kg/dunum of ammonium sulfate.

TABLE 3

Estimated Costs and Returns from the Traditional Wheat Production System and from an Alternative System for the Rain-Fed Region of Jordan.[1]

Item	Unit	Price	Traditional System Quantity	Traditional System Value	Alternative System Quantity	Alternative System Value
Costs						
Land preparation	dunum	0.97	1.86	1.80	1.86	1.80
Seeds	kg	0.14	11.84	1.66	11.84	1.66
Fertilizer	kg	0.14	10.42	1.46	10.42	1.46
Combine rental	dunum	1.64			1	1.64
Harvest labor	dunum	6.50	1	6.50		
Thresher rental	dunum	1.85	1	1.85		
Grain sacks	number	0.60	2	1.20	1.90	1.14
Straw sacks	number	0.60	2	1.20		
TOTAL	JD			15.67		7.70
Revenue						
Grain	kg	0.15	222	33.3	210	31.65
Straw	kg	0.11	164	18.04		
Grazing	dunum	2.30			1	2.30
TOTAL	JD			51.7		33.95
Returns to family labor, land, overhead, management, and risk	JD			36.03		226.25

[1] For the traditional system the wheat is cut and shocked into bundles. After drying, the bundles are collected and transported to a stationary thresher where the grain is threshed. The wheat straw is bagged for use on the farm or for sale as feed for sheep and goats. For the alternative system the wheat grain is harvested with a combine, the straw left in the field for grazing.

TABLE 4

Statistical Estimates of Lentil Yield Response Functions

for the Rain-fed Region of Jordan.[1]

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	-35.09 (1.14)	14.31 (0.51)	-20.7 (-0.67)	15.09 (0.54)
Low rainfall eco-climatical zone	40.3 (1.7)[2]	44.46 (1.79)*	37.04 (1.59)*	44.21 (1.78)*
Medium rainfall eco-climatical zone	0.045 (0.005)	7.43 (0.78)	-0.87 (-0.09)	7.37 (0.77)
Fertilizer kg/dunum[3]	5.69 (5.15)*	5.6 (5.19)*	6.02 (5.87)*	5.6 (5.63)*
Land area seeded to lentils (dunum)	0.769 (2.81)*		0.68 (2.53)*	
Seeding rate[4]	7.29 (3.01)*	4.35 (1.89)*	6.22 (2.59)*	4.29 (1.87)*
Mechanical seeder[5]	14.58 (0.72)	0.96 (0.049)		
R^2	0.48	0.58	0.5	0.58

[1] The dependent variable is lentil yield in kilograms per dunum.

[2] The values in parentheses are t-values. One asterisk denotes significance at the 5% level.

[3] The fertilizer source was ammonium sulfate. All farmers in the survey who reported the use of fertilizer indicated that they applied ammonium sulfate.

[4] A continuous variable (kg/dunum) of seeds sown.

[5] A dummy variable with a value of one for those farms on which a grain drill was used and zero otherwise.

TABLE 5

Statistical Estimates of Lentil Vine Yield Response Functions

for the Rain-fed Region of Jordan.[1]

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	-8.88 (-.35)[2]	21.2 (0.86)	-1.28 (-.05)	21.5 (0.87)
Low rainfall eco-climatical zone	25.322 (1.36)	26.21 (1.36)	23.17 (1.26)	26.07 (1.35)
Medium rainfall eco-climatical zone	-12.88 (-1.5)	-6.68 (-.81)	-12.9 (-1.59)	-6.69 (-0.82)
Fertilizer[3] (kg/dunum)	4.45 (4.9)*	4.7 (5.24)*	4.66 (5.65)*	4.73 (5.7)*
Land seeded to lentils (dunum)	0.69 (3.1)*		0.18 (2.86)*	
Seeding rate[4]	6.0 (2.9)*	4.55 (2.24)*	5.43 (2.7)*	4.51 (2.23)*
Mechanical Seeder[5]	7.9 (0.52)	0.47 (0.03)		
R^2	0.53	0.59	0.54	0.59

[1] The dependent variable is lentil vine yield in kilograms per dunum.

[2] The values in parentheses are t-values. One asterisk denotes significance at the 5% level.

[3] The fertilizer source was ammonium sulfate. All farmers in the survey who reported the use of fertilizer indicated that they applied ammonium sulfate.

[4] A continuous variable (kg/dunum) of seeds sown.

[5] A dummy variable with a value of one for those farms on which a grain drill was used and zero otherwise.

TABLE 6

Expected Costs and Returns for Four Alternative Lentil Production Systems for the Rain-Fed Region of Jordan.[1]

			Fertilization				No Fertilization			
			Hand Seeding		Drill Seeding		Hand Seeding		Drill Seeding	
Item	Unit	Price	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Costs										
Land preparation	dunum	0.85	1.69	1.44	1.69	1.44	1.69	1.44	1.69	1.44
Seeds	kg	0.25	11.58	2.90	11.58	2.90	11.58	2.90	11.58	2.90
Fertilizer	kg	0.14	9.60	1.34	9.60	1.34				
Seeding labor	dunum	0.35	1	0.35			1	0.35		
Drill rental	dunum	0.85			1	0.85			1	0.85
Harvest labor	dunum	8.50	1	8.50	1	8.50	1	8.50	1	8.50
Thresher rental	dunum	2.30	1	2.30	1	2.30	1	2.30	1	2.30
Grain sacks	number	0.60	1	0.60	1	0.60	1	0.60	1	0.60
Vine sacks	number	0.60	2	1.20	2	1.20	2	1.20	2	1.20
TOTAL	JD			18.63		19.13		17.28		17.78
Revenue										
Grain	kg	0.25	137.5	34.38	137.5	34.38	79.7	19.9	79.7	19.9
Vines	kg	0.13	125.2	16.33	125.2	16.33	80.5	10.47	80.5	10.47
TOTAL	JD			50.71		50.71		30.37		30.37
Returns to family labor, land, overhead, management, and risk	JD			31.08		31.08		12.09		12.59

[1] The alternatives considered include hand seeding versus mechanical seeding with a grain drill and fertilization with ammonium sulfate versus no fertilization. A fertilizer rate of 9.6 kg/dunum which was the average amount applied on those farmers which used fertilizer is included on two of the budgets and no fertilizer is included on the other two.

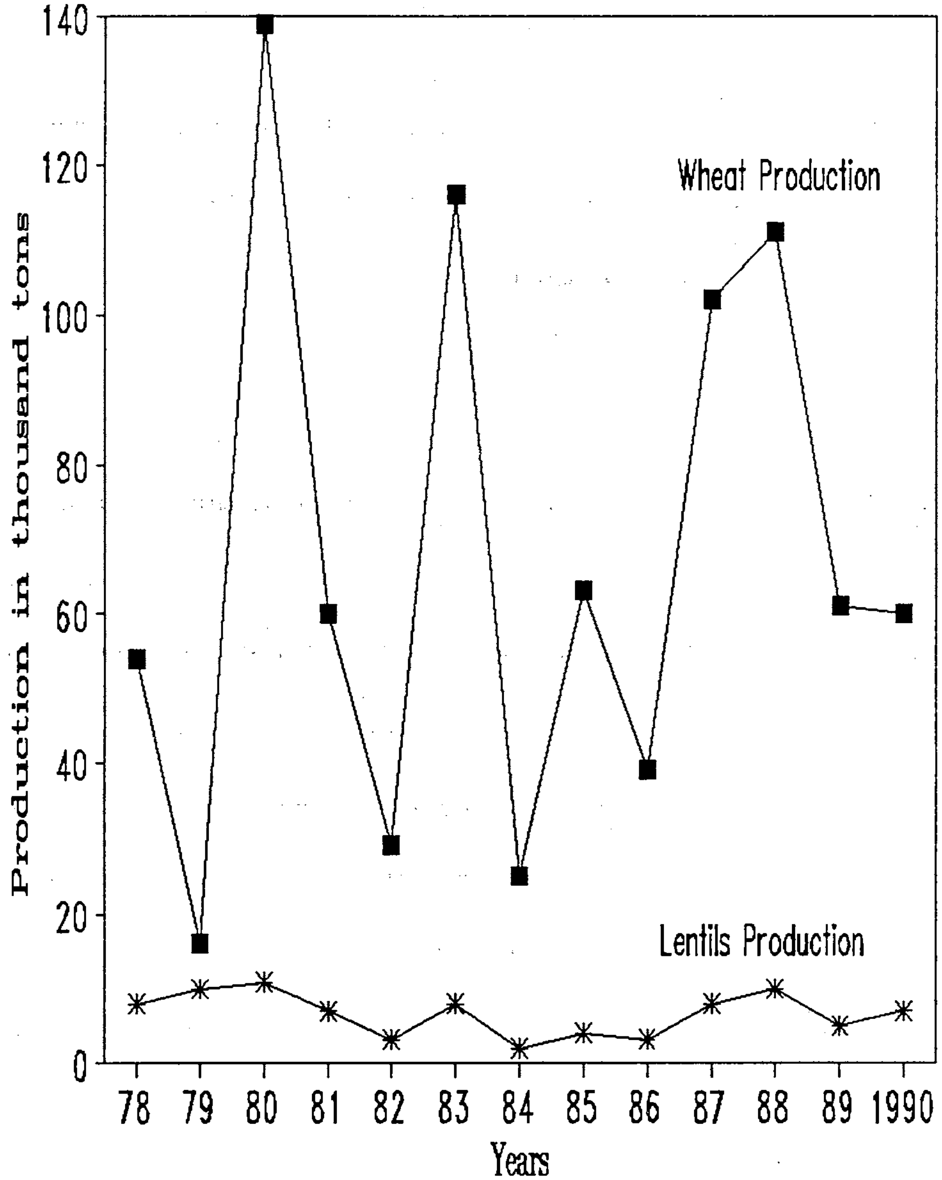

Figure 1. Production of Wheat and Lentils During the Period 1978-1990.

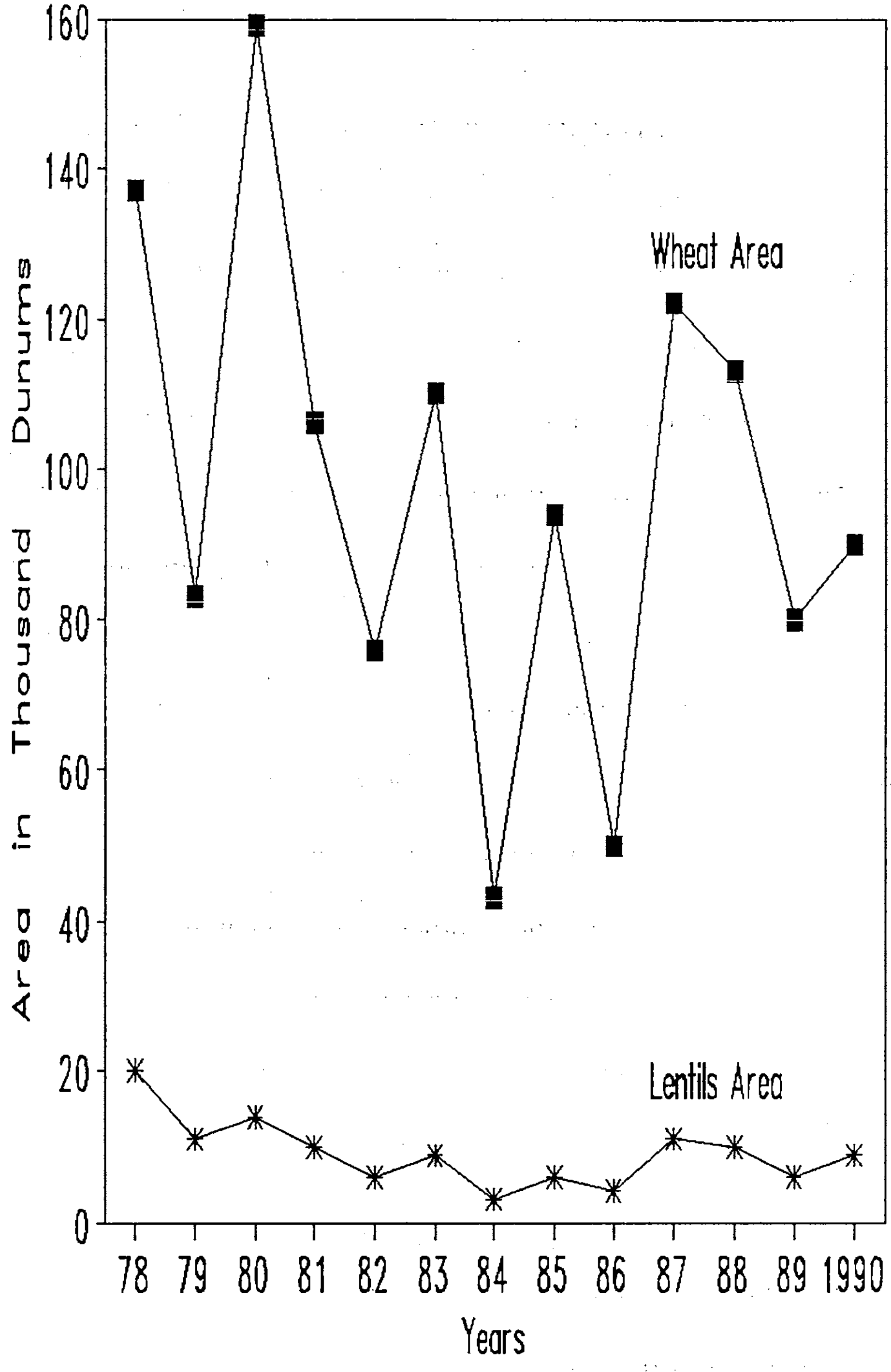

Figure 2. Area Seeded to Wheat and Lentils During the Period 1978-1990.

CHAPTER V

THE IMPACT OF THE GOVERNMENT POLICIES ON WHEAT AND LENTILS PRODUCTION IN THE NORTHERN JORDAN

INTRODUCTION

Effects of government policies on the agricultural sectors of developing countries have been the main focus of many research studies (Nelson and Panggabean; Panggabean; Rop et al; Tweeten et al). As part of the process of re-evaluating lending conditions and existing debt, the World Bank and the International Monetary Fund (IMF) have funded agricultural policy research in many developing countries. Other international donors have also supported policy analysis.

The United States Agency for International Development (USAID) sponsored several research studies for developing countries under the Agricultural Policy Analysis Project (APAP) (Rop et al; Tweeten et al). USAID funded a policy analysis study under APAP in 1988 to evaluate the production and marketing of fresh fruits and vegetables in Jordan (Tweeten et al).

Northern Jordan is characterized with limited natural agricultural resources. Efficient allocation of scarce resources by Jordanian producers in the rain-fed region is an important issue for both producers and the government. Efficient production is achieved when an economy's resources are allocated to those activities that generate the highest value to society.

Little work has been done on agricultural policy analysis in Jordan (Khalifa et al.; El-Habbab et al.; Tweeten et al.; Shepley). The majority of field crop studies have focused on wheat. Other field crops including barley, lentils, and chickpeas have not garnered as much attention from policy analysts. Wheat is the prominent traded stable food item and consequently, the prime concern of government food policy analysts.

The production of field crops in Jordan is affected by several direct and indirect government policies. Direct policies include subsidization of producer prices, monopolization of the importation of certain commodities, and subsidization of credit to farmers. Indirect policies that affect production of crops include exchange rate and trade policies. Since the majority of inputs used in agricultural production are imported, exchange rates which are announced daily by the central bank of Jordan play an important role in determining the domestic prices of inputs such as fertilizers, seeds, agricultural chemicals, and farm machinery. Trade policies that include collecting duties on imports also play a role in determining the domestic prices of these inputs.

The stated purpose of the policies in place to subsidize producers prices and credit is to provide incentives for farmers to increase the output of major field crops. It is not clear if the policies have been successful. Output has been variable over the last decade and when averaged over time, has not increased. However in the absence of the government policies, production may have declined.

The overall objective of the research reported in this chapter is to determine the impact of existing government policies including subsidization of prices and credit, and exchange rate policies, on the efficiency of producing wheat and lentils in the region. A specific objective is to determine the most efficient wheat production system in terms of social profits from among a group of twelve systems currently used by wheat producers in the region. A second objective is to determine the most efficient lentil production system from among six systems currently used in the region. A third objective is to determine the impact of subsidizing producers prices on the alternative production systems in terms of profitability and efficiency coefficients. A final objective is to determine the overall effect of exchange rates and producer price policy on the efficiency of producing the two crops under the different production systems.

Data

Primary and secondary data are used in the analysis are reported in this chapter. Primary data were obtained from personal interviews with 63 producers in the region. Social chiefs and other influential people in each village were contacted to arrange for appointments with the farmers in each village. A questionnaire was used during the interviews to ensure that questions were consistent across all farmers in the sample. The survey was used to elicit quantitative information (prices, yields, input use) and qualitative information. For example, the farmers were asked open ended questions regarding which crop they preferred to produce and why they preferred it. They were also asked about traditional production problems, opinions regarding extension services, and different farming systems.

Secondary data including annual prices of outputs and inputs, exchange rates, interest rates, and tariffs were obtained from official statistics published by the Ministry of Agriculture, Department of Statistics, Ministry of Planning, Central Bank of Jordan, and Ministry of Supply.

Enterprise budgets were constructed for each production system in the region. Two kinds of budgets were estimated, private and social budgets. Private budgets were prepared with prevailing market prices. Social budgets were constructed with adjusted prices (efficiency prices). Efficiency prices for inputs were estimated by deducting the six percent tax that government charges on imports. Efficiency prices for outputs (import parity prices) were computed by adjusting border prices for transport and marketing adjusted by the exchange rate. Table 1 includes the steps used to calculate the import parity prices for wheat during 1988-1991 as illustrated by Naylor and Gotsch (1989).

Empirical Model

Enterprise budgets obtained from the primary data were used to build several accounting matrixes. In these matrices, all measures are given in monetary units per physical unit of the commodities. The accounting matrix is called a Policy Analysis Matrix (PAM). A PAM is designed to assist in understanding interactions of the many policies that influence agricultural incentives and helps illuminate the tradeoffs (if any) between objectives (Monke and Pearson). As an empirical framework, the PAM provides measures of economic efficiency and of the transfer effects of policy on particular commodities, technologies and regions (Rop et al.).

The PAM was developed by Monke and Pearson. The basis of the PAM is a set of profit and loss identities. Three strengths of the PAM method have been noted by

Nelson and Panggabean. One is that it allows varying levels of disaggregation. The second noted strength is that it makes the analysis of policy-induced transfers straightforward. The third noted strength is that it makes it possible to identify the net effect of a set of complex and contradictory policies and to sort out the individual effects of those policies.

Model Specifications

The concept of economic profits is the fundamental part of the PAM analysis. Profit is defined as the difference between the value of outputs (revenues) and the costs of all inputs (costs).

The PAM model is depicted in Table 2. Private profits are defined in the first row as D=A-B-C. The letter A is used to define the private revenues (the revenues at the prevailing market price). Costs are divided into two components. Costs of tradable inputs (inputs which are traded in the world markets) such as fertilizers, pesticides, and seeds are included in the second column. The value of tradable inputs at the prevailing market prices (private prices) are recorded in first row and denoted by the letter B.

Tradable inputs can be imported from or exported to other countries. The third column of the matrix includes domestic factors. Costs in private prices are denoted by the letter C. Domestic factors include land, labor, and capital. Domestic factors are also called non-tradable inputs because there is no international markets for these inputs.

Column four in the matrix is labeled profits. Private profits, denoted as D in the matrix, are included in the first row of the column. Values in the fourth column are calculated by subtracting values in column two and three from the revenues in the first column. A positive difference at prevailing market prices, means an excess profit exists which encourages other firms to enter the business. Positive profits also work as a stimulus for existing firms with positive profits to increase output to earn more profits. When more firms enter the market and existing firms expand, those two actions will induce economic growth. If the market prices of inputs or outputs are distorted by either taxes or subsidies, then private profits could be a deceptive indicator.

The second row of the PAM is used to calculate social profits, E-F-G=H. Social profits or ("without policy" profits) are those profits without divergences. In Table 2, the E portrays the revenues valued at efficiency prices (social prices) and F and G indicate the efficiency values of tradable inputs and domestic factors, respectively. Positive social profits H provide an incentive for expansion of these activities, and result in apparent economic growth in the national income.

Rop et al. used a PAM approach to study agricultural growth in Kenya. They stated that "...The rationale for calculation of the individual revenue and cost elements of the second row (of the PAM)--E, F, and G--borrows heavily from the logical foundations of cost-benefit analysis and international trade theory. For example, the Little-Mirrlees method of project evaluation argues that efficiency prices for tradable outputs (E) and tradable commodity inputs (F) are given by world prices, because these prices would prevail in the economy if there were no domestic government policies. A similar conclusion comes from international trade theory--setting domestic prices equal to world prices allows the economy to exhaust potential gains from trade and realize maximum national income. The desirability of equal domestic and world prices no longer holds when the country is large enough to affect world prices, but maximum income is still associated with a particular set of world prices..." (Rop et al., p. 5).

The third row of the matrix shows the divergences or differences between the first row (private valuation) and second row (social valuation). If market failure does not exist in the product market, all divergences between private and social prices of tradable output and inputs are caused by distorting policies.

Policies which may cause divergences include subsidies, taxes and quantitative controls applied to domestic production or trade of the commodity. Price policies may also cause distortions.

In the third row, if the value of I is positive then private revenues exceed social revenues. This indicates that the government is subsidizing output prices. That is, the government is purchasing production in prices greater than international market prices. The value of the difference is a transfer from society (tax payers) to producers of that commodity.

If I is negative, the value of the social revenues is greater than the value of private revenues. This means that the government is taxing producers. In other words, the government is purchasing production in prices lower than those prevailing in international markets. The tax in this case is a transfer from producers to society (or to the government).

The letter J represents the differences between the private costs and social costs of tradable inputs. If J is negative, the private costs of tradable inputs is lower than the social costs. This means that the government is subsidizing one or more inputs such as fertilizer such that the prices of these inputs are lower than those in the international markets.

If J is positive, the private cost of inputs are greater than the social costs. This indicates that the government is taxing inputs used by farmers. The net effect is that prices paid by farmers in the region are greater than world market prices.

The letter K portrays the divergences in domestic factors. The government can affect the prices of domestic factors such as capital or land. It is not uncommon for governments of developing countries to provide subsidized credit to producers as incentives to use more capital intensive inputs such as machinery and fertilizer. In which case, the private cost of a domestic factor may be less than the social costs and K will have a negative value. But, if the government taxes domestic factors, which rarely happens in developing countries, the difference will be positive.

Taxes, subsidies, and quantity control (quotas) are commodity-specific policies. They directly affect the prices of the output or inputs. Governments may use policies which do not directly affect the analyzed commodity such as the manipulation of the exchange rate of the country's currency. Since PAM accounting is done in domestic currency and world prices are reported in international currencies, conversions are required to adjust international prices into the domestic equivalents.

The effect of exchange rate manipulation differs depending upon whether the policy results in over or undervaluation. An overvalued exchange rate occurs if there is an excess demand for foreign currencies which result in extra foreign borrowing, excessive drawing down of exchange reserves, or rationing of foreign exchange among domestic users. An undervalued exchange rate reflects an excess supply of foreign exchange that is accumulating as excessive reserves and reducing potential income (Monke and Pearson).

If the exchange rate is overvalued then it serves as an implicit tax on producers of tradable products. Overvaluation reduces the competitiveness of the local producers in international markets because they are practically taxed in both output prices and input prices.

Undervaluation of the exchange rate has the opposite consequence relative to overvaluation. Prices of tradables (output and inputs) are effectively subsidized which improves the competitiveness of the local producers in international markets. Evaluation of the consequences of an adjustment of the exchange rate is facilitated in a PAM by converting world prices into domestic prices at the social exchange rate rather than at the official rate.

The letter L denotes the net transfer of all policies affecting the studied commodity system, L=I-J-K. If the overall effect of all policies affecting input and output prices, and the exchange rate, is in favor of the producer (in the short run), L will have a positive value. Alternatively, L will have a negative value, if the policies work to the detriment of the producer.

To compare profitability and efficiency of different crops, a common numeraire must be used throughout the analysis. Ratios are an expedient approach for avoiding the problem of a common numeraire, particularly when the production process and outputs are dissimilar. Ratios are estimated from values of the PAM. Ratios can be used to rank alternatives according to different policy objectives. The ratios calculated in a standard PAM include the: 1) the Nominal Protection Coefficient (NPC), 2) the Effective Protection Coefficient (EPC), and 3) the Domestic Resource Cost coefficient (DRC).

The NPC is estimated by dividing the revenue in private prices (A) by the revenue in social prices (E). If this ratio is less than one it shows the presence of taxes on outputs. If the NPC is greater than one it indicates the presence of subsidies. When the NPC is equal to or close to one (in the absence of market failure) it reveals the absence of government intervention in the output markets which is a property desired by international donor agencies such as the World Bank and USAID.

The EPC is defined as the ratio of value added in private prices (A-B) to value added in social prices (E-F). It is another measure of incentives to farmers (Naylor and Gotsch). This coefficient indicates the combined effects of policies in the tradable commodities markets (inputs and outputs). The EPC is a useful measure because input and output policies, such as commodity price supports and fertilizer subsidies, are often part of a comprehensive policy package. An EPC less than one indicates negative incentive effects of policy (a tax on farmers) whereas, an EPC greater than one indicates positive incentive effects of policy (a subsidy) (Naylor and Gotsch).

The DRC is a measure of the efficiency, or comparative advantage of crop production. It is calculated by dividing the factor costs G by the value added in social prices E-F (Naylor and Gotsch). A DRC value greater than one indicates that the value of domestic resources used to produce the commodity is greater than the contribution of its value added at social prices. A DRC value less than one indicates that the country has a comparative advantage in producing that commodity.

Selection of the Commodity Systems

Wheat and lentils are traditional products in Northern Jordan. These crops are produced in the rain-fed areas which receives an annual rainfall between 250-450 mm (10-17.5 inches). Farmers in the region use a variety of practices. Production systems for wheat reported in this research are categorized based on: 1) two categories for the area seeded to wheat on the farm, large and small (differentiated at the mean); 2) the average field size of the land seeded to wheat on the farm (differentiated at the mean); 3) the use or nonuse of fertilization; and 4) the use or nonuse of a combine harvester. Based on the previous criteria, 16 production systems for wheat were identified (two farm size categories by two average field size categories by two fertilizer use categories by two harvest methods). Four systems were excluded because no farms in the sample met the criteria. The systems are described in Table 3.

Production systems for lentils are also categorized based on: 1) two categories for area seeded to lentils on the farm, large and small separated at the mean of the seeded area; 2) the use of commercial fertilizer; and 3) the use of seed drill verses hand seeding. Based on these criteria, eight systems for producing lentils in the region were identified (two farm size categories by two fertilizer categories by two seeding methods). Two systems were excluded from the analysis because none of the farms in the sample met the criteria. The systems are described in Table 4.

Results

Enterprise budgets were calculated for each alternative system to compute values for the PAMs. Table 5 includes detailed private and social enterprise budgets for wheat production System 1. The values necessary for the PAM cells for wheat production System 1 as described in Table 2 are identified in Table 5.

Computation of social and private profitability provide information which can be used to illustrate the impact of existing policies on production incentives. Tables 6 and 7 contain the 12 PAMs estimated for the alternative wheat production systems. The tables include private and social profitability of each production system. Costs, returns and profits are given in per dunum terms. All inputs are valued at market prices in the calculation of private costs. Land is valued at zero such that profits are the returns to land, risk, overhead, and management.

The PAMs indicate that wheat production in the region generates a positive return to fixed resources with both private and social prices. The greatest returns are achieved with System 2. Data for System 2 was gathered from five large farms (defined as farms on which the land seeded to wheat is greater than the mean (56 dunums) of farms in the sample), with large fields (defined as those on which the average field size is greater than the mean (32 dunums) for farms in the sample), that used fertilizer, and harvested the wheat with a traditional stationary thresher rather than with a combine.

The lowest returns resulted from System 15. Data for System 15 was gathered from three small farms, with small fields, that did not use fertilizer, but did harvest with a combine.

The wheat PAMs indicate that returns under both social and private prices are greater for those systems which use traditional harvest methods rather than a combine. The combine systems as used on the farms in the sample are not economically competitive with the traditional system. Several factors contribute to this conclusion.

In the region of the study, more than a third of the value of the wheat crop is in the harvested straw. Much of this value was lost on those farms on which a combine was used. The combine in the absence of some means of collecting the straw is not economically efficient.

Columns I and J in Table 6 indicate little divergence between private and social returns. In other words, the local market prices are relatively close to world prices for both inputs and outputs. This is also reflected in the value of the NPCs reported in Table 7 which range from 0.975 to 0.987. These values indicate that wheat producers received a price below the social price (the price that the farmers would receive in the absence of government policy) by 2.5 to 1.3 percent. The NPC values indicate that government intervention in wheat prices was minor. This situation is highly affected by the exchange rates which prevailed during the period for which the social price of the commodity was calculated (Table 1).

During the period prior to 1990, NPC values were greater than 1.00 indicating that the prices paid by the government were higher than the social prices. However, the increase in the nominal support price from 132 JD/MT in 1988 to 147 JD/MT in 1990 was insufficient to offset the devaluation of the currency from 0.37 JD/$ in 1988 to 0.67 JD/$ in 1990. The net result for wheat producers is reflected in the decline in the NPC from 1.92 in 1988 to 0.98 in 1990. In other words the government's monetary policy reduced the real returns to wheat producers. It also reduced the government's level of interference in the wheat market such that local prices diverge little from international market prices.

One market distortion is reflected in column J of Table 6. The positive difference indicates that producers are paying additional costs of six percent for tradable inputs as a result of the policy of charging a six percent import fee.

The negative sign of the policy impact on factor costs results from the interest rate subsidy provided to farmers. Public credit agencies such as Agricultural Credit Corporation (ACC) and Jordan Cooperative Organization (JCO) provide farmers with low interest loans. These agencies charge producers six percent interest while commercial banks charge an average interest of 12 percent.

The overall net impact of government policies was negative for nine systems and positive for three systems. This positive sign indicates that on balance wheat producers who used these three systems benefitted from the various government policies. The negative sign indicates that producers who used the nine systems were negatively impacted by government policies. Both the negative and positive values are small in comparison to total revenues indicating that the overall net impact of different government policies is minor.

The EPC, which is the ratio of value added in private prices to value added in social prices, was estimated for each of the 12 wheat production systems. The EPCs reported in Table 7, are less than one (0.97-0.98) for all 12 systems. This coefficient indicates the combined effects of policies in the tradable commodities markets (inputs and outputs). An EPC less than one reflects a negative incentive of policy (a tax on farmers). In this case the effective tax on wheat producers ranges between 2 and 3 percent.

The DRC which evaluates the efficiency, or comparative advantage of crop production was also estimated. All DRCs reported in Table 7 are less than one. A DRC value less than one reveals that the value of domestic resources used to produce the commodity is less than the contribution of its value added at social prices. In other words the country has a comparative advantage in producing wheat.

The same type of analysis conducted for wheat was also conducted for lentils. Tables 8 and 9 include results. The NPC of output ranged from 0.782-0.833 indicating that the private prices observed by the farmers are 16.7 to 21.8 percent lower than the social prices which would be observed without government intervention. The government is paying more (JD 365) for imported lentils than for those produced locally (JD 250).

The EPCs ranged from 0.759 to 0.81 for all production systems. The EPC value which is lower than one reflects that net effect of government policy is taxing lentil producers.

DRC coefficients were also found to be less than one. A DRC value less than one means that the production system is efficient and the resources are allocated efficiently. The coefficient ranged between 0.24 to 0.546. The lower the value of the coefficient the more efficient is the production system. By this criteria farms in System 4 are the most efficient. This category includes large farms that use fertilizer and hand seeding.

Based upon the PAM analysis, System 1 is the least efficient lentil production system. This category includes small farms that do not use fertilizer but do use a grain drill.

Conclusions

Production of field crops in Jordan is affected by certain direct policies such as subsidizing producers' prices, monopolizing importation of certain commodities, and providing agricultural credit at subsidized prices. It is also affected by indirect policies such as exchange rate and trade policies. The direct policies are aimed at providing incentives to producers in the region.

The overall objective of the research reported in this chapter was to determine the impact of existing government policies including subsidization of prices and credit, and exchange rate policies, on the efficiency of producing wheat and lentils in the region. A specific objective was to determine the most efficient wheat production system in terms of social profits from among a group of twelve systems currently used by wheat producers in the region. A second objective was to determine the most efficient lentil production system from among six systems currently used in the region. A third objective was to determine the impact of subsidizing producer prices on the alternative production systems in terms of profitability and efficiency coefficients. A final objective was to determine the overall effect of exchange rates and producer price policy on the efficiency of producing the two crops under the different production systems.

Primary data collected by a survey of farmers were used to build enterprise budgets for each wheat and lentil production system. These budgets were used to build a PAM for each identified system.

1. The most efficient wheat production was achieved on large farms, with large fields, that applied fertilizer, and used a traditional stationary thresher rather than a combine. This finding is consistent with the results reported in Chapter 3 in which the average variable cost was found to be a decreasing function of land area seeded to wheat and the average field size. The finding also is consistent with the finding in Chapter 4 in which the most economical wheat production system was the one which included use of fertilizer and a traditional stationary thresher.

2. The most efficient system for producing lentils in the region occurred on large farms which used fertilizer and seeded by hand. This finding is consistent with the results reported in Chapter 4 in which the yield of lentils yield was significantly dependent on the use of fertilizer.

3. Devaluation of the currency from 0.37 JD/$ in 1988 to 0.67 JD/$ in 1990 effectively reduced the real price of wheat for producers in the region. The net result for wheat producers is reflected in the decline in the NPC from 1.92 in 1988 to 0.98 in 1990. The change in the exchange rate reduced the real returns to wheat producers. It also reduced the government's level of interference in the wheat market such that local prices diverge little from international market prices. In 1988, the World Bank and the International Monetary Fund agreed to refinance Jordan's debts, if the Jordanian government agreed to follow what an economic correction plan which resulted in a devaluation of the domestic currency.

4. The overall net impact of government policies was found to be small for wheat producers and somewhat greater for lentil producers.

One limitation of the PAM analysis reported in this chapter is that the entire marketing channel, which includes production, processing, and retailing, is not evaluated. A more comprehensive evaluation requires detailed data on processing and retailing which was not available to the author.

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Table 1. Estimation of Import Parity Prices for Wheat (1986-1991).

Price Component	1986	1987	1988	1989	1990	1991
US Gulf F.O.B. US$/MT	122.40	99.40	120.70	161.20	161.20	161.20
C.I.F. Aqaba Gulf 30% more	6.72	29.82	36.21	48.36	48.36	48.36
Total C.I.F. Aqaba US$/MT	159.12	129.22	156.91	209.56	209.56	209.56
Exchange Rate JD=US$	0.35	0.34	0.37	0.51	0.67	0.68
C.I.F. Aqaba in JD/MT	55.53	43.68	58.68	106.88	140.41	142.50
Domestic Transport JD/MT	5.00	5.00	9.00	9.00	9.00	9.00
Social Wheat Price in MOS Silos (JD/MT)	60.53	48.68	67.68	115.88	149.41	151.50
Domestic Price Paid by MOS[a] to producers (JD/MT)	120.0	120.0	132.0	142.0	147.0	150.0
NPC[b]	1.98	2.47	1.92	1.23	0.98	0.90

[a]MOS = Ministry of Supply
[b]NPC = Nominal Protection Coefficent, based on import prices

Table 2. The Basic Framework of a Policy Analysis Matrix.

	Values			
	Revenues	Cost of tradable inputs	Cost of domestic inputs	Net profit
Private prices	A[a]	B	C	D
Social prices	E	F	G	H
Policy effects	I	J	K	L

[a] The symbols (capital letters) are defined as follows:

A	Total revenues in private prices (market prevailing prices-also referred to as financial prices).
B	Cost of tradable inputs (such as fertilizers, seeds, and fuel) in private prices.
C	Cost of domestic inputs (such as labor, land, and capital) in private prices.
D	Private profit, D=A-B-C.
E	Total revenues in social prices (prices which are adjusted to reflect government intervention).
F	Costs of tradable inputs in social prices.
G	Costs of domestic factors in social prices.
H	Social profit, H=E-F-G.
I	Output transfers, I=A-E.
J	Input transfers, J=B-F.
K	Factor transfers, K=C-G.
L	Net transfers, L=D-H.

Source: (Monke and Person)

Table 3. Characteristics of the Wheat Production Systems, (1992).

	Criteria of categorization				
System Number	Farm Size	Average Field Size	Fertilization	Combine	Number of Farms in Sample
System 1	large[a]	large[b]	yes[c]	yes[d]	4
System 2	large	large	yes	no	5
System 3	large	large	no	yes	3
System 4	large	large	no	no	1
System 5	large	small	no	no	2
System 6	large	small	yes	yes	0
System 7	large	small	yes	no	0
System 8	large	small	no	yes	0
System 9	small	large	yes	yes	4
System 10	small	large	yes	no	1
System 11	small	large	no	no	2
System 12	small	large	no	yes	0
System 13	small	small	yes	yes	13
System 14	small	small	yes	no	10
System 15	small	small	no	yes	3
System 16	small	small	no	no	9

[a] Category 1, two farm sizes, large and small, separated at the mean (56 dunums) of those in the sample.
[b] Category 2, two average field sizes, large and small, separated at the sample mean (32 dunums).
[c] Category 3, yes if fertilizer is used and no if fertilizer is not used.
[d] Category 4, yes if a combine is used and no if a combine is not used.

Table 4. Characteristics of Lentil Production Systems (1992).

System Number	Criteria of categorization			
	Farm Size	Fertilization	Drill	Number of farms in sample
System 1	small[a]	no[b]	no[c]	14
System 2	large	no	no	5
System 3	small	yes	no	14
System 4	large	yes	no	10
System 5	small	yes	yes	3
System 6	large	yes	yes	2
System 7	small	no	yes	0
System 8	large	no	yes	0

[a] Category 1, two farm sizes, large and small, separated at the mean (26 dunum) of area seeded to lentils.

[b] Category 2, yes if fertilizer was applied to lentils and no if it was not applied.

[c] Category 3, yes if a grain drill was used to seed lentils and no if lentils were seeded by hand.

Table 5. Private and Social Enterprise Budgets for Wheat Produced Under System 1 (1992).

		Prices		Quantity	Budgets	
Item	Unit	Private	Social		Private	Social
Tradable Inputs						
Fertilizer (Ammonium Sulfate)	kg	0.14	0.13	9.75	1.37	1.29
Wheat seeds	kg	0.15	0.14	11.50	1.70	1.60
Grain sacks	number	0.60	0.57	2.00	1.20	1.13
Hay sacks	number	0.60	0.57			
Cost of Tradable inputs	JD				4.27[a=B]	4.02[b=F]
Domestic Factors						
Land preparation	dunum	0.97	0.97	2.00	1.94	1.94
Harvest labor	dunum	6.50	6.50			
Thresher rental	dunum	1.85	1.85			
Combine rental	dunum	1.64	1.64	1.00	1.64	1.64
Land	dunum	10.00	10.00			
Working capital	JD	0.06	0.12		0.47	0.91
Cost of Domestic Factors	JD				4.05[c=C]	4.49[d=G]
Revenue						
Grain	kg	0.15	0.15	200	29.40	30.20
Hay	kg	0.11	0.11			
Grazing	dunum	2.30	2.30	1	2.30	2.30
TOTAL COSTS	JD				8.32	8.51
TOTAL REVENUE	JD				31.70[e=A]	32.50[f=E]
PROFIT	JD				23.38[g=D]	23.99[h=H]

[a] Tradable input cost with policy (this is B in the PAM of table 2).
[b] Tradable input cost without policy (this is F in the PAM of table 2).
[c] Domestic input cost with policy (this is C in the PAM of table 2).
[d] Domestic input cost without policy (this is G in the PAM of table 2).
[e] Total revenue with policy (this is A in the PAM of table 2).
[f] Total revenue without policy (this is E in the PAM of table 2).
[g] Private profits (profits with policy). (This is D in the PAM of table 2).
[h] Social profits (profits without policy). (This is H in the PAM of table 2).

NPC = (A/E) = (31.70/32.50) = 0.98
EPC = (A-B)/(E-F)= (31.70-4.27)/(32.5-4.02)=0.96
DRC = (G)/(E-F) = (4.49)/(32.50-4.02)=0.16

Table 6. PAM Analysis of the Wheat Production Systems (JD/dunum) (1992).

System	Private Values				Social Values				Divergences			
	Output Revenue	T-Input Costs	Factor Costs	Profit	Output Revenue	T-Input Costs	Factor Costs	Profit	Output Revenue	T-Input Costs	Factor Costs	Profit
	A	B	C	D	E	F	G	H	I	J	K	L
System 1	31.70	4.26	4.05	23.39	32.50	4.01	4.49	23.99	-0.80	0.24	-0.44	-0.60
System 2	55.26	4.48	11.18	39.60	56.14	4.22	12.03	39.89	-0.88	0.25	-0.86	-0.28
System 3	20.38	2.12	2.89	15.37	20.87	2.00	3.16	15.71	-0.49	0.12	-0.27	-0.34
System 4	32.67	1.63	9.98	21.06	33.11	1.54	10.62	20.95	-0.44	0.09	-0.65	0.11
System 5	36.35	4.31	11.17	20.87	36.89	4.06	12.01	20.81	-0.54	0.24	-0.85	0.06
System 9	31.70	4.70	3.82	23.18	32.50	4.44	4.27	23.79	-0.80	0.27	-0.45	-0.62
System 10	45.90	5.10	11.21	29.59	46.70	4.81	12.10	29.79	-0.80	0.29	-0.89	-0.20
System 11	47.51	2.67	11.07	33.77	48.21	2.52	11.83	33.86	-0.70	0.15	-0.76	-0.09
System 13	26.70	4.22	3.95	18.54	27.37	3.98	4.38	19.01	-0.66	0.24	-0.43	-0.47
System 14	47.00	4.54	11.18	31.28	47.74	4.28	12.04	31.41	-0.74	0.26	-0.86	-0.14
System 15	17.29	2.25	3.93	11.11	17.70	2.12	4.26	11.32	-0.41	0.13	-0.33	-0.20
System 16	25.52	2.42	10.74	12.35	25.92	2.29	12.28	11.35	-0.40	0.14	-1.54	1.00

Table 7. Protection Coefficients for Wheat Production Systems Estimated from Table 6 (1992).

System	Private profits	Social profits	NPC	EPC	DRC
System 1	23.394	23.994	0.975	0.963	0.158
System 2	39.604	39.886	0.984	0.978	0.232
System 3	15.366	15.709	0.976	0.968	0.168
System 4	21.064	20.950	0.987	0.983	0.336
System 5	20.871	20.808	0.985	0.976	0.366
System 9	23.178	23.794	0.975	0.962	0.152
System 10	29.588	29.788	0.983	0.974	0.289
System 11	33.767	33.859	0.985	0.981	0.259
System 13	18.539	19.009	0.976	0.961	0.187
System 14	31.276	31.414	0.984	0.977	0.277
System 15	11.114	11.315	0.977	0.966	0.274
System 16	12.350	11.351	0.984	0.977	0.520

Table 8. PAM Analysis of the Lentil Production System (JDO/dunum) (1992).

System	Private Values				Social Values				Divergences			
	Output Revenue	T-Input Costs	Factor Costs	Profit	Output Revenue	T-Input Costs	Factor Costs	Profit	Output Revenue	T-Input Costs	Factor Costs	Profit
	A	B	C	D	E	F	G	H	I	J	K	L
System 1	24.13	3.63	13.39	7.11	29.64	3.42	14.33	11.89	-5.51	0.21	-0.94	-4.78
System 2	30.20	3.05	13.44	13.71	37.71	2.88	14.36	20.47	-7.51	0.17	-0.91	-6.77
System 3	51.66	5.10	13.75	32.82	64.89	4.81	14.78	45.31	-13.23	0.29	-1.03	-12.49
System 4	54.79	5.84	13.79	35.16	67.39	5.51	14.86	47.02	-12.60	0.33	-1.07	-11.85
System 5	46.15	4.78	14.44	26.94	59.00	4.51	15.49	39.00	-12.85	0.27	-1.06	-12.07
System 6	41.55	4.91	14.00	22.64	49.89	4.63	15.03	30.23	-8.34	0.28	-1.04	-7.58

Table 9. Protection Coefficient for Lentils Production Systems as Estimated from Table 8 (1992).

System	P-Profits	S-Profits	NPC	EPC	DRC
System 1	7.112	11.890	0.814	0.782	0.546
System 2	13.706	20.474	0.801	0.779	0.412
System 3	32.819	45.305	0.796	0.775	0.246
System 4	35.163	47.017	0.813	0.791	0.240
System 5	26.935	39.001	0.782	0.759	0.284
System 6	22.645	30.226	0.833	0.810	0.332

CHAPTER VI

SUMMARY OF FINDINGS AND POLICY IMPLICATIONS

This dissertation is concerned with the major factors that affect the production of selected field crops in the rain-fed region of Northern Jordan. Factors studied in this dissertation include land fragmentation, agricultural production systems, and selected policies which affect field crop production. The government of Jordan included an objective in their development plans to increase the production of field crops such as wheat and lentils in the rain-fed regions of the country.

In this dissertation each of the above factors was addressed in a separate essay. The essay in Chapter III, examined the issue of land fragmentation. The overall objective of the essay is to determine if field size influences production costs. To achieve such an objective, the average per unit production costs was used as a measure of economic efficiency. The results of the modeling used maximum likelihood estimation and indicated that the average variable costs of producing wheat is a decreasing function of the average field size. This finding documents that land fragmentation is an impediment to efficient wheat production in the region. Increasing average field size could reduce average variable costs of producing wheat in the region.

The essay in Chapter IV deals with the issue of agricultural production systems in the region. The essay contains an evaluation to the economics of alternative production systems for wheat and lentils in the Rain-fed Region of Northern Jordan. The overall objective of this part is to determine if several of the recommended practices for producing wheat and lentils in the rain-fed region of Jordan are economically viable alternatives to traditional practices. Primary data were obtained from a sample of 63 Jordanian farmers. Maximum likelihood estimation was used to derive parameter estimates of wheat grain yield, lentil grain yield, and lentil vine yield response functions. Estimated response function parameters were used to estimate expected yields and fertilizer requirements for enterprise budgets. The budgets were used to compare the economics of the evaluated alternatives. The results of comparing the evaluated alternatives were:

1. The wheat production system which includes combine harvesting was found to be less economical than the traditional stationary thresher system. The data suggest that programs to promote combine harvesting technology should also include provisions for straw collection. The combine in the absence of some means of collecting the straw is not economically efficient.
2. The use of a mechanical seeder did not significantly change lentil yield. However, the seeding rate was found to be lower on those farms which used a grain drill. The lower seeding rate resulted in lower yields. One conclusion that can be drawn is that mechanical seeders should be calibrated to achieve seeding rates consistent with those obtained with the traditional hand seeding method.

3. The economically optimal quantity of fertilizer for wheat is relatively insensitive to the prices of both fertilizer and wheat. Farmers who responded that they used fertilizer on wheat are applied an appropriate rate.
4. Net returns from the traditional stationary thresher wheat production system with 10.42 kg/dunum of fertilizer were estimated to be 34 JD/dunum.
5. Subsidizing the price of fertilizer is not likely to result in a substantial increase in the use of fertilizer or production of wheat. An appropriate policy instrument would be one that induced those 33% of the wheat farmers and 50% of the lentil producers who do not currently apply fertilizer to begin doing so.

In the third essay presented in Chapter 5, the issue of major policies affect field crop production in the rain-fed region of Northern Jordan was addressed. The over all objective of the essay is to determine the impact of existing government policies including subsidization of prices and credit, and exchange rate policies, on the efficiency of producing wheat and lentils in the region. Primary and secondary data were used to conduct the analysis. The Policy Analysis Matrix (PAM) was used to estimate the private and the social profitabilities of the identified systems of wheat and lentils produced in the region.

APPENDIXES

APPENDIX A

CHARACTERISTICS OF THE VARIABLES USED IN THE ANALYSIS

Table 1. Characteristics of the Variables Used in the Analysis for the Interviewed Wheat Farmers in the Rainfall Zone of 250 - 350 mm.

	Units	Boyda	Naymah	Tura	Zone
Farms	No.	4	2	3	9
Average farm size	dunums	425	190	80	258
	s.d	311	90	33	263
Average wheat area	dunums	173	48	34	99
	s.d.	147	23	20	118
Average field size	dunums	50	30	25	37
	s.d	24	5	14	21
Combine for wheat	percent	25	50	33	33
Fertilizer	percent	0	50	3	44
Average fertilizer[a]	kg	0	10	9.3	9.5
Total variable cost	JD/du	14.9	7.1	21.8	16
	s.d.	6.8	0.07	9.4	9
Average wheat yield	kg/du	132.5	135	237	168
	s.d	39	15	74	70

[a] All farmers in the survey who reported use of fertilizer indicated that they applied ammonium sulfate.

Table 2. Characteristics of the Variables Used in the Analysis for the Interviewed Wheat Farmers in the Rainfall Zone of 350 - 400 mm.

	Units	Howara	Shajarh	Magyer	Sareh	Zone
Farms	No.	4	4	7	9	24
Average farm size	dunums	141	163	63	180	136
	s.d.	66	115	36	94	95
Average wheat area	dunums	81	51	21	66	53
	s.d.	55	39	14	51	47
Average field size	dunums	56	24	21	30	31
	s.d	38	9	14	13	23
Combine for wheat	percent	100	0	86	60	62
Fertilizer	percent	100	100	86	66	80
Average fertilizer[a]	kg	10	10	10	10	10
Total variable cost	JD/du	10.1	24.5	9.5	14.6	14
	s.d.	2.2	1.8	5.0	8	8
Average wheat yield	kg/du	195	210	122	176	169
	s.d	53	64	39	68	66

[a] All farmers in the survey who reported use of fertilizer indicated that they applied ammonium sulfate.

Table 3. Characteristics of the Variables Used in the Analysis for the Interviewed Wheat Farmers in the Rainfall Zone of 400 - 450 mm.

	Units	Thenybah	Hakamah	Maro	Jayz	Zone
Farms	No.	5	7	5	7	24
Average farm size	dunums	156	187	159	123	156
	s.d.	124	106	93	100	109
Average wheat area	dunums	43	68	43	19	43
	s.d.	30	51	32	11	39
Average field size	dunums	38	42	27	18	31
	s.d.	31	27	15	12	24
Combine for wheat	percent	20	60	20	14	33
Fertilizer	percent	80	60	80	28	66
Average fertilizer[a]	kg	8	11	12.5	11	9.2
Total variable cost	JD/du	22.4	14	17	21	18
	s.d.	3	8	7	5	7
Average wheat yield	kg/du	171	166	208	125	164
	s.d.	23	63	60	43	59

[a] All farmers in the survey who reported use of fertilizer indicated that they applied ammonium sulfate.

Table 4. Characteristics of the Variables Used in the Analysis for the Interviewed Lentils Farmers in the Rainfall Zone of 250 - 350 mm.

	Unit	Naymah	Tura	Zone
Farms	No.	1	3	4
Average farm size	dunum	280	80	130
	s.d.	0	32	91
Average lentils size	dunum	20	26	25
	s.d.	0	2.4	3.6
Average field size	dunum	20	26	25
	s.d.	0	2.4	3.6
Drill for lentils	percent	0	0	0
Fertilizer	percent	0	100	80
Average fertilizer[a]	kg	0	11.3	11.3
Total variable cost	JD/du	15.7	18.8	179
	s.d.	0	0.98	1.6
Average lentils yield	kg/du	80	216.7	183
	s.d.	0	23.6	63

[a] All farmers in the survey who reported use of fertilizer indicated that they applied ammonium sulfate.

Table 5. Characteristics of the Variables Used in the Analysis for the Interviewed Lentils Farmers in the Rainfall Zone of 350 - 400 mm.

	Units	Howara	Shajarh	Magyer	Sareh	Zone
Farms	No.	3	5	7	7	22
Average farm size	dunum	121	136	63	157	117
	s.d.	65	115	36	94	92
Average lentils area	dunum	23	32.6	17	31	26
	s.d.	12	16.5	11	14	15
Average field size	dunum	23	32.6	17	25	24
	s.d.	12	16.5	11	11	14
Drill for lentils	percent	33	20	14	14	18
Fertilizer	percent	66	100	28	43	55
Average fertilizer[a]	kg	10	9.6	10	9	9.1
Total variable cost	JD/du	21	19.4	16	17	18
	s.d.	0.7	1.3	1.9	1.0	2.3
Average lentils yield	kg/du	130	161	59	79	98
	s.d.	24	43	33	35	54

[a] All farmers in the survey who reported use of fertilizer indicated that they applied ammonium sulfate.

Table 6. Characteristics of the Variables Used in the Analysis for the Interviewed Lentils Farmers in the Rainfall Zone of 400 - 450 mm.

	Units	Thenybah	Hakamah	Maro	Jayz	Zone
Farms	No.	5	8	5	4	22
Average farm size	dunum	170	171	159	175	165
	s.d.	135	108	93	125	111
Average lentils area	dunum	35	39	23	11	29
	s.d.	26	25	19	6	23
Average field size						
Drill for lentils	percent	0	13	0	0	5
Fertilizer	percent	75	88	80	0	64
Average fertilizer[a]	kg	8	9.2	9.5	0	9.1
Total variable cost	JD/du	16	18.2	18.4	17	17.4
	s.d.	0.4	1.9	1.7	1.4	1.9
Average lentils yield	kg/du	76	103	135	85	101
	s.d.	22	37	43	9	9

[a] All farmers in the survey who reported use of fertilizer indicated that they applied ammonium sulfate.

VITA 2

Amer Jabarin

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Doctor of Philosophy

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