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by

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NOTE ON JORDANIAN CURRENCY AND MEASUREMENT UNITS

The currency of Jordan is the Dinar.

A Jordanian dinar = 1,000 fils

1 J.D. = $3.11

1 Dunum = $\frac{1}{10}$ Hectare = $\frac{4}{9}$ Acres

I. DESCRIPTION AND EXPLANATION OF THE WHEAT SUBSECTOR OF JORDAN

1. Bread Consumption

a. The Jordanian diet

The diet of most of the people of Jordan is not seriously deficient in calories and protein. The average adult, however, consuming between 2,300 and 2,800 calories daily, of which close to 50 percent may come from bread, is on a lower nutritional level than that of some of the Middle Eastern countries, such as Lebanon and Iraq. In 1952, a study of low-income workers found that many infants and small children suffer from a lack of vitamin A and the vitamin B complex, especially riboflavin. Malnutrition is most severe among infants and occasionally results in eye diseases and general growth retardation. Nevertheless, starvation is rare in Jordan (33).

The Jordanian society is divided into three major social groups: the Bedouin tribe, the rural people, and the urban people. In addition to these groups, there is a large portion of Jordan's population consisting of Palestinian refugees and West Bank displaced persons. Basic food rations provided to these latter two groups by the United Nations Relief and Work Agency (UNRWA) and the Supreme Ministerial Committee (SMC), respectively, contain about 1,500 calories per day. The refugee diet, although lower in caloric intake, is nutritionally equivalent to that of most citizens of

Jordan. Supplementary feeding and milk distribution programs are provided to benefit children and pregnant women. The contents of the Jordanian's diet vary according to the different life styles of Jordanians. Three basic life styles exist in Jordan: (i) nomadic, (ii) rural, and (iii) urban.

(i) The diet of the Bedouin nomads The Bedouin nomads who roam the Jordan desert have a fairly conservative, unvaried diet. It consists mainly of camel's milk and dried dates, supplemented with boiled wheat and rice. On special occasions, however, a Bedouin feast may include trays of boiled mutton, rice, pine nuts, and leben (a semisolid, curdled milk similar to yogurt). Camel's meat is consumed mostly by wandering nomads. Settled nomads who are engaging in dryland farming and animal grazing have food diets similar to the rural Jordanians.

(ii) The diet of rural Jordanians Villagers subsist on a diet of bread, leben, olives and olive oil, cheese, onions, and seasonal vegetables. Wheat bread is eaten with all meals; villagers consume more wheat than any other group. A villager's breakfast may consist of nothing more than bread dipped first in olive oil and then into a dish of powdered thyme. Lentils and chick-peas are dried for storage but cooked before eating. Lentil soup is one of the few hot meals served in village homes. Additional vegetables may include tomatoes, beans, okra, squash, and eggplant.

Meat is scarce, and beef is seldom consumed because cattle are valued more for their milk and as work animals.

(iii) The diet of urban Jordanians Town and city dwellers have a more varied diet and consume more fruits, vegetables, and meat than the rest of the population. Popular dishes may include green beans cooked with tomato sauce and lamb served with cooked rice. A commonly served dish known as "hummus" consists of crushed chick-peas mixed with sesame seed oil and topped with olive oil. Such foods can be served at any meal and are in demand by all the people of the Middle Eastern countries. Most people show a marked preference for lamb, mutton, and goat's meat. Beef, however, is scarce, and pork is not eaten because of the Moslem religious proscription.

b. Wheat consumption

Jordan's wheat is a major diet component for most of the population. Eating habits among all income groups in most Middle Eastern countries include consuming a large amount of wheat bread with every meal.

Although there have been no scientific studies to estimate the exact per capita consumption rate of wheat in Jordan, it is considered to be among the highest rates in the world. Rough estimates given by the Department of Agricultural Research and Extension would place the rate between 140 and 150 kg annually. The Ministry of Supply tends to accept the upper limit as more accurate because it is closer to figures reached by studies done in Syria, the neighboring country which most resembles Jordan in its social traditions and living conditions. Calculations made in the present study indicate per capita consumption for rural areas to be 180 kg and for urban areas 150 kg.

Such uncertainties in statistical estimates for per capita consumption are not uncommon among developing nations. Wide variations in estimating per capita consumption of wheat exist in Turkey which apparently surpasses Jordan's rate and ranks among the leading countries of the world in terms of per capita consumption. Arthur Coffing (6) in his study calculates the per capita consumption level of wheat to be over 200 kg; while the Food and Agriculture Organization (11), FAO, statistics based on Turkish production data indicate 173 kg for all cereal, and Organization for Economic Cooperation and Development (34), OECD, estimates the figure at 163 kg.

Jordanian people usually eat bread in large quantities, and it is a strong social custom to serve fresh baked bread with every meal. There is no substitute for bread. Cooked rice and/or potatoes may be served as complementary dishes at dinner and supper, but loaves of bread are always present. Higher income groups may consume a higher quality of bread but still consume relatively large amounts.

However, as indicated earlier, the rate of bread consumption in rural and nomadic villages is even higher than that of urban areas. One reason for this may be that urbanites eat rice with almost every dinner meal; whereas rural people more often eat rice along with other traditional dishes only on Fridays and at feasts or special occasions.

City people rarely bake bread at home. They usually buy fresh bread daily from their neighborhood bakery. A few families may bake at home, but such a trend is fast diminishing. It has become much more convenient for the man of the family to stop at the bakery on his way home and buy fresh bread. Whereas urban households are less particular about the quality of their wheat bread in rural areas, people feel very strongly about making good, fresh bread at home.

Those farmers who have no wheat stored at home and the non-farming rural residents, such as soldiers and government workers, have a high preference for buying wheat at 60-65 Jordanian Dinar (J.D.) per ton rather than buying flour or bread at the much subsidized lower price.

After obtaining the wheat, the rural people take a certain amount, which usually covers a week's needs, to the village custom miller who charges 7 fils (1 J.D. = 1,000 fils) for milling each kg of wheat. Every evening, the wife prepares enough dough for the following day's bread and then bakes it early the next morning. If she does not bake at home, she will carry the flour to the village custom baker who usually charges by the number of loaves at a rate equivalent to 10 fils/1 kg of bread.

The following figures illustrate how much value the rural people place on making their own bread.

Cost of wheat	62-65 J.D./ton
Cost for milling	6-8 J.D./ton
Cost for baking	8-10 J.D./ton
Total	76-83 J.D./ton

Urban people, on the other hand, buy bread at the rate of 50 fils/kg which amounts to 50 J.D./ton of bread. Thus, we find the rural people pay 26-33 J.D./ton more as a result of the subsidy paid by the government at different stages of the wheat subsector.

Rural Jordanians who live in bigger villages and towns are entitled to such a saving. Because it is part of the village social tradition and also because it apparently brings much self-satisfaction to the rural people, they choose to bake their own bread from their local wheat; and, consequently, they pay more for it. Other groups of villagers seem to have no choice but to bake their own bread; for example, those who live in small, faraway villages would have to go to a larger town to buy bread or flour if they chose not to bake at home. However, it is likely that even if these farmers had easy access to bought bread or flour, they would insist upon making their own.

c. Total expenditure, food expenditures, and the price of bread

Jordan has had a quite stable price level for bread over the past thirteen years--1962-75. Bread prices have made only a very slight increase throughout that entire period. Table 1.1 shows the price trend of bread.

Table 1.1. Price of bread for the period 1962-1975[a]

Year:	'62	'63	'64	'65	'66	'67	'68	'69	'70	'71	'72	'73	'74	'75
							(fils/kg)							
Price:	43	45	45	48	50	50	50	50	50	50	50	50	50	50

[a]Source: Statistical Year Book, Serial issues, Department of Statistics.

Thus, Jordanian households have enjoyed bread as one among very few items which has not been subject to the high price increases over the past fifteen years.

However, it has been the Jordanian government's policy to keep the bread and flour prices at their low level by subsidizing the wheat which has flowed to the major milling companies and then flowed as flour to the city bakeries throughout the country. But the real benefit of such low prices is being swept away by the high increases in other food as well as nonfood items. For example, food prices (other than bread) increased 35 percent from 1973 to 1974; housing, 8 percent; clothing, 13 percent; other food and services, 6 percent; and the general price level climbed 20 percent in that one year (8).

In terms of price trend, statistics show that from 1967 to 1975 the consumption price index for Amman city was as follows:

Base Year 1967 = 100

Food	307.7
Housing	139.4
Clothing	155.1
Other goods and services	139.1

Obviously, food reflects the sharpest increase (207.7 percent) among the major consumed groups, followed by clothing, housing, and other goods and services--55.1 percent, 39.4 percent, and 39.1 percent, respectively (8). A detailed data analysis of this consumer price index reveals that among major food items cereal and bakery products have risen the slightest, only 11.5 percent since 1967. The sharpest rise was in fruit prices, 673.5 percent; followed by vegetables, 413.3 percent; meat, poultry, and fish, 109.3 percent; other foods, 103.6 percent; and dairy products and eggs, 64.2 percent. Hence, the cost of bread, when compared with other food items, is very modest and occupies a very small portion of the Jordanian household budget.

A family of seven people would consume 3 kgs of bread daily which costs 150 fils or--at the rate of 3 kgs x 50 fils/kg--about 4.5 J.D. per month. No data has been gathered on income distribution in Jordan which would help in deriving the share of bread expenditure relative to other consumption expenditures and to total budget.

However, a study on family expenditure surveys published by Jordan's Department of Statistics shows the relative importance of expenditure groups for Amman city in the base year 1967 to have been as follows:

Food	35.02
Housing	32.28
Clothing	12.14
Other goods and services	20.56
Total	100.00

Bread occupies a share of only 4 percent of the total household budget and a share of 4/35.2 x 100 = 11.4 percent of the food budget (7). Therefore, even though the price of bread remains constant, because the prices of other food items are rising sharply, the bread expenses in the household budget, in general, and in the food budget, in particular, are minimized. The quantity of per capita bread consumption remains high.

2. Jordan's Low and Variable Wheat Production

Jordan has been experiencing a severe shortage in meeting the domestic wheat requirement and extreme variations in the size of wheat production over the past decade. As a consequence, the country has suffered a big burden in its national budget. Jordan purchases wheat through Public Law 480 Title I and receives relief through wheat donations from international agencies and charitable organizations; but in spite of these sources, Jordan has to offset its deficit by importing wheat from world markets.

The historical record of the aggregate wheat production, the wheat cultivated area, and the national average wheat yield over the past twenty years, 1954-74,[1] presents an accurate picture of the magnitude of this wheat variability problem. Table 1.2 reports Jordan wheat production, cultivated area, and the national average yield for the years 1954-1974.

From Table 1.2 as well as Figure 1.1, we notice that the year-to-year variation in the level of wheat production and yield is quite high. For example, wheat production in 1972 was 160,914 tons. In 1973, it went down to 37,652 tons, less than one-fourth of the 1972 production level. Then, in 1974, it went up to 180,000 tons. While this year, 1975, the crop is expected to go down to 60,000-70,000 tons. This oscillating pattern in the production of wheat, the nation's most important food stuff, and the drastically low yield of the wheat drylands have a substantial economic impact on the wheat farmers' level of living. Also, the rural people working at wheat harvesting, transporting, marketing, and processing are affected. And finally, the government must carry out an indisputable responsibility to provide the wheat market with a sufficient amount of imported wheat to satisfy the people's needs and to cover the deficit of this nonsubstitutable food stuff.

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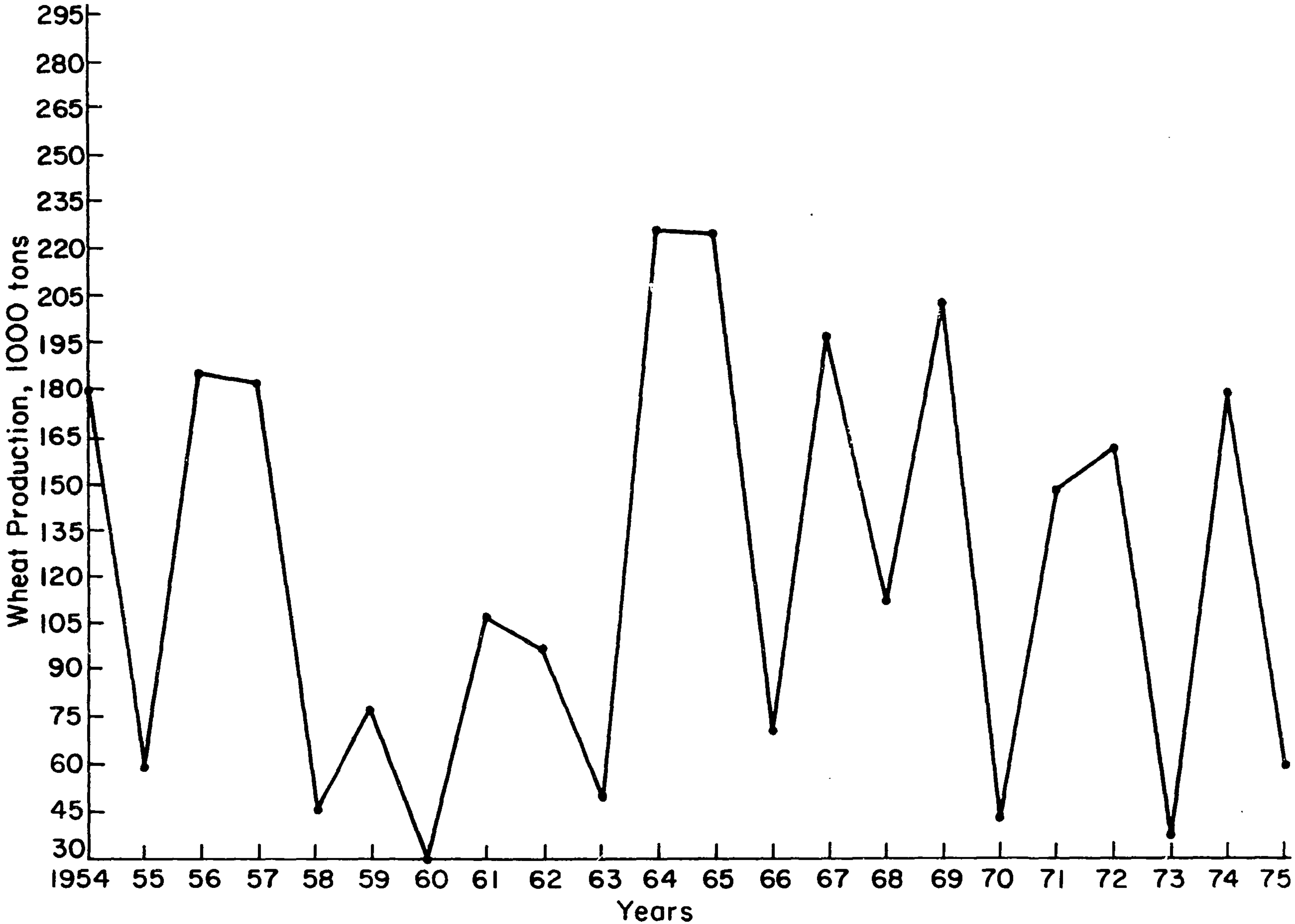
[1]Statistics given throughout this study are for the East Bank only, unless designated otherwise.

Table 1.2. Jordan wheat production, area, and the national average wheat yield, 1954-1975[a]

Year	Total area cultivated with wheat in Dunums	Total production in tons	Wheat yields kg/Du
1954	2,077,192	179,018	86
1955	2,121,950	60,284	28
1956	2,520,310	186,756	74
1957	2,239,268	182,656	81
1958	2,356,676	46.001	19
1959	2,122,588	79,683	37
1960	1,928,725	29,599	15
1961	2,096,939	106,121	50
1962	2,224,825	96,547	43
1963	1,565,926	50,038	31
1964	2,314,528	224,788	97
1965	2,239,608	224,492	100
1966	1,719,506	71,453	41
1967	2,259,870	196,086	86
1968	2,183,812	111,461	51
1969	2,076,750	201,054	96
1970	1,218,975	45,183	37
1971	2,164,823	148,477	68
1972	1,902,367	160,614	84
1973	1,364,657	37,652	27
1974	1,975,537	180,00	92
1975	1,500,000	60,000	40

[a]Source: Ministry of Agriculture, Department of Statistics.

Figure 1.1. Annual fluctuation in Jordan wheat production, 1954-1974


Wheat Production, 1000 tons
295
280
265
250
235
220
205
195
180
165
150
135
120
105
90
75
60
45
30
1954
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
Years

A high rate of population growth, 3.4 percent, has raised the total wheat consumption by 10,000 tons every year since 1968. At the current production level and because of the varying patterns exhibited over the past years, Jordan has experienced a continuing shortage in its domestic wheat supply. Table 1.3 reports Jordan wheat production, requirement and annual shortage or surplus, 1954-1975. We notice from Table 1.3 and Figure 1.2 that since 1968, even in the years of highest rainfall and best production, the national requirement far exceeds the highest production level.

Since 1967, Jordan's maximum production has been 200,000 tons; while the annual requirement has surpassed this level, apparently due to the influx of over 300,000 displaced persons from the West Bank because of the 1967 war. Since then, the gap between the aggregate production levels and consumption requirements seems to have widened at an increasing rate. Concomitantly, the size of wheat imports is rising at the same rate.

a. The role of wheat relief and donations

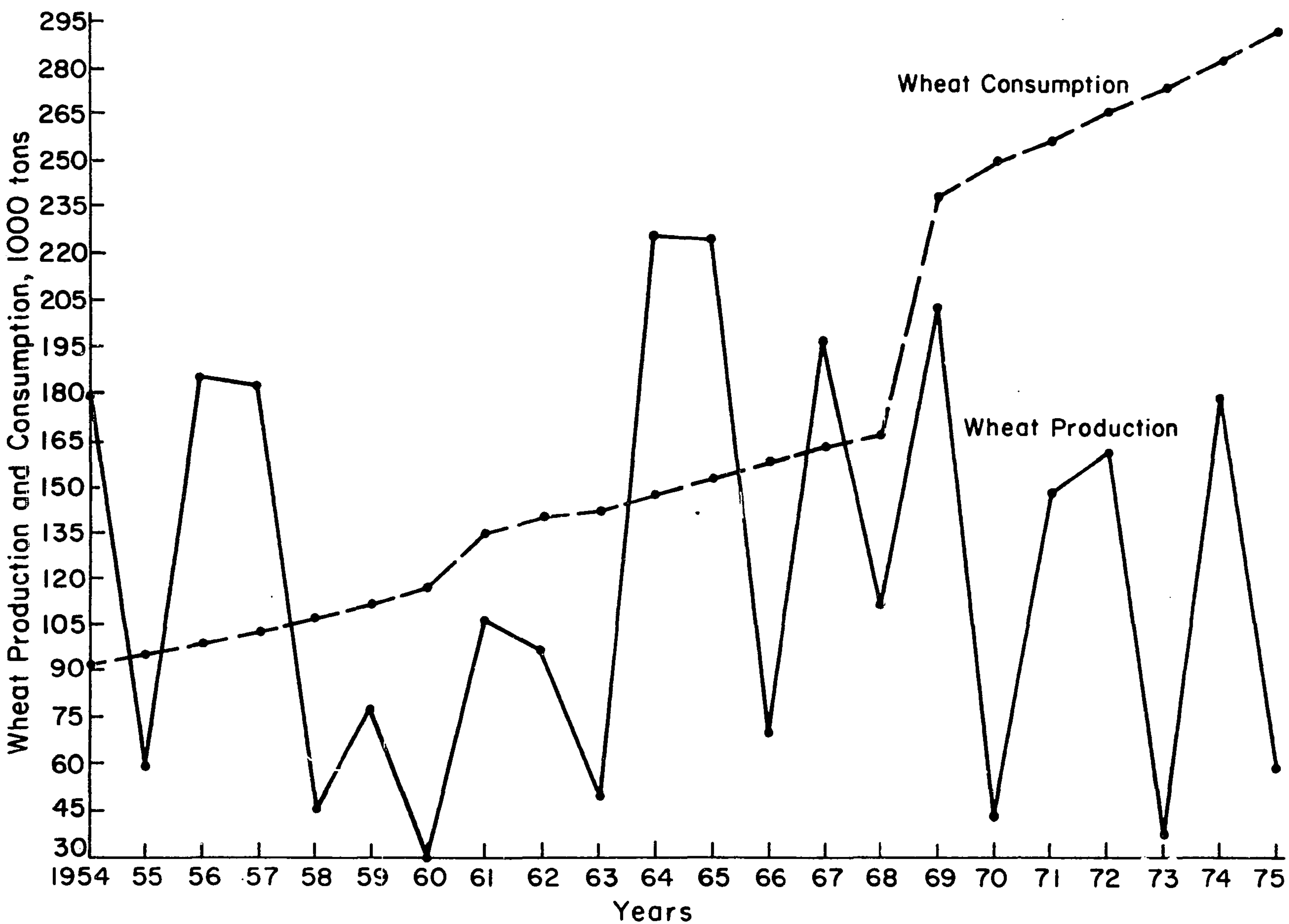
Since Jordan declared independence in 1946, the state has passed through a military and political crisis which in 1950 resulted in having Jordan be subject for immediate relief from the United Nations through the establishment of its agency UNRWA. The purpose was to provide food, shelter, health care, and educational opportunities to the Palestinian refugees who were dispossessed of their homes in Palestine following the 1948 war. The monthly per capita

Table 1.3. Jordan wheat requirement, actual production, and annual shortage or surplus, 1954-1975[a]

No.	Year	Population	Annual wheat requirement	Actual production	Annual shortage or surplus
			tons	tons	tons
1	1954	620,342	93,051	179,018	+ 85,967
2	1955	642,147	96,322	60,284	- 36,038
3	1956	662,832	99,424	186,756	+ 87,332
4	1957	686,791	103,018	182,656	+ 79,638
5	1958	720,000	108,000	46,001	- 61,999
6	1959	746,770	112,015	79,683	- 32,332
7	1960	781,136	117,170	29,599	- 87,571
8	1961	900,776	135,116	106,121	- 28,995
9	1962	932,000	139,800	96,547	- 43,253
10	1963	961,500	141,225	50,038	- 94,187
11	1964	992,000	148,800	224,788	+ 75,988
12	1965	1,024,000	153,600	224,492	+ 70,892
13	1966	1,059,000	158,850	71,453	- 87,397
14	1967	1,094,000	164,100	196,086	+ 31,986
15	1968	1,126,000	168,900	111,461	- 57,439
16	1969	1,600,000	240,000	201,054	- 38,946
17	1970	1,668,000	250,000	45,183	-205,017
18	1971	1,723,000	258,450	148,477	-109,973
19	1972	1,774,000	266,100	160,914	-105,186
20	1973	1,831,000	274,650	37,652	-236,998
21	1974	1,889,592	283,438	180,000	-103,438
22	1975	1,950,071	292,510	60,000	-232,510

[a]Source: Ministry of Agriculture, Department of Statistics.

Figure 1.2. Jordan wheat requirement and actual production, 1954-1975


Wheat Consumption
Wheat Production
Wheat Production and Consumption, 1000 tons
295
280
265
250
235
220
205
195
180
165
150
135
120
105
90
75
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45
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1954
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71
72
73
74
75
Years

relief ration consists of the following: (i) 10 kg flour, (ii) 600 gm sugar, (iii) 500 gm rice, and (iv) 375 gm soybean oil. It is estimated about 50,000 tons of wheat in the form of flour is being imported every year through UNRWA. (A detailed analysis of free wheat given by UNRWA and others follows in Chapter VII.)

As a result of the 1967 war and the occupation of the West Bank of Jordan by Israeli forces, war refugee problems emerged again. Large numbers of Palestinians from the West Bank and Gaza Strip (estimated at over 300,000) took refuge on the East Bank. A high government committee, SMC, was formed to take care of those displaced persons and provide them with shelter, food, health care, and educational services. The monthly per capita food ration is similar to the UMRWA relief program.

Another 35,000 tons of wheat are provided free of charge to about 270,000 displaced persons in Jordan. Two major foreign contributors donate wheat to this relief program. Each year, the European Common Market donates about 3,000-4,000 tons of wheat, and West Germany donates around 8,000-9,000 tons. The rest of the required relief, which is estimated to be about 23,000 tons, is being imported by Jordan's government from the world wheat market.

The World Food Program, which is one of FAO programs, also contributes in a very constructive way to the wheat deficit problem. Usually, WFP operates through specific labor intensive projects in rural areas, such as cleaning land, planting trees, and building roads. The total wheat flour which has been utilized as partial payment of wages for the past ten years, 1964-74, was about 89,300 tons; also, an average of 9,000 tons of wheat was brought annually to the country from numerous Western European countries and others under this World Food Program.

Finally, CARE and the Lutheran and the Catholic charitable societies donate around 1,000-3,000 tons of wheat annually as part of their rural and community development projects in Jordan.

To sum up this relief section, we find that the total donations and relief which come to the country free are 73,000 tons of wheat distributed as:

UNWRA	50,000 tons
ECM	3,000 tons
WFP	9,000 tons
West Germany	9,000 tons
Charitable societies	2,000 tons

Undoubtedly, a sizable amount of wheat is being brought to the country free to relieve war refugees and displaced persons.

This total relief program represents 28.71 percent of the total wheat requirement and represents 53.60 percent of the aggregate deficit. In other words, Jordan gets free flour and wheat to cover about half of its wheat shortage and relieve a large part of the chronic food deficit which the country has been under since 1967. This also represents a significant aspect of the internal wheat market in Jordan and creates a unique situation in the wheat market as we shall see in Chapter VII.

However, when viewed from a long-range perspective, this sizable relief shipment of wheat has limited potential. If the UNRWA terminated its operation in the area and if other contributors stopped their wheat donations, Jordan would have to face an additional shortage of 73,000 tons. All the circumstances indicate that UNRWA has a short time to operate. It has been under a continuing budget deficit and financial difficulties.

Also, the world wheat supply no longer has a surplus, which makes the continued donations of other countries less probable. This will add another significant element and raise a warning signal to Jordanian decision makers to look for better ways to cut their wheat deficit. As it looks, improving the efficiency of wheat production in Jordan is the safest way because it depends least on international conditions.

3. Current Agribusiness Services Prevailing in Wheat Dryland Areas

Despite the dominance of traditional agricultural practices in the dryland farming sector, there are some agribusiness custom services being performed in Jordan. Yet, these services could function much better if the circumstances were changed and the degree of awareness heightened among the wheat farmers and the custom servicemen themselves.

The following are the current agribusiness custom services in Jordan.

a. Tractor services

Jordan's rain-fed agriculture uses tractor custom services mainly in the plain areas; and there are a large number of tractors available for tilling and, to a much less degree, for other input application. These tractors are owned and operated by private men who till the lands, either as a full-time or part-time career. This type of service (tilling) is rendered on the basis of the number of dunums (unit) of land. The payment for the service is also determined by the type of tilling desired, such as whether the land is to be plowed deep or shallow and whether it is to be tilled in one direction or crossed in two directions (east-westward and north-southward).

It is realized that there is, in general, no shortage in the number of tractors in Jordan's rural area; but the fact still persists that there are poor tilling operations, very rough lands, and bad seedbed preparation. The land is unlevel and full of stones and weeds. The farmers put the blame on tractor custom operators who take the easy path in tilling the land and refuse to change the way of tilling which has been practiced over the years. In addition, the tillage tools are in most cases inappropriate to the type of land or for the purpose of tillage. The farmers seem to have no choice in asking for equipment; rather, they must accept whatever the custom operator has on his tractor, which most often is a disc plow.

If farmers ask for a change in the direction of plowing, the operator demands more money because it takes a longer time to till in two directions. It seems the demand is justified, but the farmers are both unable to pay more and unwilling to bear the added expense at a time when they are trying to minimize operation costs. The farmer usually pays 0.300 J.D. to have a dunum of land tilled in summer; and when he has 50 dunums, this simply means he has to pay 0.300 J.D. x 50 = 15 J.D. Such a sum is hard for a Jordanian dryland wheat farmer to own, much less spend; so in most cases, farmers pay part of it at the time and the rest later. To ask tractor operators for better tilling means to accept the tractor man's request to pay, say, 500 fils per dunum; that is to pay 10 J.D. more than the 15 J.D. he would normally pay or 70 percent increase in tillage cost. For most wheat farmers interviewed for this study, this seems beyond their financial capacity. In addition to this, the risk element attached to rain-fed planting and the general conditions prevailing in dryland farming negate any improvement in tillage.

The tractor custom operator, on the other hand, faces the higher cost of operating the tractor because of higher fuel and maintenance costs as well as the general higher cost of living; all these prevent him from changing the tilling path without demanding higher pay. Most of the tractor operators interviewed pointed out the very low margin left for them by the 0.300 J.D./dunum charge. This depressed fare also prevents them from improving their equipment and their services. Their general response was, "It is just not paying off."

The whole tilling operation must be studied in terms of its technical and economic aspects. Tilling improvement can be appreciated more by accepting the view of some agronomists who believe that, through proper utilization and application of machinery in the field of cultivation, wheat yield can be raised by at least 50 percent because of better tillage and proper seedbed preparation.

A study of the tilling operations in Jordan would be very valuable and would play a significant role in improving the whole picture of wheat growing. Such a study may deal with:

(i) the cost of tractor operation to cover the fuel, oil, and all other direct costs as well as indirect costs;

(ii) the returns to tractor services;

(iii) the basic problems faced by the custom tractor man in his operation;

(iv) the basic problems faced by farmers regarding tilling services provided by tractor custom operators;

(v) the effect, consequences, and possible solutions to the above problems;

(vi) the potential wheat yield improvement resulting from adopting the recommended practices; and

(vii) the possible obstacles facing adoption of such practices.

b. Combine services

Combine harvesting is dominant in the dryland wheat plain areas of Jordan. Wheat farmers adopted such techniques very rapidly, due to the many direct and good advantages they provide over hand harvesting. Among these benefits are:

(i) less loss and waste of wheat--in the past, wheat farmers harvested by hand pulling or by cutting with sickles. In both cases, wheat losses and wastes were large.

(ii) cleaner seed because use of the combine avoids mixing the seeds with dirt and other weed seeds;

(iii) faster operation than hand harvesting; and

(iv) lower cost than hand harvesting.

Due to the above direct benefits and the availability of combines, adoption rate of the improved technique is very high. It is estimated about 90 percent of the wheat fields in the plain areas is being harvested with combines. But on the hilly and rocky grounds where it is difficult for combines to operate, hand pulling and sickle cutting are being used. In both cases, farmers benefit from the straw, "tibin," which can be used to feed their animals.

Combines are operated in a way similar to the tractor services where custom operators visit farmers and make payment arrangements to harvest their fields. The charge is based on the number of dunums as in the case of tilling. There seem to be no complaints on the part of farmers against combine custom operators. The farmers are more satisfied with combine harvesting than with the tractor tilling.

These combines are owned and operated by private men who make such operations their part-time careers during the harvest season. It is observed that there have been no shortages in this kind of equipment.

c. Seeding services

In the wheat dryland farming areas of Jordan, seeding is done mostly by handbroadcasting. A very few graindrills are being used in some higher rainfall areas and at the demonstration plots of the Ministry of Agriculture; to the knowledge of this writer, there are only two graindrills under use in the northern region of Jordan. Those two are owned and operated by the co-op organization, and the demand from the members to use them is quite high. Farmers must wait until they get their turn to plant their fields with these seeding tools.

Handbroadcasting is still predominant in all of Jordan's dryland wheat farming areas. Farmers usually hire a custom seeding man who is skillful in this kind of work. In recent years, there has been a shortage of these custom men who get paid on a daily basis.

Graindrilling is still in its early stages and has not been adopted widely among the wheat farmers. This is due to the unavailability of such improved agricultural tools; also, the awareness of the advantages graindrills could provide is still low. Some farmers who have observed the work of the graindrills have reservations concerning their efficiency. Misconceptions about the way the graindrill operates may hinder its adoption. Farmers believe that handbroadcasting covers all the fields without leaving any spaces unplanted with wheat, while graindrills operate so as to leave large spaces between the lines. These spaces, it is believed, could be planted with wheat to increase the total production. Farmers may not be right in their conception of the inefficiency of graindrills; however, there has been no actual measuring of wheat yields in both handbroadcasting and graindrilling. According to agronomists, these spaces left by the graindrilling method give better allocation of resources--organic matter--and moisture to the planted seeds.

Farmers do really wish to try to graindrill services, especially at this time when the shortages of labor and unavailability of custom seeding men, accompanied by high wages, tend to give farmers the incentive to use machines. There have been no agribusiness agents in this type of service (improving seeding services). It might be a great risk to private enterprise to introduce such services, or the profit margin may be low which discourages private men from entering such business. However, the evidence shows a trend toward using the graindrill, especially in the higher rainfall areas. There must be some attempts to encourage private men to enter these services as they do tractor and combine services.

d. Seed cleaning and treatment

Seed cleaning is a new practice among wheat farmers and is still in the early stages of adoption. Cleaning the wheat seed consists of purifying the seeds from weed seeds and classifying the wheat seeds according to size. Some farmers take their wheat to the Department of Agriculture in the bigger cities where they have the facilities to clean and classify the seeds. Other farmers, maybe a larger percentage, have small screeners in their homes which do the cleaning; and the rest of the farmers plant the wheat seeds without cleaning or treatment. Treating the seeds with chemicals against smut disease is just starting to spread after the farmers suffered considerably from the smut disease and lost a high percentage of their wheat crop. Farmers buy the chemicals from the agribusiness stores and mix them with the seed before planting, aiming at protecting the wheat kernels from smut disease. There are no private agribusiness services which provide for this type of activity, and farmers must do such operations themselves if they wish to improve their wheat production.

Recently, cooperative organizations have been giving farmers (members) the so-called "improved seeds" which are cleaned, purified, and treated seeds. These are given on a loan basis, and the members must repay the same amount of wheat after their harvests.

e. Pesticide chemicals and spraying services

Weeds are a persisting problem in the rain-fed wheat areas as other sections of this thesis will show. Farmers suffer from the harm weeds cause to their wheat plants.

The response of farmers to these weeds varies according to their degree of awareness and their financial capacity. The agribusiness role in this field is confined to the two phases of (i) making available 2, 4-D and other pesticide chemicals to farmers and (ii) providing spraying services to wheat farmers.

Agribusiness stores seem to have no shortages in providing 2, 4-D to the wheat farmers who wish to buy. Furthermore, they try to sell their materials by making information advertisements which explain the advantages of such chemicals in killing weeds and saving wheat crops.

The private sector seems to be functioning ineffectively in providing spraying services. There are very few agribusiness people who provide such services to the wheat farmers. Spraying is one of those improved techniques, and its results could be seen and felt. Yet, this technique is not being widely adopted because of the general nature of spraying. It calls for specialization and specialists to perform this type of activity, and it requires a good degree of knowledge and skill to mix the chemicals and determine the proper time for spraying. The writer found very few agribusiness sprayers during his more than six-month visit to the northern region of Jordan. A fortunate interview with one, and maybe he was the only agribusiness agent in Irbid, revealed two interesting and perhaps crucial points. (i) Farmers have, in general, a low degree of confidence in the spraying technique's ability to kill the weeds. (ii) Farmers have a problem of financing their purchases for improved inputs. This agribusinessman emphasized the fact that farmers do not have cash money and like to borrow to finance their operation. Most farmers who dealt with this spraying agribusinessman asked him if they could pay at the harvest season. Add to these two problems the low margin they (agribusiness sprayers) get for providing their spraying services; all these problems make such a profession not very attractive to enter.

f. Fertilizer application

Farmers of the rain-fed areas use very little fertilizer for their wheat plants. Agribusiness stores sell their fertilizers to farmers who come and ask to buy them. However, the demand is low, especially after the high boost in the prices of fertilizers. Recently, the cooperative organizations and the Ministry of Agriculture have entered the agribusiness and imported large amounts to be sold to the farmers at supported prices. This subsidized fertilizer sells at a price 15 percent less than the private agribusiness price.

g. Land supply

Jordan has a total land area of about 22,000,000 acres, but the cultivated area consists of only about 10 percent of that total.

The rest of the land is considered topographically and climatologically part of the Syrian Desert. The rain-fed agricultural lands expand and contract according to the weather conditions prevailing throughout the winter growing seasons. In the good rainfall years, the wheat farming may extend to the fringe of the marginal lands; and in the poor rainfall years, a great proportion of good lands may be left uncultivated because of the high probability of crop failure. However, from the interviews with wheat farmers, it was revealed that in good rainfall years many farmers leave part of their land uncultivated because of the unavailability of enough cash to enable them to cultivate all the land. Thus, land supply in the rain-fed areas seems very large and could be expanded horizontally if the funds were obtained and managed.

4. Wheat Merchants, Millers, and Bakers

In Jordan, wheat merchants can be classified into the following categories:

a. Village wholesale merchants

b. Rural city merchants

c. Terminal city merchants

a. Village wholesale merchants

In most wheat dryland areas, there are a few wheat merchants in each village who usually grow wheat in addition to undertaking wheat buying and selling activities. Village wheat merchants are small businessmen and handle small quantities of wheat. Because of the traditional village system prevailing in Jordan where farmers socially associate with each other closely, we find village merchants have closer contact with farmers; and most are aware of village wheat production conditions. Due to the small size of wheat trade the village merchants deal with, some merchants function two parallel but distinctive tasks in wheat trade: (i) buying wheat for his own account and (ii) acting as an intermediary agent-middleman between village farmers and rural city merchants. City wholesale merchants charge a sales commission fee as shown below.

(i) <u>Basic activities of wheat village merchants</u> There are two ways by which the wheat trade takes place at the village level--either the village merchant visits wheat farmers and solicits wheat, or farmers come to the village wheat merchant's little store and offer their wheat sample.

In both ways, if the two parties are interested in the deal, they would bargain about the price until reaching an agreement. The agreement usually includes the price of wheat and terms of trade, such as delivery, packing, and payment.

Usually, a farmer prefers the merchant to come and pick up the wheat from his home because it is more difficult for farmers to find a truck and workers to carry the wheat up to the merchant's store. After agreeing on these terms, the merchant goes to the farm with a truck, a number of workers, bags, and a scale measurement for weighing the wheat. The village merchant usually likes to keep the wheat sample the farmer gave to him in order to compare it with the bulk of wheat at the farm; and he reserves the right of stopping the deal if the wheat sample was better than the wheat offered for sale--for example, if the sample is cleaner and has bigger size wheat seeds. According to village merchants interviewed, such problems rarely happen.

In the case of a village merchant acting as a middleman between farmers and wholesale rural city merchants, he visits farmers, obtains samples of their wheat and their asked price, then goes to the rural city wholesale grain market and offers the samples to the city merchants whom he thinks are interested in purchasing wheat. If a city merchant accepts the sample and price, then the purchase takes place as indicated above. The middleman gets his commission, which is usually paid by the merchants at the rate of .500-1.00 J.D./ton of wheat.

b. Rural city wholesale merchants

Jordan dryland areas are grouped according to their locations into five major governmental districts--Irbid, Amman, Balqu, Karak, and Maan. In each district, there is one city which represents the trading center of the district. For example, Irbid city is considered the center of the northern region of Jordan. Most of the agricultural trade activities of this district take place in Irbid. Grain merchants have been traditionally very active in internal and external grain trade. However, the wheat trade in recent years was reduced and limited to Jordan's major trading cities after the Jordanian government did not allow wheat exporting and importing with the neighboring country, Syria, and after the Jordanian government interferred with wheat imports and established support programs. However, Irbid wheat merchants still perform more selling and purchasing transactions than urban cities, due to the rural characteristics of the Irbid population who continue to buy wheat for their own daily bread consumption.

An Irbid wheat merchant has a relatively large-size shop where he stores his wheat and other grains in 100 kg bags. Most of the wholesale grain merchants were forced to enter the retail sale business due to the deterioration of the wheat business in general. Selling grains (wheat, barley, lentils, kirssaneh, chick-peas, and beans) and field crops at smaller quantities was undertaken to make some profit and to help to cover the fixed cost. Irbid grain merchants buy wheat most of the time directly from the farmers who usually come to the market with their wheat samples to show and bargain for a price. Sometimes, the merchants visit farmers at their villages and try to make a deal with them. The Irbid wheat merchants' customers are several rural households; small wheat merchants in faraway villages in poor producing wheat areas, as in the eastern lands; and the Ministry of Supply who recently bought directly from Irbid wheat merchants.

c. Urban city wholesale merchants

Here, we refer to Amman as the urban city whose wheat trade has been affected most by the Jordanian government's intervention in the wheat subsector through the government's importing wheat, providing subsidized wheat to major millers, and controlling prices of flour and bread. All these governmental measures have affected drastically Amman merchants and reduced their size of operation; this subject will be dealt with in length in other sections of this study. Most of Amman's wheat merchants buy their wheat from Amman and Balqa wheat farmers, and sometimes from Irbid farmers, and sell it to the Ministry of Supply; poultry farms where wheat is being used for feed; a few households who still do their baking at home; retailers and groceriers who usually sell wheat and other grains in smaller quantities; and wheat merchants in other areas.

d. Local custom millers

There are a great many small custom milling houses spreading throughout the country. They provide wheat milling services to the villagers. It is very easy to recognize the existence of each mill from a distance because the engine of the mill has a very distinctive rhythm. Most of these mills are quite old and simple but seem to operate very efficiently on a small-scale operation. Rural wives bring a quantity of wheat, enough for the whole week, to the custom mill house and spend a joyful time talking with the neighbors who happen to be in the same place.

The custom miller charges for his services on the basis of weight units (kg). The going rate among villages ranges between 5-7 fils/kg or 5-7 J.D./ton of wheat. It seems the existence of such traditional milling operations on the village level has smoothened the internal flow of wheat in each village and satisfied the people's need for wheat flour, thereby avoiding a bottleneck problem in furnishing wheat, flour, and bread in rural centers. The writer believes that having each village satisfy itself with its wheat milling and bread baking is a great advantage to Jordan's decision makers and Ministry of Supply officials at the capital. This would reduce their responsibility to satisfy the densely-populated urban cities, such as Amman and Zarqa.

e. Local custom bakers

In Jordan's rural villages and many places in urban areas, custom bakers provide important services to the people of the area. After the wives prepare the flour, make it into dough, and divide it into circular-type loaves, the son or daughter of the family carries these unbaked loaves on a wooden tray early in the morning and takes it to the neighboring bakery. Within a short period of time, about half an hour, the fresh baked bread is ready. Custom bakers, who may be wheat farmers also, charge on a monthly basis according to the number of loaves he baked daily. This would mean, in terms of weight, at the rate of 10 fils/kg of bread.

Usually, these village custom bakers do not sell bread but only sell their service of baking bread. Some farmers have their own baking facility at home and need not use the services of custom bakers, but the majority bake at the custom bakeries. While this tradition has persisted in Jordan's rural villages, it is diminishing at an increasing rate from urban areas where it has become very convenient to buy fresh baked bread from commercial bread bakeries.

f. Big commercial millers

Jordan has a large number of small-size mills spreading throughout the country and the rural areas in particular. In addition, there are six big commercial milling companies, which provide flour to all commercial bakeries, located in urban and semiurban areas in the country. Those six mills are distributed into the three largest cities in the country--three mills in Amman, two mills in Zanqa city, and one mill in Irbid city. They seem to reflect the population density and the size of flour demand in each city and its surrounding area. In the past two years, the government has started to furnish these mills with all their wheat requirement, exclusively. The Ministry of Supply has been taking the responsibility of importing wheat and selling it at a subsidized price of 33 J.D./ton, including the transportation cost from the port of Aqaba to the milling house for both hard and soft wheat. Before this government arrangement took place, mill companies used to import directly from abroad about 20 percent of their requirement and purchase locally about 40 percent; and the government imported the remaining portion about 40 percent. Most of these large mills operate three shifts a day and produce two basic kinds of flour on the following basis. A ton of wheat is milled into the following: 60-65 percent flour of grade one, 22-25 percent flour of grade zero, and 18-22 percent bran and impurities. Each one of these six mills sells flour to a government-assigned number of commercial bakers. The sale prices of flour are as follows: flour of grade zero is sold at 44 J.D./ton; flour of grade one at 38.5 J.D./ton. In addition to these commercial bakeries, the Ministry of Supply gives permits to a certain number of flour merchants to obtain their requirements from those six mills.

Bran is sold by government permits to poultry farms for feed.

Milling companies are not happy with this government intervention and controlled operation; and from interviews made with three mills, the writer learned of the drastically low profit margin which the mills are operating under. The controlled wheat purchase price and flour sale price make their operations almost nationalized and create a lack of competition between mills.

g. Commercial bakeries

Commercial bakeries, mostly concentrated in urban areas, sell a popular kind of bread, a rounded, flatten type of loaf called "kemaj." Those bakeries obtain their flour needs from the six major mills. Although the baker has the choice of which mill to buy his demanded flour from, neither price nor quality of flour are his privilege to ask for. In addition, bread prices are controlled at 50 fils/kg or 50 J.D./ton. Under such a price level, the bakers have increasing pressure to reorganize their operating expenses. Labor's increasing wage demands are the most severe problem the bakers are encountering. Because of controlled bread and flour prices, the bakers cannot afford to increase wages; and as a result, the labor turnover rate is quite high. Some bakers expanded their baking line to include a higher quality of bread at higher prices which do not fall under the government price control.

A ton of flour of grade one makes, on the average, about one and a quarter ton of bread. A continued dispute goes on between the bakers and the Ministry of Supply regarding the bread-making regulations and price control. This dispute has been reflected by shortages of bread and poor services in the bread market.

5. Government Input Market Intervention

The Jordanian government's intervention in the agricultural input market is less clear than in the output market. There has been no clear-cut government strategy in providing and assisting wheat farmers with needed inputs and extension services, and there is no government control over the private agribusiness operation in the input market.

However, as national goals were spelled out in the agricultural sector, the Ministry of Agriculture undertook the responsibility of doubling the aggregate wheat production by 1980. This goal is aimed at self-satisfying the population's wheat requirements and relieving the national budget from the sizable foreign exchange to be allocated for importing wheat.

A new emphasis has been to focus on developing and distributing improved wheat seeds to dryland farmers. This project has two phases--the first phase is to provide cleaned and treated seeds selected from good local varieties which suit dryland conditions. The major two varieties are Horani Nawawi and F8. The second phase is to provide and distribute genetically improved wheat varieties, such as Deir Alla No. 2, which is a cross between local variety, Horani Nawawi, and the Turkish variety, 1110/T. This is a higher yielding variety, resistant to drought conditions. The Ministry of Agriculture distributes these improved seeds to wheat farmers in a form of loan-in-kind to be repaid from their wheat at the next harvest season.

In addition to the above contributions, the Ministry of Agriculture provides the following services to wheat farmers.

a. Seed cleaning services

There are some seed cleaning facilities at the offices of the Ministry of Agriculture in different cities. Wheat farmers can use these facilities free of charge by bringing their wheat to these centers to get them cleaned.

b. Spraying weeds services

Offices of the Ministry of Agriculture stand ready to provide spraying services to wheat farmers. A request form must be completed and turned in. There is a nominal fee to be paid by farmers to cover only the cost of chemicals.

c. Fertilizer services

Occasionally, the Ministry of Agriculture imports certain quantities of fertilizers and sells it to farmers at a reduced price.

d. Agricultural loans

Through the Agricultural Credit Corporation (ACC), cash loans are furnished to farmers. These loans are of three kinds--short, medium, and long run. Loans are granted within the framework of the rules and regulations outlined by the ACC. From the wheat farmer survey conducted for this study, the writer observed that the poverty and the subsistence level conditions which prevailed among wheat farmers was one of the real obstacles to adopting improved agricultural inputs. However, despite the acute need for agricultural loans, many farmers refrain from soliciting government loans because of the interest rate rules which are perceived by farmers on religious grounds as an unacceptable arrangement. Thus, many farmers would not borrow and, therefore, are unable to purchase and use the appropriate inputs because of a lack of funds.

e. <u>Agricultural cooperative services</u>

Jordan has witnessed a somewhat late cooperative movement. However, the government's policy for the past few years seemed to sponsor this movement and strengthen its role which it hoped to play as a leading growth media for improving the dryland wheat production practices. The government set up the Central Cooperative Organization and appointed local managers in rural cities for the purpose of providing for the necessary needs of wheat farmers, such as improved seeds, loans, tractor services, graindrills, spraying services, and others.

The village farmers have mixed feelings about the cooperative. Many farmers interviewed from villages where cooperatives have not been created expressed willingness and desire to participate in the potential cooperative to be established in their village. However, the greater proportion of farmers in villages where cooperatives have been in existence refrained from participation in its activity because of religious reasons, such as paying interest on loans.

6. Government Wheat Market Intervention

In the recent years, Jordan's government has been increasing its role of intervention in the wheat subsector, until the middle of 1973 when it assumed complete control of wheat imports and for all practical purposes dominated the overall operation of the wheat subsector. The assumption of government intervention in the wheat subsector stems from two basic aspects--one is the continuing wheat deficit Jordan faces, and the second is the government's goal of keeping the price of bread for Jordanian households at its low level of 50 fils/kg.

Government intervention in the wheat subsector has several aspects:

a. Wheat price support program

b. Wheat import policy

c. Wheat export policy

d. Distribution of wheat at subsidized prices

e. Control of prices of flour and bread

a. Wheat price support program

This program aims at encouraging wheat farmers to expand their wheat acreage and increase their land productivity by offering a purchase price of 55 J.D./ton for commercial wheat. Thus, through this price support, the government tried to enter the private wheat market and encourage farmers to sell their wheat to the government. However, this program, which came into existence in the past year only, did not succeed; and the farmers did not respond favorably to such a program. Major factors which were responsible for this were: (i) the timing of the government's announcement was wrong. The Ministry of Supply announced its offer three months after the harvest season of 1974, at the time when many farmers had sold a sizable portion of their wheat. (ii) The price difference between government and wholesale purchase market was not large. At the time the government announced its price support at 55 J.D./ton, the wholesale purchase price was 52 J.D./ton. (iii) The government's set of rules for purchasing was not an incentive for the farmers to sell their wheat through the government program. Farmers were to send a sample of their wheat for purity inspection, had to bring their wheat to the Amman center, and were to get paid later by checks. All these bureaucratic rules caused farmers to favor the flexibility of the private wholesale merchants and sell their wheat to them, even at 3 J.D./ton less than the price support level. Consequently, because there has been no flexible systematic means of organization to implement this program, the Ministry of Supply was able to buy only 10,000 tons, most of which came from Irbid and Amman wholesale wheat merchants and not from farmers.

b. Wheat import policy

As mentioned earlier, Jordan's government had the indisputable responsibility of furnishing the internal bread market with its needs of wheat and flour; and because Jordan's local production plus the relief programs and donations of wheat do not suffice to meet the total country's requirement, the government has been engaging in wheat imports from the world wheat market through P.L. 480 Title I. Jordanian private wheat merchants are no longer entering this external trade sphere because the government sells the imported wheat to major milling companies at much below the import price. Therefore, private wholesale grain merchants are unable to import wheat for the purpose of selling it to milling companies and are unable to sell locally purchased wheat to mills. The Jordanian government imports wheat at price levels that ranged from 40-50 up to 80-90 J.D./ton and sell it at 33 J.D./ton to milling companies. Under these government arrangements, greater portions of Jordanian wheat merchants' economic activities have been eliminated; and the market supply and demand forces for wheat were disrupted. A detailed analysis on the effect of government wheat purchases and import policy is forthcoming in later sections of this study.

c. Wheat export policy

Because of the acute shortages in wheat supply, Jordan's government restricts private grain merchants from exporting wheat or flour, except small quantities are permitted to be exported to the northern part of Saudi Arabia which is adjacent to the southern region of Jordan. The annual exports are estimated at 8,000-10,000 tons. In the pre-1967 period, wheat was allowed to flow to the West Bank of Jordan; but after the occupation, no wheat trade was permitted with the West Bank. Therefore, the wheat wholesale merchant's business has been reduced largely by the government's import and export policies.

d. <u>Distribution of imported wheat at subsidized prices</u>

According to the government prepared wheat supply and distribution tables, the Ministry of Supply imports wheat, distributes it to the six major milling companies at 33 J.D./ton, and sets up the rules by which milling companies should operate and sell flour to bakeries and flour merchants. One of these rules is to process a ton of wheat into 65 percent flour of grade one, 15 percent flour of grade zero, and 20 percent bran and impurities. Casual inspection by the Ministry of Supply is made at the mill to assure the quality of the flour and of sales according to the government rules.

e. <u>Flour and bread price ceiling</u>

The Jordanian government's ultimate purpose of importing wheat and selling it at a price level much lower than the import price was to enable households to buy bread and flour at this low level. To achieve this goal, the government sells imported and local wheat to milling companies at 33 J.D./ton and imposes the following flour sale prices:

Flour of grade one	38.5 J.D./ton
Flour of grade zero	44.0 J.D./ton
Bran	20.5 J.D./ton

At these prices, bakers and flour merchants purchase the flour; and the government has placed a set of restrictions to sell bread at 50 fils/kg or 50 J.D./ton. Flour merchants must sell flour of certain quantities to households at 40.5 J.D./ton for grade one flour.

7. Explanation of the Wheat Subsector of Jordan

The purpose of this study is to present an economic explanation and evaluation of the wheat subsector of Jordan. Jordan's wheat subsector includes the vertical set of economic activities starting from the stage of wheat production, passing through marketing and processing, and ending with the ultimate purchases of bread by Jordanian households. This, in effect, will encompass all the participants in this subsector which are, according to the stages of economic activities, as follows:

a. In the production of wheat: (i) wheat farmers and (ii) farm suppliers-input agribusinessmen.

b. In the wheat marketing: (i) wheat merchants at all levels, village wholesalers, rural city and terminal wholesalers, and retailers; (ii) wheat middlemen; (iii) government local purchasing agents; (iv) government importing agents; and (v) wheat donors and international contributing agencies.

c. In the wheat processing: (i) large-size milling companies, (ii) middle-size milling custom operators, and (iii) commercial bakers and custom bakers.

d. In the wheat distribution: (i) bread consumers-Jordanian households, (ii) feeds for animals, (iii) seeding requirements, and (iv) exporting limited quantities to Saudi Arabia.

Jordan's wheat subsector also includes government institutions which affect and coordinate these successive stages of wheat flow, such as the Ministry of Agriculture, the Ministry of Supply, and other governmental agencies. Thus, Jordan's wheat subsector is a complex group of interdependent and interconnected activities whose success depends on the overall operation of the subsector participants.

The central concept behind this study is that, in order to investigate and evaluate any problems of this subsector and in order to develop effective remedial strategy and policy, requires a study of the total operation of this wheat subsector or, as Ray Goldberg calls it, the total commodity system (15). For example, to investigate the problem of wheat dryland productivity and to identify barriers to improved input adoption by Jordan's farmers will require a study of the availability of these improved inputs at the farm suppliers at the right time and prices that farmers are able and willing to use them. Wheat yield improvement would require a study of farmers' expectations of their land productivity and the economic incentives to produce and expand his production. Such efforts call for an investigation of public policy in the agricultural sector and of national goals that are set up according to priorities. Higher prices of wheat, as one incentive to wheat farmers, may be achieved by marketing mechanisms. Higher demands for farmers' wheat will push up the price level for wheat, which is necessary in order to create an incentive for wheat farmers to adopt the higher cost of modern practices and expand their production. Therefore, a study of the marketing of wheat is interconnected with investigating the economic incentives to increase wheat yields. If farmers who improve their wheat dryland productivity are faced with a depressed market demand for wheat and, consequently, with a lower level of prices, farmers will end up by incurring losses and ultimately contract wheat acreage and/or reduce modern input application at an early stage of adoption of new wheat dryland technology. However, if the government allows the prices of wheat to respond to the market shortages of wheat, the consumer will face higher bread prices. This, from the public policy stand, may not be desirable and may be politically dangerous. If the government insists on keeping the price of bread at its low level, 50 fils/kg, and at the same time plans to increase the wheat dryland productivity, it must continue a price support program and allocate an adequate sum for subsidizing this wheat subsector. Government responsibility in implementing its program and, thereby, interfering with the wheat market requires highly efficient public policy makers. The government's nonprice increase policy for bread would interrupt the free market price mechanism and may replace it with a government-imposed pricing policy for wheat, flour, and bread and with government control of quality specification to guarantee a smooth flow of wheat, flour, and bread in the market. Apparently, greater linkages between production, marketing, and processing exist; and the linkage persists in spite of government intervention through price supports and price ceilings. In addition, Jordan receives a sizable quantity of wheat donations from the United Nations special agency, UNRWA, and other international organizations which purchase wheat at easy terms through P.L. 480 Title I. All these introduce significant external elements over which the country has no control. The Jordanian government's responsibility to launch wheat improvement projects, to reach self-sufficiency in wheat, and to reduce dependency on foreign aid would require greater allocation of resources but, in the long run, would have had its positive impact had the P.L. 480 program become inoperational and had international agencies terminated their assistance. It seems a tradeoff relationship between the self-satisfaction drive by improved input adoption and between easy-terms purchases and free donations, which may terminate, may result in the country having to purchase at much higher prices from the world wheat market.

Expanding wheat production does not depend on price incentives solely. An efficient marketing system is needed to assure smooth wheat flow from the farmer sector to wheat merchants, who link the production aspect with the processing and consumption aspects. Thus, there must be effective channels by which wheat merchants can distribute their stock of wheat to milling companies and other wheat users, efficient communication systems to disseminate the price of wheat information, and improved transportation systems to facilitate the movement of wheat from village to the ultimate users as well as from lower wheat price areas to higher price markets.

The phenomenon of seasonal production of wheat combined with year-round consumption requires efficient storage facilities and a high level of coordination between production, marketing, and processing in order to avoid imbalances and bottlenecks in the flow of wheat, flour, and bread in the markets.

II. THE GAP BETWEEN PRESENT AND POTENTIAL YIELDS OF JORDANIAN WHEAT PRODUCTION

1. Current Wheat Production

Jordan's wheat yield is one of the lowest in the world, with a 16-year average of 560 kg per hectare or approximately eight bushels per acre. Scarce and erratic rainfall is primarily responsible for low yields, but poor soil-moisture management, poorly prepared seedbeds, hand seeding, inadequate fertilization, heavy weed infestations, and low potential yielding wheat varieties all take their toll (41). In addition, in some years, hot winds in late April and May while wheat is still immature, reduce yields dramatically.

The principal objective of this chapter is to study the current and the potential wheat yields in Jordan and to investigate the possibilities of improving yield through the adoption of modern agricultural practices under Jordan's weather conditions. To accomplish this objective, a need for empirical data on wheat production under both traditional (current) and improved (potential) cultural practices existed. Rough data seemed to be available in the form of governmental demonstration results. Since 1967, Jordanian officials have focused their attentions and efforts on improving local wheat production conditions. Since then a series of agricultural demonstrations have been conducted annually to show, teach, and demonstrate to wheat farmers the effect of a package of improved practices on their wheat land productivity. The response to the improved inputs is measured as the difference in wheat yields between the yield obtained on the demonstration plots and the yields from adjoining fields which received traditional cultural practices. The fields receiving traditional practices are designated as check plots. The results of these demonstrations will be used in this study as the best empirical data available on wheat production improvement in Jordan.

a. <u>The effect of the package of improved input on wheat yield under annual cropping practices</u>

Table 2.1 reports the average wheat yields of traditional and annual cropping demonstration plots over the period 1968-1973, distributed by major districts. This table presents the effectiveness of the package of improved inputs on dryland wheat areas by major district and shows the national average wheat yield for both traditional and improved cultural practices. The district of Balqa shows the greatest response of any of Jordan's districts. The average yield for the demonstration plots over seven years is 77.27 percent higher than the check. Amman, Irbid, and Karak follow with 54, 50, and 47.5 percent increases in yields, respectively. Maan ranks lowest with an average increase of 29.41 percent. This table does not allow for much further analysis pertaining to the potential for improvement at the wheat drylands in Jordan. The need for additional information on the size of the dryland area and its distribution among rainfall belts in each district seems to exist. However,

Table 2.1 Average yields on annual cropping demonstration plots over the period 1968-1973, distributed by major districts[a]

District	I Annual cropping demonstration wheat yield kg/du	II Check wheat yield kg/du	III Difference between annual cropping demonstration and check yield (I - II)	IV Percentage difference (III ÷ II x 100)
Irbid	164	109	55	50
Amman	191	124	67	54
Balqa	195	110	85	77
Karak	121	82	39	47
Ma'an	88	68	20	29
Average (national)	151.8	98.6	53.20	54

[a]Source: (28).

the table shows that the national average wheat yield on the traditional farms is 98.6 kg per dunum. Although this estimate differs from the general estimate of 80 kg, it is consistent with the analysis of the annual cropping demonstrations, which were generally performed in areas that receive annual rainfall above 300 mm and thus naturally have higher yields than those areas of less than 300 mm. Most of the summer fallow demonstrations were chosen in areas which receive less than 300 mm. The national average wheat yield on a traditional farm in areas receiving less than 300 mm of moisture is estimated at 69.5 kg per dunum, as seen in Table 2.2. An average of these two national yields, 69.5 and 98.6, would be 84 kg, a figure very close to the general estimate of 80 kg. Table 2.1 also indicates that the national potential wheat yield, within the current existing technical knowledge, is estimated at 151.8 kg per dunum if the package of improved inputs is adopted. This means the increase in yield over that of the traditional farm will be approximately 54 percent. If we assume that the period 1968-1974 covers a complete weather cycle, we can hypothesize that a 50 percent increase in yield in areas receiving over 300 mm annual rainfall is quite possible if farmers use the recommended kinds and rates of inputs.

b. <u>The effect of the package of improved inputs and the practice of clean summer fallow on wheat yields</u>

Table 2.2 reports average wheat yields of traditional and summer fallow demonstration plots over the period 1968-1974, distributed by major districts.

Table 2.2. Average yields on the summer fallow demonstration plots over the period 1968-1974, distributed by major districts[a]

District	I Summer fallow demonstration wheat yield kg/du	II Check wheat yield kg/du	III Difference between SFD and check (I - II)	IV Percentage difference (III ÷ II x 100)
Irbid	133	80	53	66
Amman	178	113	65	58
Balqa	142	65	77	118
Karak	136	77	59	77
Maʿan	20	12	8	67
Average (national)	121.8	69.5	52.4	76

[a]Source: (28).

This technique--summar fallowing--aims at conserving 30 to 50 percent of the precipitation which falls during the fallow year, making it available for the following wheat-growing season. The Balqa district also ranks first regarding the effect of summer fallowing on the wheat yields with a 118 percent increase. The Karak, Maàn, and Irbid districts follow with 77, 67, and 66 percent increases, respectively. The Amman district ranks lowest with 58 percent. Although these results do not provide us with sufficient information, such as the rainfall and conserved moisture estimates necessary to make some analytical conclusions, the total average is nevertheless useful in studying the overall response of summer fallowing, plus the improved inputs' application on the national level. The national average yield under summer fallowing is estimated at 121.8 kg per dunum, while the traditional yield under the same weather conditions, but without fallowing, is around 69.5 kg. This 52.4 kg, or 76 percent, increase is mainly a function of two integrated factors: (1) the conservation of moisture through the clean fallowing practices in the fallow year and (2) the implementation of improved inputs. How much each factor has added to the wheat yield is difficult to estimate with the available data; however, the normal logic of reasoning would suggest that if we assume that both the annual cropping and summer fallowing demonstrations were under the same weather condition, the 76 percent increase in the wheat yield can be broken down into the following components:

(i) A 54 percent increase resulting from the package of improved inputs. This is the same as is obtained by the national annual cropping demonstration yields.

(ii) Summer fallowing contributes a 22 percent increase (76-54).

2. Analysis of Irbid Region Wheat Production

Since the field of investigation for this study focused on Irbid district, the writer intends to look more closely at the government wheat improvement project results in this district. For the purpose of this study, the project data on Irbid is rearranged and tabulated according to the following rainfall strata:

I. Less than 250 mm

II. 250 - 300 mm

III. 300 - 400 mm

IV. Over 400 mm

Only one annual cropping demonstration is recorded in the area under less than 250 mm rainfall (Mafraq) and for only one year (1968). Similarly, for summer fallowing demonstration, one demonstration is recorded in the area of less than 250 mm rainfall (Hayyan Rowaibed) and for only one year (1973) (29).

Because of this limited number of observations recorded for Rainfall Belt I, less than 250 mm, a meaningful yield average cannot be constructed to represent this belt over the period 1968-1973. Therefore, no recorded yield average will appear in the following tables.

a. <u>The effect of the package of improved inputs on wheat yield under annual cropping practice in Irbid region</u>

Table 2.3 reports the average wheat yield on traditional farms, according to their location on the rainfall isohyetal map. This yield data were collected from traditional farmers whose fields are adjacent to the annual cropping demonstration plots. Variations in yields in different years for any one belt can be attributed to annual rainfall fluctuations. Therefore, we can tell that 1970 and 1973 were very poor rainfall years, in which wheat yields for Rainfall Belt II, for example, were 40.5 and 59.5 kg per dunum, respectively.

In these two years (1970, 1973), Jordan was faced with a drastically low national production level. 1969 was a good year, with wheat yield averaging 85 kg per dunum for this rainfall belt. The other three years reported (1968, 1971, 1972) were considered average, with 76.7, 76.5, and 67.3 kg yield per dunum, respectively. Rainfall Belt III (300-400 mm) shows higher yields every year than those of Rainfall Belt II. The overall (1968-1973) average for Rainfall Belt II is 67.58, while 121.61 kg for Rainfall Belt III. This sizable difference (55.57 percent) is attributed mainly to the difference in the amount of rainfall each belt receives. However, Rainfall Belt IV's average yield is not as high as that of Rainfall Belt III, despite higher amounts of annual precipitation. Jordan's wheat project advisors believe the soil and topography of the

Table 2.3. Average yields on annual cropping traditional plots over the period 1968-1973, distributed by rainfall belts in the Irbid district[a]

Rainfall belts	1968	1969	1970	1971	1972	1973	Average
				(kg/dunum)			
I. Less than 250 mm	--	--	--	--	--	--	--
II. 250-300 mm	76.67	85	40.5	76.50	67.33	59.5	67.58
III. 300-400 mm	103.33	90	111.0	115.67	182.67	127.0	121.61
IV. Over 400 mm	97.14	80	150.0	115.38	123.33	131.5	116.23
Average (national)							101.81

[a]Source: (28).

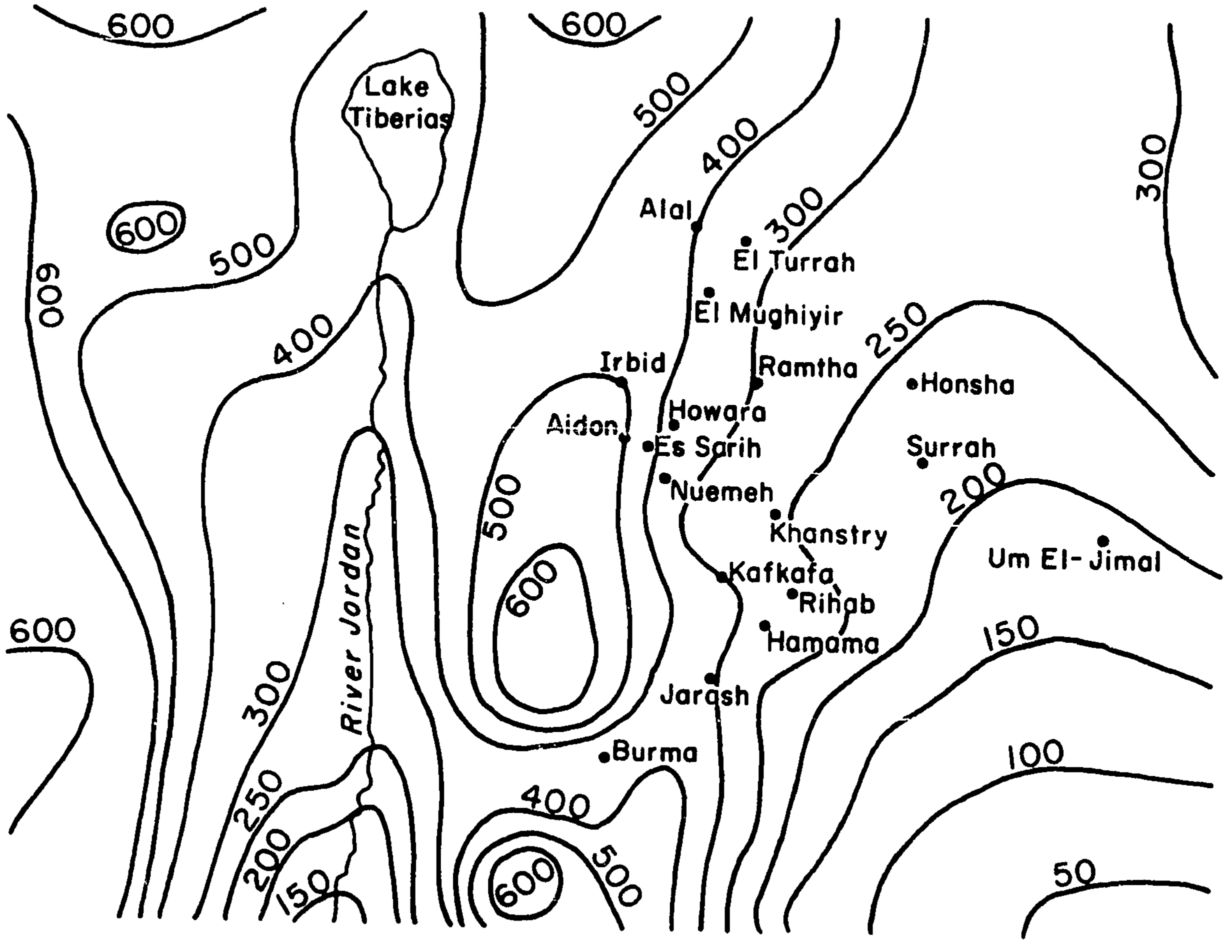


Figure 2.1. The distribution of surveyed villages on the isoheytal rainfall map

drylands in Rainfall Belt IV negatively affect wheat yields, for shallow soil and steeper sloping of the land affect wheat cultivation and growth. The total average yield for the Irbid district over these three belts and over the period 1968-1973 is 101.81 kg per dunum. A closer study of this table may lead to a confusing interpretation, in that what is considered a very poor year in one year for one belt may not be the case for another belt. For example, 1970 Rainfall Belt II showed an extremely low level of yield, while for Rainfall Belt III, 1970 did not reflect a bad wheat yield. It has been observed that variations in wheat yields among villages are high, even within the same rainfall belt. Indeed, wide variation may exist between farms in the same village. These differences in traditional yields can be attributed to a group of factors, such as variation in the amount of precipitation a farm receives, its soil conditions, and the differences in wheat culture practices among traditional farmers.

Table 2.4 reports the recorded average wheat yields on the annual cropping demonstration plots in the Irbid district. These demonstration results represent the potential of Jordan's wheat dryland and its responsiveness to the package of improved inputs application. There has been no precise measurement of the amount of precipitation each plot received and no clear mention of the kind and rate of each input each plot received. However, a number of reports written by the project advisors have indicated that the annual

Table 2.4. Average yields on annual cropping demonstration plots over the period 1968-1973, distributed by rainfall belts in the Irbid district[a]

Rainfall belts	1968	1969	1970	1971	1972	1973	Average
				(kg/dunum)			
I. Less than 250 mm	--	--	--	--	--	--	--
II. 250-300 mm	125.33	128.00	32.50	120.00	80.33	99.00	97.53
III. 300-400 mm	160.67	195.20	139.50	173.00	221.30	172.80	177.00
IV. Over 400 mm	153.00	200.00	181.25	187.25	159.80	186.30	177.93
Average (national)							150.82

[a]Source: (28).

cropping demonstration plot usually receives the following improved inputs for each dunum of land (24).

(i)	Fertilizers:	15-25 kg of nitrogen 4-14 kg of superphosphate
(ii)	Herbicides:	135 gm of sodium salt 2, 4-D to control weeds
(iii)	Wheat seeds:	5-15 kg of improved, cleaned, and treated seeds of domestic variety
(iv)	Graindrills:	seed planted by graindrills
(v)	Tillages:	two tillages for leveling off the ground and seedbed preparation

The six-year average yields for Rainfall Belts II, III, and IV are 97.53, 177, and 177.93 kg per dunum. Quite a difference in yield can be noted between Rainfall Belts II and III because of higher rainfall level but almost the same yield was produced in Rainfall Belts III and IV. This is a very consistent phenomenon with the recorded traditional yields pattern shown in Table 2.3, following the same explanation. That is, despite the higher rate of precipitation demonstration plots in Rainfall Belt IV receive, their topographical and soil conditions--steeper sloping ground and shallow soils--seem to be responsible for the not-much-higher yield response than that of plots in Rainfall Belt III. A national average of wheat yield over the six-year period (1968-1973) and over the three rainfall strata shows about 150.82 kg per dunum. This average will have a meaningful interpretation after study of Table 2.5.

This table reports the yield increase over that of traditional

Table 2.5. Difference in average wheat yields between annual cropping demonstration and traditional plots over the period 1968-1973, distributed by rainfall belts in the Irbid district[a]

Rainfall belts	1968	1969	1970	1971	1972	1973	Average
				(kg/dunum)			
I. Less than 250 mm	--	--	--	--	--	--	--
II. 250-300 mm	48.67	43.0	-8.00	43.50	13.00	39.5	29.95
III. 300-400 mm	57.33	105.2	28.50	57.33	38.67	45.8	55.47
IV. Over 400 mm	55.93	120.0	31.25	71.88	36.50	54.8	61.73
Average (national)							49.05 (= 48%)

[a]Source: (28).

plots, resulting from the adoption of the recommended package of improved inputs. Yield differences are obtained by subtracting the traditional yield-average each year from its corresponding annual cropping demonstration yield. It is observed that in a poor rainfall year, the yield from the annual cropping demonstration was less than its corresponding traditional yield; this case is clear in 1970, known as a poor year, when a negative effect resulted from applying fertilizers which require more moisture to dissolve. A production-economics analysis will illustrate this classical case in the next section. The national average of yield increases over the three belts, and for the period 1968-1973, shows 49 kg per dunum or 48 percent increase in yield over the average traditional yield.

b. <u>The effect of the summer fallow technique on wheat yield</u>

To study the effect of summer fallowing technique on the wheat yields, the following three tables (Tables 2.6-2.8) illustrate the project results in the Irbid district.

Table 2.6 exhibits the average wheat yields in check (traditional) plots which are adjacent to the summer fallowing plots. These yield plots were grouped according to their location into three rainfall strata--250-300, 300-400, and over 400 mm level. The traditional farm practices indicate to us that these yields are obtained from fields which were either planted annually with grain crops or left abandoned for one year (traditionally fallowed)

Table 2.6. Average yields on traditional plots adjoining summer fallowing plots over the period 1969-1974, distributed by rainfall belts in the Irbid district[a]

Rainfall belts	1969	1970	1971	1972	1973	1974	Average
				(kg/dunum)			
I. Less than 250 mm	--	--	--	--	--	--	--
II. 250-300 mm	95	n.a.	57	64	48.5	122.0	77.30
III. 300-400 mm	120	80.0	n.a.	133	25.0	110.4	93.68
IV. Over 400 mm	n.a.	90.5	n.a.	95	n.a.	126.0	103.83
Average (national)							91.60

[a]Source: (28).

Table 2.7. Average yields on summer fallow demonstration plots over the period 1969-1974, distributed by rainfall belts in the Irbid district[a]

Rainfall belts	1969	1970	1971	1972	1973	1974	Average
				(kg/dunum)			
I. Less than 250 mm	--	--	--	--	--	--	--
II. 250-300 mm	145	n.a.	101	121.0	90	155.0	122.40
III. 300-400 mm	230	165	--	168.0	35	148.8	149.36
IV. Over 400 mm	n.a.	164	--	134.5	--	156.5	151.67
Average (national)							141.43

[a]Source: (28).

Table 2.8. Difference in average wheat yields between summer fallow demonstration and traditional plot average yields over the period 1969-1974, distributed by rainfall belts in the Irbid district[a]

Rainfall belts	1969	1970	1971	1972	1973	1974	Average
				(kg/dunum)			
I. Less than 250 mm	--	--	--	--	--	--	--
II. 250-300 mm	50	n.a.	44	57.0	41.5	33.0	45.10
III. 300-400 mm	110	85.0	n.a.	35.0	10.0	38.4	55.68
IV. Over 400 mm	n.a.	73.5	n.a.	39.5	n.a.	30.5	47.83
Average (national)							49.54 (= 54%)

[a]Source: (28).

because low and late rainfall discouraged farmers from growing wheat. No tilling or weeding took place throughout the whole fallow year.

The wheat yield average for the three belts show a consistent pattern with the level of rainfall. 77.3, 93.68, and 103.83 kg of wheat per dunum of land are the average Irbid district yields for Rainfall Belts II, III, and IV, respectively. National average of the three belts for the six-year period is 91.60 kg. This is higher than the national average, 80 kg, as well as higher than the traditional nonsummer fallow average yield of 69.5 kg.

Table 2.7 reports the project's summer fallow demonstration average yields in the Irbid district. It represents, in fact, the potentiality of the summer fallow technique which Oregon State agronomy specialists (project advisors) have promoted in order to raise wheat yield in the lower rainfall dryland areas. The six-year average of wheat yields in each belt show a consistent trend with the level of rainfall in each belt. 122.4, 149,36, and 151.67 kg per dunum are the average yield for Rainfall Belts II, III, and IV, respectively. The national average over the three belts and for the period 1969-1974, 141.14 kg, illustrates future potential yield for traditional farmers if the summer clean fallow and the package of improved input were adopted.

Table 2.8 is constructed by subtracting the traditional yield in each year from the yield of its corresponding summer fallow demonstration. The difference (increase) in the wheat yield can be attributed to two main improvement factors:

(i) the use of the summer clean fallow technique to preserve moisture in the fallow year, and

(ii) the application of the package of improved inputs.

The six-year average showed an increase of 45.10, 55.68, and 47.83 kg per dunum for Rainfall Belts II, III, and IV, respectively. A national average of yield increase over the three belts is 49.54 kg or about 54 percent above the traditional yield.

c. Conclusions

Finally, an overall summary, represented by Table 2.9, combines the two kinds of demonstration results, annual cropping demonstrations with the package of improved inputs used, and the summer fallowing demonstrations with both summer fallow technique and improved inputs used. Rainfall Belt II shows a positive difference between the two kinds of demonstrations, 29.95 and 45.10. Summer fallowing plus the package yielded a 45.10 kg increase from a dunum of dryland, while only the addition of the package increases the yield by 29.95. This implies summer fallowing has caused the yield to rise by 15.15 kg. The situation in Rainfall Belts III and IV is not as clear as with Rainfall Belt II. Both yield increases for summer fallowing and cropping demonstrations in Rainfall Belt III are the same, while scientific inference will suggest the results to be different. This can be explained by grouping yield results from different plots in different villages and different years under the same rainfall belt. For instance, while the average check yield in annual cropping

Table 2.9. Summary of the Irbid district yield demonstration results, distributed by rainfall belts, average over the years 1968-1974[a]

	Package of improved inputs			Package of improved inputs and summer fallowing		
Rainfall belts	Demonst. results	Check	Differ-ence	Demonst. results	Check	Differ-ence
I. Less than 250 mm	--	--	--	--	--	--
II. 250-300 mm	97.53	67.58	29.95	122.40	77.30	45.10
III. 300-400 mm	177.00	121.61	55.47	149.36	93.68	55.68
IV. Over 400 mm	177.93	116.23	61.73	151.67	103.83	47.83
Average (national)	150.82	101.81	49.05 (= 48%)	141.14	91.60	49.54 (= 54%)

[a]Source: Constructed from (28).

demonstrations for Rainfall Belt III is 121.61 kg, we find it to be 93.68 kg in the summer fallow check yield and the same with the demonstration yield. The same type of explanation will be applied to Rainfall Belt IV, which shows opposite results to what is normally expected. Here, the increase in yield because of use of the improved package, 61.73 kg, is higher than the yield increase because of both summer fallowing and the improved package, which is 47.83 kg. However, in spite of these counter-results, the percentage increase of the grand average yield in the summer fallow demonstrations, 54 percent, exceeds that of the annual cropping demonstrations, 48 percent.

3. Production Economics Analysis

The purpose of this section is (1) to make some economic interpretation of the demonstrations results, (2) to investigate the economic efficiency of traditional versus potential wheat production, and (3) to provide some suggestions in the field of improved inputs application under different weather patterns. This analysis will be made under the limitation of the data available.

a. The data available

Because the general purpose of the wheat project was to increase wheat production yield through the adoption of improved inputs, most of the activities of this project were concentrated in conducting agricultural demonstrations throughout the dryland areas to show, teach, and encourage wheat farmers to use better inputs and farming methods in order to obtain higher wheat yields. Hence, for the past seven years (1968-1974), all the data available were in the form of the following:

(i) Wheat yields in check plots adjacent to the demonstration plots These yields represent those of traditional farms where the following inputs are normally applied per dunum of land:

(1) 8-15 kg of seeds of local varieties;

(2) little or no manure or chemical fertilizer applied;

(3) little weeding work or none; and

(4) one shallow tilling after hand broadcasting of the seed to cover it into the soil.

This group of inputs will be referred to as the traditional bundle of inputs.

(ii) Wheat yields in the demonstration results These yields would be represented as potentially attainable had the farmer used the recommended inputs. However, there has been no clear and precise specification of the quantities of improved inputs which were used for each demonstration. A further investigation by questioning project staff revealed that in most of the agricultural demonstrations, the following improved inputs were used per dunum of land:

(1) Fertilizers: 15-25 kg of nitrogen
4-14 kg of superphosphate

(2) Herbicides: 135 gm of sodium salt 2, 4-D

(3) Wheat seeds: 5-15 kg of cleaned and treated seeds of known domestic variety

(4) Tillages: two tillings for leveling off the ground and seedbed preparation

(5) Graindrill: wheat seed planted by graindrills.

This group of inputs will be referred to the package of improved inputs.

(iii) Precipitation estimates Although the moisture variable is considered the limiting factor in wheat production, there has been no real measurement of the amount of precipitation a plot receives during the wheat growing season. Because of the important function moisture data has in the analysis of wheat production, the writer will depend on two major estimates which will help to estimate the amount of rainfall the plot received in a given year:

(1) The rainfall belt, placing the plot village into one of the four major rainfall strata, according to its location, which tells its average historical rainfall level.

(2) The general weather conditions (in terms of rainfall) Jordan has had in a specific year.

For our analysis purposes, we find that the national winter season can be classified into one of three major descriptions--good rainfall year, poor rainfall year, and average rainfall year. This generalization would implicitly assume that the national weather condition in any one year prevails over all the Jordan dryland areas proportionally. That is to say, if Jordan was described as having received a good rainfall season in year x, each village within each rainfall stratum would have had a "good" amount of rainfall relative to its historical average within its rainfall belt. Thus, how much good village A has received in a good rainfall year would depend on the rainfall belt this village (A) falls under. Higher rainfall belts receive proportionally higher amounts of precipitation than do lower rainfall strata.

(iv) Input-output relationship   There have been no controlled experiments on the effect of certain input variables on wheat yields under a specified weather condition. This kind of research is very valuable in production economics to construct the mathematical relationships between different rates of certain inputs such as those of fertilizer, seeds, the number of tillages, the depth of graindrilling, or the rate of spraying; and the wheat yield, to determine the optimal rate of each input application.

Within these limitations in the availability of data, economic theory of production will be used to show the wheat yields in both traditional and potential farms under both good and poor rainfall years.

b. Source of data

Data used of wheat yields in Rainfall Belt II (250-300 mm) to represent good and poor rainfall years, 1970 and 1971 are taken from traditional (check) plots and potential (demonstration) plots.

(i) Poor year: 1970 was nationally known as a bad rainfall year with Rainfall Belt II having

a. average traditional yield at 40.5 kg per dunum[1]

b. average potential yield at 32.5 kg per dunum[2]

(ii) Good year: 1971 was considered nationally a good rainfall year with Rainfall Belt II having

a. average traditional yields at 76.5 kg per dunum[1]

b. average potential yield at 120 kg per dunum[2]

$$P_{wy} = f \text{ (package of improved inputs)}$$

$$T_{wy} = f \text{ (bundle of traditional inputs)}$$

where:

P_{wy} = potential yield, and

T_{wy} = traditional wheat yield.

---

[1]See Table 2.3.

[2]See Table 2.4.

P_{Gwy} = f (package of improved inputs)

T_{Gwy} = f (bundle of traditional inputs)

where:

P_{Gwy} = potential yield in a good year (1971)

T_{Gwy} = traditional wheat yield in a good year (1971)

120 kg = f (package of improved inputs) ... P_{Wwy} ... 1

76 kg = f (bundle of traditional inputs) ... T_{Gwy} ... 2

$D_{Gwy} = P_{Gwy} - T_{Gwy}$

where:

D_{Gwy} = difference in wheat yield between potential and traditional plots in a good year.

$D_{1971} = 120 - 76.5$

$D_{1971} = 43.5$ kg

Similarly, in a bad rainfall year

P_{Bwy} = f (package of improved inputs)

where:

P_{Bwy} = potential wheat yield in a bad rainfall year (1970).

T_{Bwy} = f (bundle of traditional inputs)

where:

T_{Bwy} = traditional yield in a bad rainfall year (1970).

$$32.5 \text{ kg} = f \text{ (package of improved inputs)}$$

$$40.5 \text{ kg} = f \text{ (bundle of traditional inputs)}$$

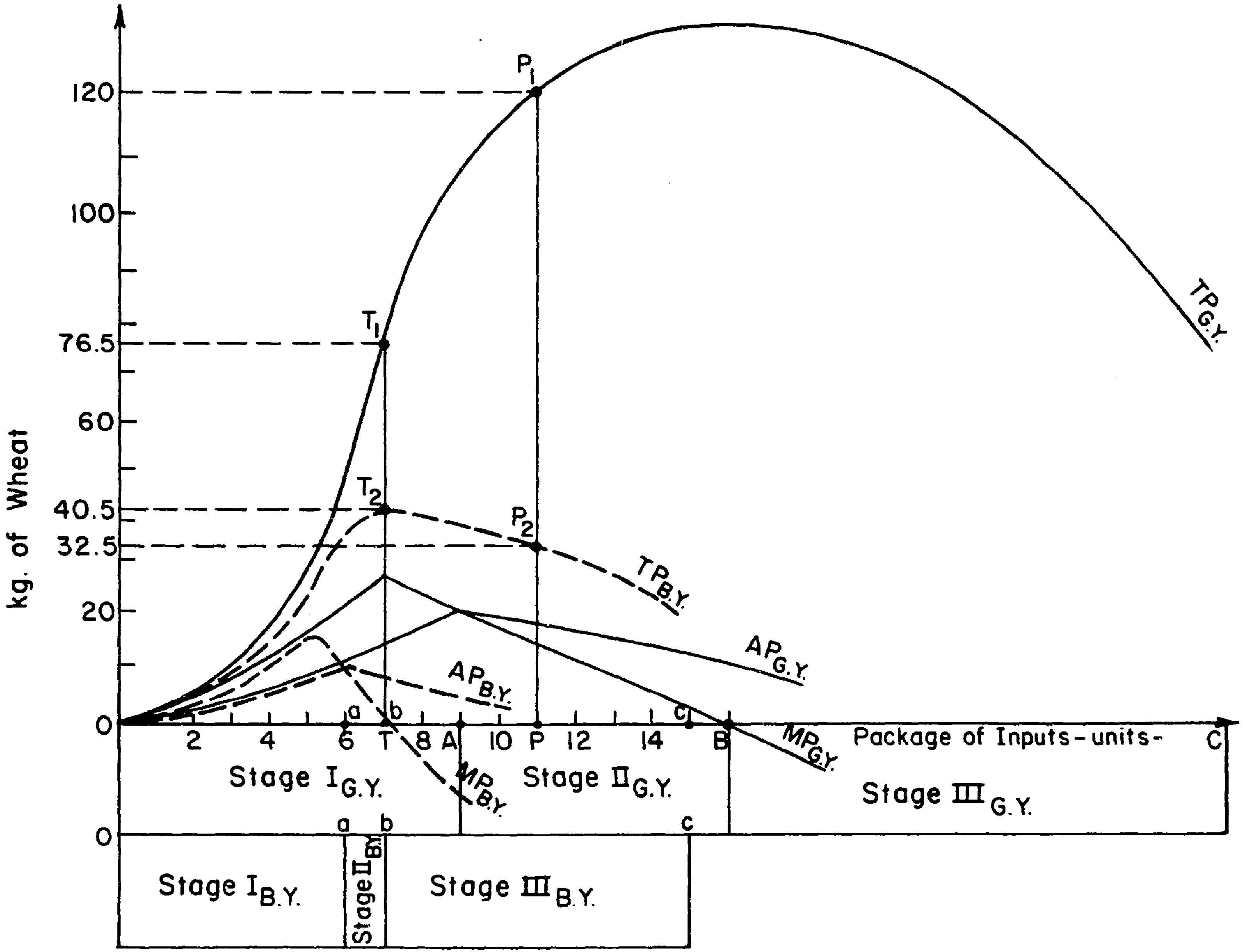
$$D_{Bwy} = P_{Bwy} - T_{Bwy}$$

$$D_{1970} = 32.5 - 40.5$$

$$D_{1970} = -8 \text{ kg per dunum.}$$

For the purpose of presenting the mathematical relationships between inputs and wheat yields in both traditional and potential yields under good and poor rainfall years (1971, 1970), we use the classical shape of production function and assume that with one variable input, the bundle of traditional input and the package of improved inputs both consist of the same inputs, which vary in quantity of units of application. We assume that the package of improved inputs consists of 11 units and that traditional bundle of inputs consists of the same type of inputs but of less quantity, say, seven units as shown by Figure 2.2.

Figure 2.2. Jordan total, average, and marginal products of wheat in good and bad rainfall years



kg. of Wheat
120
100
76.5
60
40.5
32.5
20
0
P1
T1
T2
P2
TP G.Y.
TP B.Y.
AP G.Y.
AP B.Y.
MP G.Y.
MP B.Y.
a
b
c
2
4
6
T
8
A
10
P
12
14
B
Package of Inputs-units-
C
Stage I G.Y.
Stage II G.Y.
Stage III G.Y.
Stage I B.Y.
Stage II B.Y.
Stage III B.Y.

4. Economic Interpretation of Wheat Yields

In 1971 (a good rainfall year), one production function for both potential and traditional wheat production was drawn and identified by the curve, TP_{Gy}, and both the marginal and average product curves were drawn similarly and stages of production were determined. For 1970 (a poor rainfall year), another production function was drawn and identified by the curve, TP_{By}, as was done in determining 1971.

a. In a good rainfall year

The traditional farmer uses OT inputs (seven units) and produce at point T_1 (76.5 kg/du). At this point in the production function, he combines seven units of input with a good level of rainfall, say, 370 mm. For this level of moisture, it appears he uses too small amounts of inputs. In other words, this given amount of moisture was too much and uneconomically utilized when combined with only seven units of inputs. This situation places the traditional farmer at operation in stage I for the inputs, which shows that he operates beyond the extensive margin and in stage III for the moisture available, which means that he produces beyond the intensive margin for moisture. For both input and moisture, he produces in uneconomic stages of production, while the potential farmer uses 11 units and produce at P_1 (120 kg). He combines these units of input (11 units) along with 370 mm of precipitation, thus yielding a much better position on the production function.

At P_1, the potential farmer operates in the economic stage (stage II) for both moisture and the package of inputs.

b. Production in a poor rainfall year

Here, both farmers, traditional and potential, use the same level of inputs as they do in the good rainfall year. The traditional farmer uses 11 units of input but now combined with a much lower level of moisture, say, 200 mm. With this combination, a potential farmer produces at point P_2 and yields 32.5 kg.

As shown graphically, a potential farmer produces in stage III for his input which implies he uses too much input, that is too intensively with the combination of too little moisture. Thus, he operates with respect to input beyond the intensive margin and, therefore, his marginal product of input is negative as shown by the marginal product curve and produces in stage I with respect to moisture, i.e., beyond the extensive margin. A traditional farmer combines only seven units of input with the low level of moisture, 200 mm. With this combination, he is placed to produce in stage II for both moisture and input as shown by point T_2 and yields 40.5 kg/du. A traditional farmer here produces at the intensive margin for input, where the marginal product of input has reached zero but not negative; this implies a traditional farmer operating at the optimal point in his production function.

Another graphic illustration will use the production function for two variable inputs and show the optimal input proportion between the moisture level and the package of inputs. For this analysis, we use the same actual data for Rainfall Belt II in the Irbid region to cover two years:

(i) 1970 is considered a bad year, when the average rainfall for Rainfall Belt II was only 200 mm.

(a) Traditional farmers used seven units of input and harvested 40.5 kg/du.

(b) Potential farmers used 11 units of input and harvested only 32.5 kg of wheat/dunum of dryland.

(ii) 1971 is considered a good rainfall year. The average rainfall received by Rainfall Belt II was assumed to be 370 mm.

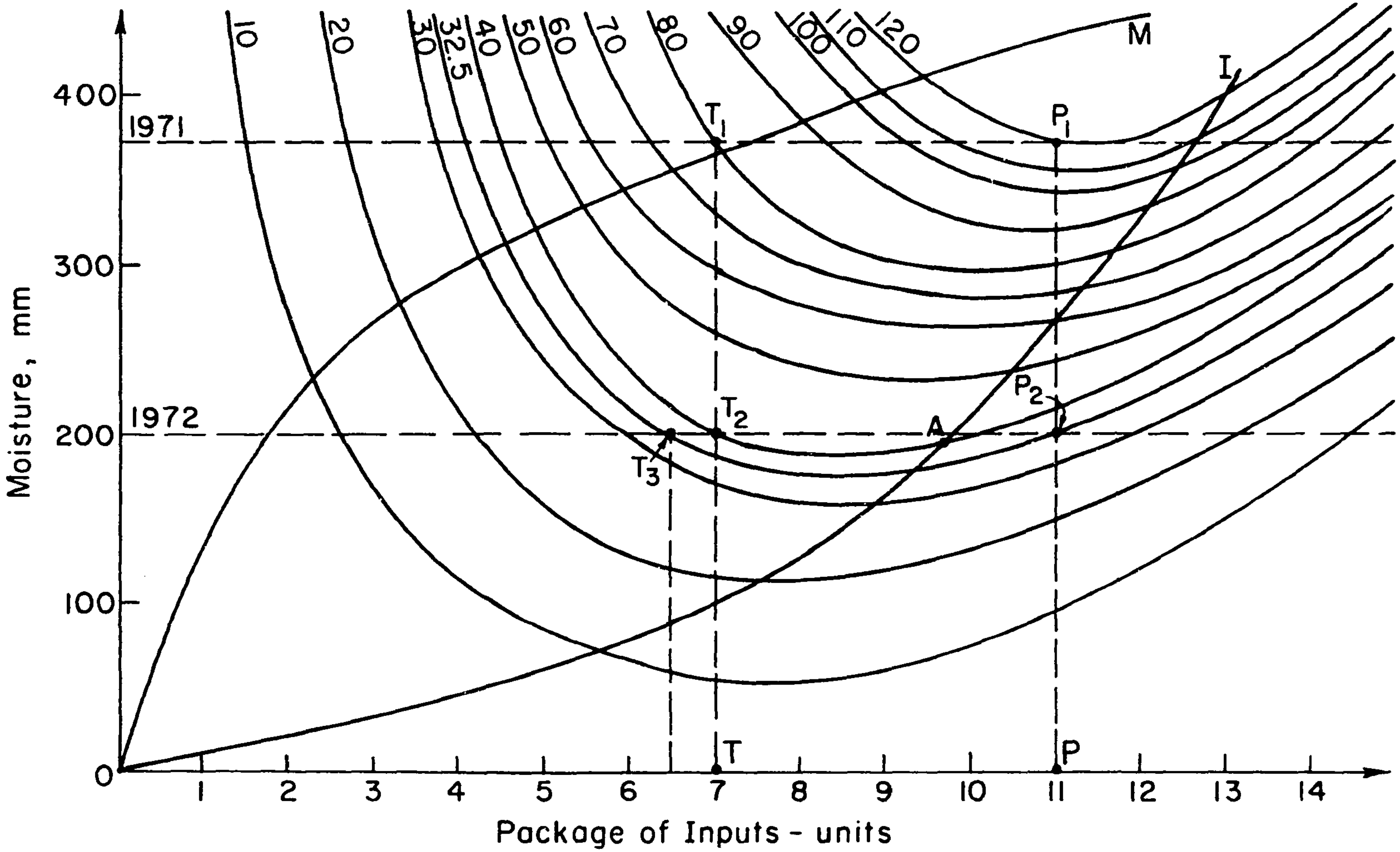
(a) Traditional farmers used seven units of input and harvested 76.5 kg/du.

(b) Potential farmers used 11 units of input and harvested 120 kg of wheat/dunum.

Graph II depicts the position of four production points located on isoquants. Production functions are normally assumed to possess convex isoquants, bowed toward the origin with a decreasing rate of technical substitution as the package of inputs is substituted for moisture along an isoquant (17).

In a bad rainfall year (1970), traditional farmers combine seven units of input with 200 mm of precipitation and produce 40 kg/du as shown in point T_2 at the isoquant 40 kg. Apparently, this farmer is operating between the ridge limes OM and OI which indicates the economic region of production or, as identified in the explanation of Graph I, stage II. This means the combination of seven units of input with 200 mm precipitation was just optimal

Figure 2.3. Isoquant map and the relevant range of production of wheat in Jordan


Moisture, mm
Package of Inputs - units
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14
1971
1972
10
20
30
32.5
40
50
60
70
80
90
100
110
120
M
I
T1
T2
T3
T
P1
P2
P
A

input proportion and produced 40 kg of wheat. A potential farmer used 11 units of inputs in combination with 200 mm of moisture and produced 32.5 kg as indicated by point P_2 at the 32.5 isoquant. This shows that inputs were used uneconomically since 32.5 kg of wheat per dunum can be produced by combining 200 mm rain along with only 6.5 units and, therefore, saving 4.5 units, as illustrated at point T_3. More output, 40 kg, using less input, seven units, can be produced, as in the case of the traditional farmer. A potential farmer, by producing at P_2, used inputs beyond their intensive margin point (A) which means the marginal product of input at P_2 is negative.

In a good rainfall year (1971), a traditional farmer combined seven units of input with 370 mm of moisture and produced, at point T_1, 80 kg. This point is outside the economic region of production. Here, the farmer combined too little input with too much available moisture, i.e., he operated beyond the intensive margin for moisture, identified as stage III and beyond the extensive margin for input, or stage I. A potential farmer combined 11 units of input with 370 mm of rainfall and produced 120 kg of wheat, as is shown by point P_1 on the isoquant 120 kg. This apparently shows production in the economic region which indicates proper input combination between moisture and the package of input.

5. Conclusion

In a good rainfall year, the input proportions employed by potential farmers were on a sound economic basis as shown in the production function graphs, where an additional four units of inputs (11-7) added 40 kg of wheat (120-80). In terms of cost analysis, if we assume the following prices (a) an input unit would cost farmers, perhaps, 250 fils and (b) one kilogram of wheat could be sold at 60 fils. Thus, the additional cost over traditional cost would be 4 x 250 fils = 1,000 fils (1 J.D.), and the additional return would be 40 kg x 60 fils = 2,400 fils (2.4 J.D.). The net return from improved input is equal to 2.4 - 1 = 1.4 J.D./dunum. However, in a bad rainfall year, the potential farmer did not optimize his wheat production. Actually, he incurred losses, as he combined too much input with a much lower moisture level. Thus, the marginal productivity of input was negative as illustrated graphically. He produced only 32.5 kg/dunum, while the traditional farmer with less input yielded 40.5 kg/dunum. Therefore, the potential farmer incurred losses in two areas:

(1) Less output - foregone returns

40.5 - 32.5 = 8 kg
8 x 60 fils = 480 fils

(2) More input cost

11 - 7 = 4 units
4 x 250 fils = 1 J.D. (1,000 fils)

Thus, the total loss equals 1 J.D. + .480 = 1.48. Such a position can be avoided if the optimal input proportions, mainly the proportion of moisture and package of input and mainly fertilizer and seeds, can be determined. This task will depend on the ability of scientists to predict the amount of precipitation which will fall during the growing season. Once this is determined, agronomists will be able to decide the most efficient input combination to be used with this level of moisture, and once these technical relationships are set up, economists will be able to manipulate the input prices to decide the most economical combination of input to produce a given level of yield; i.e., economists can maximize wheat yield for a given input mix or minimize the cost of wheat production for a given level of wheat yield.

6. The Jordanian Government's Wheat Improvement Program

Since 1967, Jordanian officials have focused their attentions and efforts on improving the national wheat yield, with expected results reducing dependence on foreign assistance; for example, obtaining wheat from the United States on easy terms under the P.L. 380 Title I. This would also relieve the government of the responsibility of importing wheat and paying high prices in foreign exchange. Any increase in wheat yield would sustain the economic conditions of wheat farmers and improve their drastically low level of living. The government of Jordan and USAID are cooperating in the development of a Jordanian wheat project. The goal of the project is to double domestic wheat production by 1980. The USAID contribution to the project provides for technical assistance, some grants of equipment and supplies, and participant training. Oregon State University, under contract to USAID since 1968, provides technical assistance and both practical and academic training. Due to similarities in the amounts and pattern of rainfall between eastern Oregon and Jordan, Oregon State University is particularly well equipped to provide these services and has the special expertise to work effectively in Jordanian dryland wheat-producing areas.

7. Major Activities of Wheat Improvement Project

Two major activities of the project are annual cropping and summer fallow demonstrations. These agricultural demonstrations are placed on privately-owned farms in order to attract farmers' attention and to teach and demonstrate to them the effect of improved practices on wheat yields. These experiments are not conducted on government-owned experiment stations because farmers in developing countries tend to have little confidence in what they observe at these stations. Project personnel select the villages, choose the field sites, and ask landowners to allow them to be used as demonstration plots. The conditions under which the agreement is concluded is quite favorable to the landowner, for project personnel provide all the inputs--tilling, graindrilling, spraying, and fertilizing--free of charge. Except for the amount of wheat needed to replace the seeds used to plant the crop, the farmer receives the wheat harvested from the demonstration plot. Through the growing season and at harvest, the project personnel invite farmers from neighboring areas to visit the plots and witness the effect of new technology on the wheat yield.

8. Kinds of Agricultural Demonstrations

a. Annual cropping demonstrations

These demonstrations are conducted in areas that receive more than 300 mm of average annual rainfall and where farmers usually raise wheat as a winter crop. In these areas, wheat is rotated with another winter crop such as lentils or with a summer crop such as watermelon. Farmers sometimes use a three-year crop rotation such as wheat-lentils-summer crop. The size of each demonstration plot is about 20 dunums (two hectares). Prior to the wheat planting season, the project personnel till the land and prepare the seedbed to accommodate the graindrill. Then, the improved seeds, fertilizers, and herbicides are used at the proper rate and time with the proper methods. When, during the growing season, farmers from surrounding villages are invited to visit the plot, they can see the wheat plants' growing condition under the recommended inputs application, and can compare with adjoining fields which use traditional practices. By tradition, the land is tilled once only after hand seeding to cover the seeds, and fertilization and spraying are rarely used. It is hoped that by contrasting the two growing wheat fields under the same weather conditions, farmers will be given incentive to adopt these new and improved techniques.

b. Summer fallow demonstrations

Plots for conducting summer fallow demonstrations are chosen in areas receiving less than 300 mm of average annual rainfall. Plots of 50 dunums (five hectares) each are selected and managed in accordance with the experience developed in eastern Oregon and Washington over the past 30 years. Chisel plows and rod weeders are used to provide minimum tillage methods of weed control. The principal objective of this procedure is the accumulation and storage of moisture for use in the following crop year when the same package of improved inputs used in the annual cropping demonstrations is applied. Through the use of summer clean fallowing practices, it is estimated that 30-50 percent of the total moisture of the fallow year will be conserved. Thus, if the land received 500 mm of precipitation in the fallow year, an additional 75-125 mm of moisture will be available for the next wheat-growing season when another 200-500 mm of rainfall should occur. This provides sufficient moisture to produce an above-average wheat crop and thereby avoid a poor crop or crop failure. Project personnel recommend the use of 12-15 kg of ammonium nitrate and 5-8 kg of triple superphosphate for fertilizing and sodium salt 2, 4-D at the rate of 135 gm per dunum for spraying to control weeds; the optimum level of each input has not been established under Jordanian conditions. There is an urgent need for scientific research in order (1) to determine the best equipment for each tillage operation under Jordan's soil conditions and the best timing and depth for each tilling operation, (2) to decide the most efficient types of graindrills to suit Jordan's land topography in each major dryland area, (3) to specify the optimal rate of each kind of fertilizer and the optimal time for its application, and (4) to decide the most effective kinds of herbicides to control specific and dominant domestic weeks and grasses. Research is currently in progress in these areas.

III. THE SURVEYS

The main objective of this study is to investigate the economic efficiency of the wheat subsector in Jordan. Jordan's wheat subsector includes the vertical set of economic activities starting from wheat production, through the marketing and processing of wheat and ending with the consumption of bread by Jordanian households. This, in effect, encompasses all participants in this subsector, who are--according to the stages of economic activities they are involved in--the following:

a. In the production of wheat: (i) wheat farmers; and (ii) farm suppliers--input agribusiness.

b. In wheat marketing: (i) wheat merchants at all levels, village wholesalers, rural city and terminal wholesalers; (ii) wheat middlemen; (iii) local government purchasing agents; (iv) government importing agents; and (v) wheat donors and international contributing agencies.

c. In wheat processing: (i)large milling companies; (ii) custom millers; (iii) commercial bakeries; and (iv) custom bakers.

d. In wheat distribution: (i) bread consumers--Jordanian households; (ii) farmers who buy feeds for animals; (iii) seeding requirements; and (iv) exporting limited quantities of wheat to Saudi Arabia.

e. Government institutions which affect and coordinate these successive stages of wheat flow, such as the Ministry of Supply, the Agricultural Credit Corporation, the Ministry of Commerce and the National Planning Council. Thus, the survey includes four major groups of participants: (i) wheat producers; (ii) agribusinessmen furnishing agricultural materials, equipment, and services to the dryland wheat farmers; (iii) agribusinessmen in wheat marketing, milling and bread making; and (iv) public or government policy makers and participants in the production, marketing, processing and consumption of wheat.

1. Survey of the Wheat Producers

a. The area of the study

The Irbid region, which represents the northern region of Jordan, was selected as a study area and as the field of investigation for the production of wheat. This selection was made after a good deal of study of Jordan's wheat-producing areas and as a result of the general interest of the Jordanian government in looking at this region as a "growth leader" in wheat improvement plans. Wheat is produced in all governmental districts--Irbid, Amman, Balqa, Karak, Maàn. In addition, wheat is produced on a small scale in the Jordan Valley under irrigated conditions. However, the Irbid district represents the most important wheat-producing region in the country and has significant potential for improvement due to the following characters, as cited by the Agricultural Research and Extension Department (27).

(i) The area used for wheat in this region is 35 percent of the total area of wheat in Jordan, while the production of this region is 40 percent of Jordan's total production.

(ii) The rainfall in the region is high and well distributed, and other climatic conditions are suitable for wheat production.

(iii) The land in the Irbid region is flat and the soil is deep, which encourages the use of agricultural machinery. The Irbid region is considered the natural continuation of the Horan plain which has been famous for wheat production since the dawn of history.

(iv) The density and distribution of the population in the different villages is an essential element for encouraging wheat production in addition to the population's ability to accept new methods in agriculture.

(v) Most of the wheat areas in the Irbid region are linked with a good network of roads, aiding in the transportation of the produce.

(vi) The trade and storage of wheat is common in the region.

(vii) Wheat is considered vital produce of the region, as 60 percent of the population works in agriculture, their major source of income.

(viii) Agricultural cooperative societies engaged in wheat production in cooperation with the ministry of agriculture are available.

b. The sampling procedure

Because in dryland farming rainfall level is the limiting factor in wheat production, as well as in cultural practices and the general adoption of improved inputs, the Irbid region was divided into four major zones--rainbelts--on the basis of the average annual rainfall each zone receives. (i) Rainbelt I--less than 250 mm per annum; (ii) Rainbelt II--250-300 mm; (iii) Rainbelt III--300-400 mm; and (iv) Rainbelt IV--above 400 mm. Wheat production is concentrated in zones two and three[1], as shown in Table 3.1.

On the basis of the relative importance of these wheat producing zones, a stratified sample of 200 farmers in twenty villages--10 farmers in each village--was distributed into the four rainbelts. Table 3.2 shows the size of each zone in terms of the number of farmers interviewed, villages visited and the percentage weight of each belt.

In order to select the villages in each rain belt, a detailed rainfall map had to be obtained. Bigger and scattered villages in each rainbelt were chosen to obtain a representative sample of the villages. For example, it will be noted that the Ramtha area was

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[1]For more description of the rainbelts, see Chapter V.

Table 3.1. Average wheat cultivated area, total production and wheat yield of Irbid region distributed by rainfall zones[a]

Rainfall zones	Average total wheat cultivated area in 000 dunums	Average total wheat production in 000 tons	Average wheat yield kg/du
Less than 250 mm	83	3.4	40
250-300 mm	340	17.5	52
300-400 mm	382	23.2	82
Above 400	90	10	111
Totals	695	54.1	

[a]Source: (28).

chosen to represent four villages in Rainbelt II because of its relative importance as a major wheat producing area in the belt (see Appendix A). Individual wheat farmers were the units of the population survey. Ten farmers interviewed in each village were selected randomly after visits to the municipal government offices in bigger villages and through the Mokhtar[1] guest home in smaller

[1]The Mokhtar is considered the leader of the village.

Table 3.2. Number of farmers and villages surveyed distributed by rain belts

Rain belts	Number of villages	Total number of farmers interviewed	Percentage weights
Less than 250 mm	3	30	15
250-300 mm	7	70	35
300-400 mm	7	70	35
Above 400 mm	3	30	15
Totals	20	200	100

villages, where ten farmers willing to talk about their wheat farming practices were assembled. Farmers were most often interviewed in the morning and afternoon, although occasional visits to the fields took place where wheat farmers were cultivating their land, so as to get first-hand information from the field on issues such as the weeds problem, tillage practices, etc. The author spent a period of over four months in very close contact with wheat farmers, receiving warm welcome from every farmer in each village visited. Once farmers understood the purpose of the survey and the interest of learning about the cultivation practices, they were very cooperative in responding to the questionnaire.

2. Survey Focus of Wheat Farmers

The major problem in Jordan's wheat production involves the low yield and the sharp annual variability in the total wheat production. The average national wheat yield is estimated at 70 kg/ dunum or 8 bushels per acre. A principal objective of the wheat farmer survey was to provide an understanding of the economics of wheat production and the major obstacles farmers face in improving their production. More specifically, the objectives of the study were several.

(a) Investigation of farmers' current production practices and the inputs used. These include their tillage practices, seeding, weed-control, fertilization and the adoption of the summer fallow practice. Furthermore, the survey aimed at measuring the present adoption rate of each of the following recommended improved inputs: (i) proper seedbed preparation and tillage practice; (ii) the use of improved varieties of seed; (iii) the adoption of graindrills; (iv) chemical fertilization; (v) chemical spraying; and (vi) the implementation of the clean summer fallow practice.

(b) Investigation of farmers' knowledge and awareness of the existence of improved cultural practices and their expectations in terms of the effect and cost of improved inputs on the productivity of dryland wheat-farming land will have on individual farmers.

The farmers' knowledge--perceived or actual--of both cost and return of a practice is fundamental in order for him to make an adoption decision.

Study of farmers' attitudes, acceptance and incentives toward the use of improved input. Within the farmers' knowledge and expectation of an improved input, the survey aimed at understanding their willingness and the conditions under which they would accept the adoption of improved inputs and the possible incentives that can be employed to sustain the farmers' desires to use these recommended inputs.

3. Survey of Agribusinessmen in Wheat Production

This survey includes interviews with a number of private agribusiness enterprises which furnish agricultural services, materials, and equipment to wheat farmers. With respect to agribusiness services, four major groups of participants were interviewed: (i) custom tillage operators; (ii) seed broadcasters; (iii) custom chemical sprayers; and (iv) combine harvesting operators. In addition, all major agribusiness importing companies in Jordan--six companies--were surveyed to study their importing procedure and the difficulties they could face, as well as the sales of inputs to wheat farmers and the major problems agribusinessmen encounter in their business.

4. Survey of the Agribusiness Role in Wheat Marketing, Milling, and Bread Making

a. Wheat merchants

To study the economic activities pertaining to the flow of wheat from the farm to all levels of wheat markets, a selected number of wheat wholesalers were interviewed in: (i) the village wholesale wheat market; (ii) the Irbid--as a rural city's--wholesale wheat market; and (iii) the Amman--as an urban city's--wholesale market. A total of ten wheat merchants from the above markets were interviewed to study the purchase mechanism of the wheat from the village farmers, the responsibility of wheat transport from the farm site to the merchant's store, the storage of wheat, and the sale of wheat on each of these three marketing levels.

b. Wheat millers

Two major milling operations exist in Jordan: commercial milling companies and small custom millers. The survey includes both of these activities. A number of village custom-millers and five of the six major milling companies were interviewed to study their economic operation, which includes the purchase of wheat, processing--milling--of the wheat into flour and the sales of flour.

c. Bread makers

As in the milling industry, there are two major participants in the bread making industry: custom and commercial bakeries. The bread making survey included these two activities by interviewing a number of village custom bakers and ten bread bakeries located in Amman. The study aimed at understanding the economic activities of purchases of flour, bread making and the sales of bread to the ultimate Jordanian consumers.

5. Survey of the Jordanian Government's Role in the Wheat Subsector

Several interviews were conducted with the major policy makers in the Jordanian government. With respect to wheat production, a number of interviews were made with the major personnel responsible for the wheat improvement program at the Ministry of Agriculture and at the Department of Agricultural Research and Extension, the chief of the Agricultural cooperative organization in Amman and with their local officers in Irbid, and with the financial manager of the Agricultural Credit Corporation.

In the marketing and processing of wheat, almost all Jordanian government officials at the Ministry of Supply, and the National Planning Council in Amman were interviewed. The major issue discussed with all these public policy makers was the role and effect of the Jordanian government in the wheat subsector. More specifically, these interviews were carried out to study government programs regarding the improvement of wheat-production conditions, through direct government agricultural services provided to the wheat farmers and price support programs which encourage farmers to increase their wheat acreage and improve their cultural practices.

In wheat marketing, government intervention in both the internal and external wheat trade through government wheat import and export policies was studied. In the area of wheat processing and bread making, the goal was to study the role and effect of government intervention in the milling industry by the distribution and sales of wheat to the major milling companies at subsidized prices and the control of the flour sale-price. Finally, these interviews were to study the role of government intervention in the bread industry, represented in the control of sources of flour and the price of bread. In addition to all these direct governmental policies in the wheat internal trade, processing and baking activities, the government of Jordan is responsible for closing the gap between the annual wheat requirements and the local production by importing wheat through P.L. 480 and other foreign wheat sources.

IV. FINDINGS OF THE FIELD STUDY BY IMPROVED INPUTS

1. Tillage Practices

a. Current tillage practices

Jordan dryland wheat farmers are tillage minimizers; they conduct the least tillage operation possible for wheat production. In most of the area cultivated in wheat, no tillage operation takes place prior to the seeding season, and only one shallow tillage is undertaken, mostly by disc plows after sowing to cover the seeds on the soil surface. As a result of current practice, wheat fields are very rough and full of weeds and stones. It seems likely that tillage could be improved and this would in turn raise wheat land production and bring better yield to farmers. In none of the rainfall belts do farmers prepare seedbeds before they start seeding.

The land currently planted in wheat may fall under one of these previous conditions: (1) It was abandoned last year, maybe a farmer decided not to grow wheat, because of poor weather conditions or financial inability. So, the farmer leaves the land idle all year without any tillage or chemical spraying to control the weeds. This practice is called traditional fallow in Jordan. Very few farmers till their land even once during the summer to kill the weeds, the majority of farmers would wait until after the seeding to kill weeds and cover the wheat seeds in one tillage operation. (2) The land may have been used for lentils in the preceding winter season and, after the hand-pulled harvesting of lentils, left bare until the coming wheat growing season. (3) The land may have been used for summer crops such as watermelons; if so the land has been tilled at least three times during and before the summer season. After the harvest of this summer crop, the land will remain bare. After wheat seeding it will receive one tillage operation to cover the seeds and to kill weeds.

Why does the farmer not prepare a seedbed for his wheat production? This is an essential area of inquiry. At the top of the list is the farmer's need to minimize wheat production cost. To till the land twice, once prior to seeding and after would raise costs 20-40% or 0.200-0.300 J.D. per dunum of land. Secondly, the farmer has no experience with seedbed preparation, he never has done it and neither did his father or grandfather. The farmers around him do not and never have done tillage to prepare seedbeds for wheat. Ninety-nine percent of wheat farmers interviewed do not till their land prior to the seeding season. They feel hand broadcasting does not require any seedbed preparation, only those few farmers who use graindrills for seeding are required to make a seedbed to allow the drill to function properly. They till the land and level it off to allow the drill to place and distribute the seeds evenly and at a uniform depth. Seedbed preparation is associated with graindrill, not hand broadcasting.

The tillage activities farmers undertake, the kind of equipment used, and the amount of mechanical tilling being practiced by farmers in the Irbid region are reported in Table 4.1. These

Table 4.1. Interviewed farmers' tillage practices

How farmers get their land tilled	Frequencies	
	No. of farmers	Percentage
By farmers themselves with their own tractors	11	5.5
By farmers themselves with their own draft animals	4	2.0
By hired custom-tractor operators	148	74.0
By farmers themselves with their own draft animals on the rocky and steep ground and by hired tractor operators on the Plains ground	37	18.5
Total	200	100.0

important findings were collected by interviews with farmers in the Irbid region.

79.5 percent of the interviewed farmers use a completely mechanized tilling system on their wheat farms; 2 percent use completely draft animal systems; and the remaining 18.5 percent use tractors on the part of their land which permits the use of machinery and animal power for the other part, which is steep or full of rocks and stones where tractors and discs cannot be used safely. Therefore, it can be said that 98 percent of the Irbid farmers use mechanical power on their levelled fields and 2 percent use animal power. With this high rate of adoption of machinery in tillage practices, we can conclude that the tillage system, in the dryland of Jordan, is fully mechanized where the topographical characteristics of the wheat farms permit. Almost all the flat, nonrocky ground is tilled by tractors with either disc plows or moldboard plows and, only in the steep fields, animal draft and wooden plows are in use. A breakdown of Table 4.1 according to the rainfall belts is shown in Table 4.2.

Table 4.2 reveals no significant variation between farmers in different rainfall areas with respect to the high rate of mechanical power use in tillage practices. The high adoption rate (over 90 percent) of mechanized tilling is prominent among all the four belts.

At the outset, this high rate of adoption of mechanical power looks very impressive for traditional wheat farmers; however, the tillage operation is being minimized by wheat farmers. Farmers have been asked how many times they till their land prior to wheat planting. Table 4.3 reports farmers' responses.

A cross-tabulation of wheat farmers' tillage practices according to their rainbelt location reveals no variation between farmers in the four belts with respect to seedbed preparation. Table 4.4 shows the wheat farmer responses in each belt.

No farmers in each belt undertake seedbed preparation.

Table 4.2. Interviewed farmers' tillage practices distributed by rain belts

How farmers get their land tilled	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
By farmers themselves on their own tractors	6	20	--	--
By farmers themselves on draft animals	--	--	2	2.86
By hired tractor custom operators	24	80	53	75.71
By farmers on draft animals for rocky and steep ground and by hired tractor operators on the Plains ground	--	--	15	21.43
Total	30	100	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
5	7.14	--	--	11	5.5
2	2.86	--	--	4	2.0
41	58.57	30	100	148	74.0
22	31.43	--	--	37	18.5
70	100.00	30	100	200	100.0

Table 4.3. Interviewed farmers' seedbed tillage preparation practices

How many times do you till your land prior to wheat planting	All belts frequencies	
	No. of farmers	Percent
None	198	99.0
One time	1	0.5
One time only when using graindrill for seeding	1	0.5
Total	200	100.0

A closer look at wheat farming systems within each belt may clarify this consistent tillage minimization.

Farmers in Belt I, less than 250 mm. Farmers in this belt grow wheat and barley annually. No crop rotation or fallow system is being used on this dryland. After wheat is harvested in June, the ground is left to the animals for straw grazing and remains untouched until the next winter season, around November. If rain falls early and the total amount of rainfall looks promising, farmers decide to grow wheat and barley. After the seeds are sown, a shallow tillage operation is undertaken to cover the seeds with soil and cut off the weeds. If the rains come late and the winter

Table 4.4. Interviewed farmers' seedbed tillage preparation practices distributed by rainbelts

How many times to you till your land prior to wheat planting	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
None	30	100	70	100
One time	--	--	--	--
One time only when using graindrill for seeding	--	--	--	--
Total	30	100	70	100

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
68	97.14	30	100	198	99.0
1	1.43	--	--	1	0.5
1	1.43	--	--	1	0.5
70	100.00	30	100	200	100.0

season looks dry, farmers may leave their land idle until the next year without any tillage or chemical weed control. Sometimes the land is not planted for two or more years in succession.

Farmers in Belt II, 250-300 mm. Farmers of this belt perform more tillage practices, in total, than those in Belt I, but do not till before planting wheat. Most farmers follow a two-year crop sequence, wheat-lentils. Lentil growing requires more tillage than wheat. The land of Belt II is thus tilled more than that of Belt I. However, no tillage operation takes place for wheat seed-bed preparation. After the lentil crop is harvested in May and June, by hand pulling, the ground is cleaned of straw and lies bare until November when farmers start to plant wheat and till the ground after seeding.

Farmers in Belts III and IV, 300-400 mm and over 400 mm. In both of these higher rainfall belts, a significant percentage of the farmers grow summer crops such as watermelons in rotation with winter crops, wheat and lentils, in the following sequence: wheat-lentils-summer crop. With this summer cropping sequence, even more tilling activity takes place. Summer crops require tillage to conserve moisture by controlling the weeds. Farmers invest more in tillage operations to secure successful summer crops which yield high cash returns (7-12 J.D./dunum) while the wheat yield is generally low and brings low economic returns (70 kg/du x 50 fils/kg = 3.50 J.D./dunum as gross returns). For summer crops, one tillage is conducted the summer before, after lentils are harvested.

Two tillages are undertaken prior to the planting of watermelons, and one tillage by animals after the seeds are planted to control weeds.

Because wheat is grown immediately after the summer crop in Belts III and IV (wheat-lentils-summer crop), farmers consider summer cropping as similar and of the same value to wheat as clean summer fallow but paying instead of costing. As a result of the very good care the land receives throughout the summer crop season and since wheat is planted in November, two months after watermelons are harvested, in August, farmers do not till their land before the seeding takes place. They wait until after enough rain, then start seeding and till to cover the seeds and kill the emerging weeds.

b. <u>Farmers' knowledge of the effect of proper tillage practices and yield rise expectation from improved tillage operation</u>

Farmers' knowledge of better tillage practices and evaluation of their current practices have been investigated. Interviewed farmers are asked if they believe more or different tillage practices from what they currently use would increase wheat yield. Table 4.5 reports farmer responses.

97.5 percent of the interviewed farmers responded positively while only 2.5 percent believe that there are no changes which could be added to the current tillage practice to increase the yield. This in effect says that 97.5 percent of the farmers are not satisfied with their current tillage practices. This high respect for yield

Table 4.5. Interviewed farmers' evaluation of their current tillage practices

Do you believe more or different tillage methods would increase your wheat yield	All belts frequencies	
	No. of farmers	Percent
Yes	195	97.5
No	5	2.5
Total	200	100.0

increase from tillage (over 90 percent) is dominant throughout all the rainfall belts. Farmers' replies are as shown in Table 4.6. All wheat farmers believing tillage would increase wheat yield (97.5 percent) were asked to mention up to three specific tillage practices which they perceived as most likely to give better wheat land utilization. All farmers' responses were grouped into the following six major tillage activities.

1. Increasing the number of tillages prior to the wheat planting season.
2. Tilling the ground deeper than currently tilled.
3. Levelling off the ground.

Table 4.6. Interviewed farmers' evaluation of their current tillage practices distributed by rainbelts

Do you believe more of different tillage methods would increase your wheat yield	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Yes	27	90	69	98.5
No	3	10	1	1.5
Total	30	100	70	100.0

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
70	100	29	96.7	195	97.5
--	--	1	3.3	5	2.5
70	100	30	100.0	200	100.0

4. Removing the stones from the ground.

5. Tilling the ground crossed tillage pattern.

6. Turning over the soil.

However, farmers were found to place different evaluations and importance on these major tillage additions and changes. Table 4.7 illustrates the degree of significance each of the six tillage suggestions received. The relative frequency of each suggested tillage indicates the proportion of farmers who believe a change in their tillage practice would increase wheat yield. Increasing the number of tillages was mentioned by 175 farmers out of 197 (89 percent) and received the highest priority in farmers' perception of how to go about raising yield by improving the tillage practice. It is very interesting to note that although farmers are actually minimizing the tillage operation down to one of the lowest levels are nevertheless very much aware that the wheat fields need more tillage, to smooth the soil, increase the moisture absorption capacity, and reduce runoff.

Second in importance in the farmers' evaluation is conducting a crossed tillage operation. This means tilling the field in two directions, east-westward and north-southward. Farmers have been experiencing a continual deterioration in their ground from the poor one-way tilling which is repeated in the same direction over many years. This has created rough ground. This problem is of concern to farmers but seems hopeless because the shape of their land often does not permit the custom-tractor operator to till in

Table 4.7. Interviewed farmers' tillage suggestions to improve wheat land productivity

What are most important tillage suggestions farmers perceive to improve wheat land productivity	Frequencies	Percent	Rank of Importance
To increase the number of tillages after the wheat harvest and before planting the wheat	175	37.0	First
To till the ground in two directions--crossed tillage	96	21.5	Second
To till the ground deeper after the harvest season	73	16.0	Third
To level the ground	50	11.0	Fourth
To remove the stones from the field ground	48	10.5	Fifth
To turn over the soil	15	3.5	Sixth

two directions, i.e., much land is in narrow and long strips (50 m x 2 km), also the tractor operator may refuse to crosstill because of possible damage to his tractor in crossing the ridges or longer work time, or greater fuel consumption. If additional costs must be born by the custom-tractorman, he refuses. The farmer, on the other hand, refuses or is unable to pay him more. So tillage practices remain.

Seventy-three farmers out of 195 (37.4 percent) suggested tilling the land deeper than currently to open the ground to the sun and to "bring up new soils." The farmers' current summer tillage depth ranges between 16-30 cm, as shown in Table 4.8. A cross-tabulation of tillage depths by rainbelts reveals no significant variation among the farmers in the four rainfall areas with respect to their perception of the current tillage depth. Table 4.9 indicates that the majority of farmers in each belt perceive the current summer tillage falls in the range 16-30 cm. Jordanian wheat farmers believe strongly in deep summer tillage. It is felt that deep tillage increases the organic matter in the soil, improves the moisture infiltration capacity of the ground, and brings up new soils.

Levelling off the ground is the fourth change in importance to wheat farmers. Fifty farmers mention this operation, which represents a real problem in Jordan drylands. Rocky, uneven ground obstructs seeding and causes uneven application of other inputs such as fertilizer and chemical weed spray. Harvest operations are also less efficient with nonuniform wheat stands and swaying and bouncing of combine sieves.

Another problem farmers are aware of and would like to remove is the existence of stones in the fields. This is a hazardous condition for machinery with high risk of breakage. Tillage operations are not effective.

One final change in tillage practices farmers mention would be to turn over the soil through tillage operation in order to bring "new soil" to the surface of the ground. Farmers believe that land

Table 4.8. Interviewed farmers' estimates of the summer tillage depth

What is your estimate of your summer tillage depth in centimeters	All belts frequencies	
	No. of farmers	Percent
11-15	4	2.0
16-20	34	17.0
21-25	90	45.0
26-30	61	30.5
31-35	9	4.5
36-40	2	1.0
Total	200	100.0

becomes exhausted over the years and like to till the ground in such a way to allow new soils from inside the ground to replace the "exhausted" soil.

A cross-tabulation of farmers' suggestions by rain belts does not reveal significant differences in the opinions of farmers in different rain belt areas, especially with respect to the first three tillage changes: increasing the number of tillages, using cross tillage, and tilling the land deeper. The majority of votes

Table 4.9. Interviewed farmers' estimates of the summer tillage depth distributed by rain belts

What is your estimate of summer tillage depth in centimeters	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
11-15	2	6.67	--	--
16-20	6	20.00	16	22.86
21-25	13	43.33	32	45.71
26-30	9	30.00	18	25.71
31-35	--	--	4	5.71
36-40	--	--	--	--
Total	30	100.00	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
1	1.43	1	3.33	4	2.0
10	14.29	2	6.67	34	17.0
35	50.00	10	33.33	90	45.0
19	27.14	15	50.00	61	30.5
3	4.28	2	6.67	9	4.5
2	2.86	--	--	2	1.0
70	100.00	30	100.00	200	100.0

were cast in favor of these three techniques.

Farmers' expectations of the wheat yield increase that may be achieved through proper tillage practices have been investigated. The purpose of asking farmers to formulate some quantitative yield rate increase expectation through better tillage practice is to better understand the farmers' technical knowledge about the effect of tillage operation on wheat yield through the moisture conservation and weed control. It is also hoped to understand the farmers' evaluation of tillage in terms of economic return represented by a certain rate of wheat yield increase over traditionally tilled wheat land. Fifty-four percent of Irbid farmers were able to formulate an expectation of some quantitative yield rise. While 43.5 percent of farmers believed positively in the effect of tillage on dry-land productivity but were unable to formulate any yield increase rate. Table 4.10 reports farmers' responses and yield expectations. A breakdown of Table 4.10 to show responses in each rainfall area is presented in Table 4.11. About 60 percent of the farmers in Belts I and IV were unable to provide any quantitative rate increase while 40 percent and 31.4 percent of the farmers in Belts III and II, respectively, did not make any yield increase estimate. However, a range between 25 percent and 34 percent increase in wheat yield is very dominant wheat farmers' responses in all the belts.

Table 4.10. Interviewed farmers' yield rise expectation from improved tillage operation

What is your yield increase estimate in percentage over traditional yield resulted from improved tillage operation	All belts frequencies	
	No. of farmers	Percent
15-24	23	11.5
25-34	66	33.0
35-44	3	1.5
45-54	10	5.0
55-64	3	1.5
65-74	2	1.0
75-84	--	--
85-94	1	0.5
Do not know how much quantitatively but believe will have positive effect on wheat yield	87	43.5
Do not believe improvement in tillage will affect yield	5	2.5
Total	200	100.0

Table 4.11. Interviewed farmers' yield rise expectation from improved tillage practices distributed by rain belts

What is your yield increase estimate in percentage over traditional yield resulted from improved tillage operation	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
15-24	--	--	11	15.7
25-34	8	26.67	27	38.6
35-44	--	--	2	2.9
45-54	2	6.67	4	5.7
55-64	--	--	1	1.4
65-74	--	--	1	1.4
75-84	--	--	--	--
85-94	--	--	--	--
Do not know how much quantitatively but believe will have positive effect on wheat	18	60.00	22	31.4
Do not believe improvement in tillage will affect yield	2	6.67	2	2.9
Total	30	100.00	70	100.0

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
8	11.43	4	13.33	23	11.5
25	35.70	6	20.00	66	33.0
1	1.43	--	--	3	1.5
4	5.70	--	--	10	5.0
2	2.86	--	--	3	1.5
1	1.43	--	--	2	1.0
--	--	--	--	--	--
1	1.43	--	--	1	0.5
28	40.00	19	63.33	87	43.5
--	--	1	3.33	5	2.5
70	100.00	30	100.00	200	100.0

c. Farmers' attitudes and acceptance of improved tillage practices

As a result of the current tillage system in which farmers in all rainfall areas try to minimize their tillage operation, and as such poor tillage practices are carried out in the Jordan dryland, leading to unlevelled ground, farmers were asked to give their views and evaluations of two suggested tillage techniques. These are the shallow rapid tillage operation and the district-collective-tillage system. The shallow rapid tilling system, which would be conducted more frequently during the summer, aims at improving the ground infiltration capacity for moisture, levelling off the ground, and cleaning the field of weeds and stones. The collective tillage operation is aimed at helping farmers who own small land pieces fragmented in different locations and those farmers who own large enough pieces of land having very odd shapes, narrow and long, and not permitting the crossed tillage system for each farm individually. Collective tillage by some organized agribusiness can provide its services to farmers in one area. With regard to the shallow rapid technique, we find farmers in general believe in deep tillage: "The deeper the tillage, the better for the ground." Therefore, farmers were found to oppose such a suggested technique and were very unfamiliar with such suggestions. Table 4.12 summarizes farmers' knowledge of the suggested shallow rapid tillage system. The great majority of farmers (95.5 percent) indicates no previous knowledge of the advantages of this technique. Even after this system was explained, the notion of deep tillage persists in the

Table 4.12. Interviewed farmers' knowledge about a system of rapid shallow tillage distributed by rain belts

Have you heard of a system of rapid shallow tillage	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Yes	--	--	1	1.43
No	30	100	69	98.57
Total	30	100	70	100.0

	Belt III frequencies		Belt IV frequencies		All belts frequencies	
	No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
	6	8.57	2	6.67	9	4.5
	64	91.43	28	93.33	191	95.5
	70	100.00	30	100.00	200	100.0

Table 4.13. Interviewed farmers' attitudes toward a rapid shallow tillage system

Do you accept to practice rapid shallow tillage operation	All belts frequencies	
	No. of farmers	Percent
Yes	1	0.5
Yes if proved better than deep tillage	1	0.5
No	198	99.0
Total	200	100.0

farmers' minds, as seen in Table 4.13. Almost all interviewed farmers (99 percent) would refuse to accept the adoption of shallow tillage operation for the summer idle period. Farmers in different rain belts reflect no variation in attitude toward such a suggested tillage system. Table 4.14 summarizes farmers' acceptance of this shallow rapid tillage system. The great majority of farmers in each belt cast their votes in favor of a deep tillage operation.

However, farmers were more positive in accepting the collective tillage system. As indicated above, one of the most severe obstacles in adopting better tillage techniques is in the general shape of

Table 4.14. Interviewed farmers' attitudes toward a rapid shallow tillage system distributed by rain belts

Do you accept to practice rapid shallow tillage operation	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Yes	--	--	--	--
Yes if proved better than deep tillage	--	--	--	--
No	30	100	70	100
Total	30	100	70	100

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
1	1.43	--	--	1	0.5
--	--	1	3.33	1	0.5
69	98.57	29	96.67	198	99.0
70	100.00	30	100.00	200	100.00

farmland itself, in very long and narrow pieces (50 meters x 1,000 meters). A second factor is the small size of landholdings which inhibits the custom-tractor operator from conducting crossed tillage. In the light of these obstacles farmers face, the collective tillage system received general acceptance by wheat farmers, although some farmers placed slight conditions on their acceptance. Table 4.15 indicates farmers' responses. 45.5 percent of the farmers surveyed would accept this tillage proposal; 31.5 percent would agree to participate in such a system if their neighbors agreed to the collective sharing tillage operation; and 4 percent agreed under the condition that they would adopt and participate in the collective tilling system if it proved effective and more beneficial to farmers than the current tillage practice. The remaining 19 percent of the farmers indicated unwillingness to adopt the collective tillage practice. A breakdown of Table 4.15 to study farmers' acceptance in each rain belt is presented in Table 4.16. Farmers in Belt IV were found to be more accepting of the collective tillage system than those in Belt I (6.67 percent is the refusal rate in Belt I and 26.67 is the refusal rate in Belt IV). This variation in attitudes can be attributed to physical conditions rather than to awareness variations. Farmers in Belt IV, with a higher rainfall rate, were found to have small, narrow landholdings, which makes farmers more willing to accept the collective tillage system, while farmers in Belt I have larger size holdings of more normal shape. The 19 percent of the interviewed farmers who

Table 4.15. Interviewed farmers' attitudes toward collective district tillage system

Do you accept to participate in a collective tillage system with your neighbors	All belts frequencies	
	No. of farmers	Percent
Yes	91	45.5
Yes, only if neighbors agree	63	31.5
Yes, only if proved better than individual tillage systems	8	4.0
No	38	19.0
Total	200	100.0

indicated unwillingness to adopt district tillage proposal gave several reasons for their refusal, as summarized in Table 4.17. Four percent of the Irbid farmers refuse the collective tillage system because they own tractors themselves and do their own tilling, and 3 percent of the farmers indicated that they own very large areas of land and feel no need to share. Most of these farms are in Belt I. 2.5 percent of the farmers interviewed argued that land is topographically unfit for collective tillage, as it is too steep and hilly. A 3.5 percent of the interviewed farmers indicated

Table 4.16. Interviewed farmers' attitudes toward collective district tillage system distributed by belts

Do you accept to participate in a collective tillage system	Belt I frequencies		Belt I frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Yes	9	30.00	28	40.00
Yes, only if neighbors agree	13	43.33	31	44.29
Yes, only if proved better than individual tillage system	--	--	2	2.86
No	8	26.67	9	12.86
Total	30	100.00	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
35	50.00	19	63.33	91	45.5
11	15.71	8	26.67	63	31.5
5	7.14	1	3.33	8	4.0
19	27.14	2	6.67	38	19.0
70	100.00	30	100.00	200	100.0

Table 4.17. Interviewed farmers' reasons for not accepting collective tillage system distributed by rain belts

If do not accept collective tillage system, what are the reasons	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Land borders may get mixed up	--	--	--	--
Farmers own their tractors	4	13.33	--	--
Farmers own large holdings	4	13.33	1	1.43
Farmers like to be free, do not like to work collectively	--	--	1	1.43
Farmers till with their relatives	--	--	1	1.43
Farmers feel cannot be done realistically	--	--	4	5.71
Farmers land is too steep	--	--	2	2.86
Farmers accept collective tillage system	22	73.34	61	87.14
Total	30	100.00	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
1	1.43	1	3.33	2	1.0
4	5.71	--	--	8	4.0
1	1.43	--	--	6	3.0
8	11.43	--	--	9	4.5
--	--	--	--	1	0.5
2	2.86	1	3.33	7	3.5
3	4.29	--	--	5	2.5
51	72.86	28	93.33	162	81.0
70	100.00	30	100.00	200	100.0

that such a proposal is unrealistic because many landowners do not reside in the village, and many farmers have different time preferences for tilling the land. The remaining 6 percent indicated unwillingness to work collectively, as they like to be free in their farming decisions and are afraid that land borders may get mixed up under the collective tillage system. Jordanian farmers mark their borders by a few stones piled at the corners and do not have other means to identify their land, except by going to the governmental agencies who keep a record of land titles and location.

2. Improved Seeds

a. Currently used wheat seed

Wheat seed is an input which is considered the most recognized and appreciated factor of wheat production by Jordan dryland farmers. This high recognition stems simply from the fact that in most of the Jordan dryland areas, especially in the low rainfall belt, wheat seeds are the only thing put in the soil to produce a crop. Thus, over the past several hundred years, until recently, wheat seeds have been the solely used input, the most essential ingredient for the survival of wheat farmers all over the Jordan dryland area. This is particularly true in the drier belts where all that farmers really apply is the seed, followed by shallow tillage to cover the seed. Hence, an investigation of what types of wheat seed farmers use and their knowledge, expectation, and acceptance of better seed has had significant bearing on the overall wheat improvement practices. Due to very long time in history that wheat has been continuously grown in this part of the world, it appears that a great many local wheat varieties are in existence and being used by Jordanian farmers. However, only a few of these varieties could be identified and traced to their origins, as in the case of the Horani Nawawi and F8 types. Other varieties are known only by describing the color and size of the seed and the shape of its wheat plant. Apparently, these local "domestic" varieties are impure and, over the years, have been mixed with other wild wheat varieties and strange weed seeds. Table 4.18 reports farmer responses to the varieties of wheat they currently use.

Forty-five percent of the interviewed farmers indicated no knowledge of the kind or name of the varieties farmers use; they simply said "It is just a domestic wheat." Thirteen percent responded by giving a general description of the color, size of seed, and the shape of the wheat head. Thus, a total of 58 percent (45 + 13 percent) of the farmers interviewed have no knowledge of the varieties being used.

29.5 percent of Irbid farmers use a well-known local variety, Horani Nawawi, a durum wheat originally from the famous Horani wheat plains of Syria. Farmers brought a quantity of this variety to Jordan in 1954 and proved that it grows well in areas of lower rainfall and resists drought conditions.

The remaining 12.5 percent of interviewed farmers use another

Table 4.18. Interviewed farmers' responses with respect to the kinds of varieties they use

What is the kind of wheat variety you plant	All belts frequencies	
	No. of farmers	Percent
Horani Nawawi	59	29.5
F8	25	12.5
Unspecified local variety	26	13.0
Farmers do not know what kind of variety they use	90	45.0
Total	200	100.0

known variety called F8, also a durum wheat, brought to Jordan in 1935 from the Akka agricultural experiment station in Palestine. This variety proved efficient under dryland conditions and in areas with above 300 mm of rainfall. Farmers' knowledge of the kind of wheat variety they are using is a good sign for potential adoption of higher yielding varieties. That is to say, those farmers who know the kind of wheat varieties they use show better knowledge and concern with wheat production and its basic input than do farmers who neither know nor use a specific known variety, as indicated above, "just domestic wheat." It is believed that farmers in higher rainfall areas show more knowledge and concern for their wheat production practices than those in lower rainfall areas. The degree of knowledge of wheat varieties varies with the rainfall variation. The higher the rainfall, the more knowledgeable wheat farmers are about the kinds of seed they use and the more frequently they use known domestic varieties. A breakdown of Table 4.18 according to rainfall belts verifies this hypothesis.

A total of 80 percent, 44.28 percent, 37.14 percent, and 30 percent of the wheat farmers in Belts I, II, III, and IV, respectively, do not know the kind of wheat varieties they are using. Conversely, a total of 60 percent, 44.29 percent, 44.29 percent, and 13.33 percent of the farmers interviewed in Belts IV, III, II, and I indicated they use the two major kinds of wheat varieties, Horani Nawawi and F8. Farmers in Belt IV contrast very clearly with their counterparts in Belt I with respect to their knowledge of the wheat varieties and the wheat seeds they use.

b. <u>Farmers' knowledge of the effect of improved seeds and yield rise expectation from its adoption</u>

In this thesis, the term "improved seeds" will be used to denote two distinctive meanings: the first to mean cleaned and treated seeds of domestic known varieties, and the second, genetically improved and higher yielding varieties. The reason for making this clarification is that among farmers and government officials in Jordan, the term "improved seeds" has been widely used to refer to the traditional varieties, chiefly Horani Nawawi and F8 after they have

Table 4.19. Interviewed farmers' responses with respect to the kinds of varieties they use distributed by rain belts

What is the kind of wheat variety you plant	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Horani Nawawi	4	13.33	21	30.00
F8	--	--	10	14.29
Unspecified local variety	2	6.67	8	11.43
Farmers do not know what kind of variety they use	24	80.00	31	44.28
Total	30	100.00	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
22	31.43	12	40	59	29.5
9	12.86	6	20	25	12.5
13	18.57	3	10	26	13.0
26	37.14	9	30	90	45.0
70	100.00	30	100	200	100.0

undergone the cleaning and purifying process and treatment with fungicides against smut disease. Meanwhile, plant breeding programs and variety testing efforts are under way by the Department of Agricultural Research and Extension to introduce high quality foundation seeds to Jordan dryland farmers.

i. Cleaned and treated known domestic varieties In the past ten years, farmers have been made increasingly aware of the importance of using cleaned and treated seeds. Table 4.20 reports the adoption rate of tyis type of improved seed by farmers.

The overall adoption of cleaned and treated seeds is 65 percent, with the remaining 35 percent of farmers using seeds from their own stock without any cleaning, purifying, or chemical treatment. For this group of farmers, the wheat yield is much less than that of those improved seed adopters. The latter group's wheat harvest is usually mixed with strange weed seeds and is susceptible to smut and other diseases. Farmers in higher rain belts are believed to be more progressive in using improved practices since the weather environment encourages the use of new practices, and the wheat land in these areas is more responsive to new practices than are the desert or marginal lands. It is believed that the higher adoption rate of cleaned and treated seeds exists in higher rainfall belts where farmers are more concerned about improving their wheat cultural practices and more aware of the existence and advantages of applying cleaned and treated seeds. A cross-sectional breakdown

Table 4.20. Interviewed farmers' adoption rate of improved seeds--cleaned and treated

Do you use cleaned and treated seeds	All belts frequencies	
	No. of farmers	Percent
Yes	130	65
No	70	35
Total	200	100

of Table 4.20 by rain belts is shown in Table 4.21. The adoption rates of cleaned and treated seeds are zero, 67.14 percent, 75.71 percent, and 100 percent for Belts I, II, III, and IV, respectively. Sharp variations exist between adoption rates in the lower and higher belts, as none of the farmers interviewed in Belt I indicate the use of improved seed, in contrast with all the farmers interviewed in Belt IV who use improved seed. More farmers in Belt III use cleaned and treated seeds than in Belt II.

A chi-square statistical test between farmers' adoption rate and their rain belt shows a statistically significant (at 99 percent level) association. Studies of farmers' knowledge and expectation of the effect of adopting cleaned and treated seeds on the wheat

Table 4.21. Interview farmers' adoption rate of improved seeds--cleaned and treated

Do you use cleaned and treated seed	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Yes	--	--	47	67.14
No	30	100	23	32.86
Total	30	100	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
53	75.71	30	100	130	65
17	24.29	--	--	70	35
70	100.00	30	100	200	100

yield indicate that wheat farmers in general have positive expectations of the effect. Furthermore, farmers showed intelligent concern about the importance of improved seeds in obtaining higher market prices for the harvested wheat crop. A wheat crop clean of weed seeds may bring as high as a 20 percent increase in the price of wheat over wheat sold with impurities. Farmers were asked to estimate how much yield increase could be obtained with the use of cleaned and treated seeds, as opposed to nonimproved seeds. Table 4.22 reports farmers' responses. Over half of the interviewed farmers were able to perceive some quantitative yield rise rate. The majority of these respondents believed wheat yields could show an increase in the range of 11-50 percent when compared with plots planned with nonimproved seeds. Forty-four percent of the Irbid farmers think positively of the use and effect of improved seeds but were unable to make any quantitative estimates. Farmers in higher rainfall belts were more capable of estimating the yield rise than those in drier belts. Table 4.23 shows that only 40 percent of Belt IV farmers were unable to provide yield rise expectations against 80 percent of farmers in Belt I. This variation can be understood since no interviewed farmers in Belt I use cleaned and treated seeds. Although a slightly higher percentage of farmers in Belt II provided yield rise estimates than those in Belts III and IV, we find that farmers in higher belts have higher yield rise expectations than do those in Belts I and II. The majority of farmers who were able to perceive yield increase rates in Belt II think in

Table 4.22. Interviewed farmers' yield rise expectations from the adoption of improved seeds--cleaned and treated

What is your percent estimate of yield increase from the adoption of improved seeds	All belts frequencies	
	No. of farmers	Percent
1-10	4	2.0
11-20	29	14.5
21-30	36	18.0
31-40	25	12.5
41-50	11	5.5
51-60	1	0.5
61-70	1	0.5
71-80	1	0.5
81-90	3	1.5
Farmers believe no rise expected from improved seeds	1	0.5
Farmers believe improved seeds increase yield but cannot make estimate	88	44.0
Total	200	100.0

Table 4.23. Interviewed farmers' yield rise expectation from the adoption of improved seeds--cleaned and treated--distributed by belts

What is your percent estimate of yield rise expected from improved seed application	Belt I frequencies		Belt II frequencues	
	No. of farmers	Percent	No. of farmers	Percent
1-10	--	--	2	2.86
11-20	--	--	20	28.58
21-30	2	6.67	17	24.29
31-40	3	10.00	6	8.57
41-50	1	3.33	1	1.43
51-60	--	--	--	--
61-70	--	--	--	--
71-80	--	--	--	--
81-90	--	--	--	--
Farmers believe no rise expected from improved seeds	--	--	--	--
Farmers believe improved increase yield but cannot make estimate	24	80.00	24	34.24
Total	30	100.00	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
1	1.43	1	3.33	4	2.0
8	11.43	1	3.33	29	14.5
12	17.14	5	16.67	36	18.0
10	14.28	6	20.00	25	12.5
6	8.57	3	10.00	11	5.5
1	1.43	--	--	1	0.5
1	1.43	--	--	1	0.5
1	1.43	--	--	1	0.5
2	2.86	1	3.33	3	1.5
--	--	1	3.33	1	0.5
28	40.00	12	40.00	88	44.0
70	100.00	30	100.00	200	100.0

the range of 11-40 percent; in Belt III, farmers expect a 11-50 percent increase; and in Belt IV, the majority of farmers believe the yield rate could be increased in the range of 21-50 percent.

A chi-square statistical test between farmers' yield increase expectation from the adoption of improved seeds and their rain belts shows a statistically significant relation (at 99 percent level) between farmer expectation and their rain belt. It is shown that farmers in higher rainfall belts have higher yield rise expectation than do those in lower belts.

ii. Genetically improved varieties   Farmers' technical knowledge of wheat seed and its genetic characteristics is very minimal, if not close to zero. Farmers who can be classified as most progressive consider the traditional varieties as improved seed, if it is cleaned and treated before the planting season. The great majority of farmers across the belts (95 percent) have not heard of genetically higher yielding varieties such as Mexipak. Table 4.24 shows that only 5 percent of wheat farmers have heard of the existence of higher yielding varieties. However, this small percentage (5 percent) of farmers is found in the higher rainfall belts--III and IV--as shown in Table 4.25. None of the farmers in Belts I and II have heard of these varieties, whereas 8.57 percent and 13 percent of the farmers in Belts III and IV, respectively, indicated some awareness of the existence of such higher yielding varieties. Although the percentage of farmers having some knowledge of these

Table 4.24. Interviewed farmers' knowledge about higher yielding varieties

Have you heard of higher yielding varieties	All belts frequencies	
	No. of farmers	Percent
Yes	10	5
No	190	95
Total	200	100

varieties is small, it is believed to reflect the fact that farmers in higher rainfall areas have more knowledge and concern about improved inputs for their wheat production than do those in lower belts. It is recognized that the higher yielding semidwarf varieties require more moisture than the marginal land can offer to sustain their growth. Even among those few farmers who have heard of the higher yielding varieties, there is no clear notion of the yield increase these varieties may bring over the traditional kind, as summarized in Table 4.26.

Table 4.25. Interviewed farmers' knowledge about higher yielding varieties distributed by rain belts

Have you heard of higher yielding varieties	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Yes	--	--	--	--
No	30	100	70	100
Total	30	100	70	100

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
6	8.57	4	13	10	5
64	91.43	26	87	190	95
70	100.00	30	100	200	100

Table 4.26. Interviewed farmers' yield rise estimation from using higher yielding varieties distributed by belts

Do you know how much percent yield increase from using higher yielding varieties	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Do not know	--	--	--	--
Farmers believe does not fit Jordan dry-land conditions	--	--	--	--
Farmers have not heard of higher yielding variety	30	100	70	100
Total	30	100	70	100

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
5	7.14	5	16.67	10	5.0
1	1.43	--	--	1	0.5
64	91.43	25	83.33	189	94.5
70	100.00	30	100.00	200	100.0

c. Farmers' attitudes and acceptance of improved seeds

Farmers everywhere seek to improve their economic situation and wish to increase their land productivity. Jordanian wheat farmers are no different. Studies of farmer attitudes and acceptance of improved seeds indicate that when asked how much they would be willing to pay for a 20 percent higher yielding variety, the majority (80.5 percent) expressed willingness to buy such varieties at any asked price. Although the purpose of such inquiry is to obtain some quantitative measure of farmers' decision on what they would pay if offered a 20 percent higher yielding variety than their traditional type, the majority of farmers were unable to decide numerically how much more they would pay. The interviewed farmers indicated willingness to pay whatever the price as long as the variety increased land productivity by 20 percent. This statement as made by the majority of wheat farmers can be attributed to the fact that wheat farmers never had had experience in buying wheat, especially good to be used only as seed. Jordanian farmers usually use wheat seeds from their own harvest or buy from wheat merchants at the market wheat price which ranges from 50-60 fils/kg or buy it from an agricultural cooperative on a loan-in-kind arrangement. Thus, the farmer gets cleaned, treated seed and repays it the next harvest season with the same amount from his own wheat. There are no private agribusinesses in the field of selling certified wheat seed. As Table 4.27 shows, 80.5 percent of interviewed farmers indicated willingness to pay any price for the seed as long as it would raise

Table 4.27. Interviewed farmers' attitudes toward the use of higher yielding varieties

How much are your willing to pay for a variety that can increase your wheat yield by 20 percent	All belts frequencies	
	No. of farmers	Percent
Farmers willing to pay whatever the price of higher yielding variety as long as it is beneficial to farmers	161	80.5
Farmers willing to pay 50 percent increase over market price of wheat	14	7.0
Farmers willing to pay 100 percent increase over market price	2	1.0
Farmers must be shown of the effectiveness of this variety before they decide to buy it	22	11.0
If the government provides the seed in loan	1	0.5
Total	200	100.0

land productivity by 20 percent. However, 11 percent of the farmers expressed some caution and stressed that seed must be demonstrated and proved before they would pay higher prices. Only 7 percent of the farmers were able to determine some price increase, indicating they would pay 50 percent over the market price of wheat.

One percent of the interviewed farmers would pay a 100 percent increase above the market price of wheat for a 20 percent higher yielding variety. One farmer (0.5 percent of interviewed farmers) would use this new seed only if the government would provide it in a loan arrangement to farmers.

Many farmers, however, expressed strong concern over this kind of higher yielding variety in terms of its baking quality as its dough elasticity and moisture absorbency. Since the eventual and ultimate use of most of the produced wheat is for bread consumption, baking quality to fit local bread types is crucial in order for farmers to accept new wheat varieties.

3. Graindrills

a. Farmers' current practices in seeding and planting the wheat

The great majority of Jordanian wheat farmers still use the traditional method of seeding, hand broadcasting the seed, and covering it with the soil by shallow tilling. As indicated in the tillage section, no farmers conduct any tilling prior to seeding for seedbed preparation since they perceive no need for such a tillage operation. It has been observed by the writer and the wheat project advisors that seedbeds in most of the wheat areas are rather poorly prepared, with broadcast seeding resulting in nonuniform and frequently irregular stands of wheat plants. Use of the graindrill as an improved practice has been emphasized by the wheat project advisor as having the following advantages over the traditional broadcast methods (13): (i) uniform depth of planting allows uniform emergence of seedlings and a more complete stand of wheat; (ii) more uniform distribution of seeds allows a saving of from 2-4 kg of seeds per planted dunum; and (iii) since the depth of planting can be regulated, the seeds can be placed to take best advantage of soil moisture.

Farmers either hire some workers to do the seeding or do it themselves. In most cases, farmers indicate their practices of hiring some villagers who are known to have good skill in broadcasting the seeds. Those "agribusiness" men are usually old wheat farmers who own small pieces of land or are landless and offer their labor services to other farmers, charging between 50-100 fils per planted dunum. Farmers desire to cover all the field and distribute the seeds evenly. The perceived purpose of this desire is to optimize wheat yield by covering all the ground and not to leave any spot in the field without seeds. By doing this, the farmers aim also at restricting the growth of weeds between the wheat plants. Farmers believe that placing seeds close to each other without any spacing will inhibit emergence of the weeds. With this philosophy in mind, farmers exhibit strong negative reactions to the graindrill because it allows 10-17 inches of space between rows.

The current use of the graindrill is considered in its very initial stage, and the adoption rate of such an improved practice is near zero. Table 4.28 reports farmers' seeding practices.

Table 4.28. Interviewed farmers' adoption rate of graindrill

How do you sow your wheat seeds	All belts frequencies	
	No. of farmers	Percent
By hand broadcasting	197	98.5
By graindrill	1	0.5
By graindrill if it was available at seeding time	2	1.0
Total	200	100.0

98.5 percent of Irbid farmers use the hand broadcast method in placing the seeds, less than 1 percent use the graindrill regularly, and the remaining 1 percent use the graindrill occasionally. Despite this almost exclusive use of the hand broadcast method by wheat farmers, a breakdown of the table should be of significant value in studying the very few adopters of the graindrill. Table 4.29 summarizes the method of seeding in each of the four rain belts. All farmers (100 percent) in Belts I, II, and IV use the broadcast method, and only a few farmers (4.29 percent) use the graindrill in Belt III. Looking closely at the latter group, we find they use the only existing graindrill owned by the agricultural

Table 4.29. Interviewed farmers' adoption rate of graindrill distributed by rain belts

How do you sow your wheat seeds	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
By hand broadcasting	30	100	70	100
By graindrill	--	--	--	--
By graindrill if it was available at seeding time	--	--	--	--
Total	30	100	70	100

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
67	95.71	30	100	197	98.5
1	1.43	--	--	1	0.5
2	2.86	--	--	2	1.0
70	100.00	30	100	200	100.0

cooperative branch in eastern Irbid. This single graindrill faces demands from many farm members in this cooperative branch who must wait their turn for the drill is available on a "first come, first serve basis." Many farmers will not wait more than a few days, and if they cannot use it, they will hire some custom seeding men to do the planting work.

Such a close-to-zero adoption rate of graindrill is quite an interesting phenomenon to observe. As a mechanized technique, it contrasts sharply with current tillage and harvesting practices. We noted that 98 percent of the interviewed farmers use mechanized tilling in the Plains area, and a similar number use mechanized harvesting while their use of the graindrill lags far behind, even in higher rainfall areas and level fields where the use of such equipment technically should be feasible. In mechanized tillage practice, we find that the 94 percent of farmers use power tillage operation depend on agribusiness services--custom-tractor operators. The graindrilling operation appears to require the same type of service, namely agribusiness to provide the seeding services. Under no condition can we expect farmers to provide the seeding services. Under no condition can we expect farmers to conduct seeding by graindrill on their own resources. Purchase of the graindrill equipment plus the tractor is beyond any single farmers' resources for only his fields. This would mean that the introduction and the adoption of the graindrilling technique would depend on the availability of agribusiness services in this type of operation, which is apparently still nonexistent. However, the interesting question is why agribusiness custom services of this type have not emerged as they did in the case of the tillage and harvest operations. It is expected that the appearance of agribusiness services of any type will depend on market demand, i.e., on farmers' demands for this kind of service. For an agribusiness agent to invest several hundred J.D. in the purchase of such equipment as a graindrill means he should be certain there would be sufficient demand for his graindrilling services. Investigation is needed to indicate why such nonemergence or lag in emergence of this type of service still persists. An investigation of farmers' knowledge of and expectation from the graindrill and their attitudes and acceptance follows.

b. Farmers' knowledge of the effect of graindrilling and yield rise expectation from the adoption of the graindrill

A large percentage of the interviewed farmers indicated knowledge and awareness of the graindrill's existence and of its basic function in placing seeds in the ground. Table 4.30 reports farmers' responses with respect to their knowledge of the existence of the graindrill. 89.5 percent of the farmers interviewed have heard of the graindrill while only 10.5 percent of the farmers indicated no knowledge of such a tool. It is believed that farmers in higher rainfall belts are more aware of the graindrill than those in lower belts. Table 4.31 reports farmers' awareness rate in each of the four belts. Although the majority of the farmers in

Table 4.30. Interviewed farmers' knowledge about the graindrill technique

Have you heard of a graindrill	All belts frequencies	
	No. of farmers	Percent
Yes	179	89.5
No	21	10.5
Total	200	100.0

each belt has heard of the graindrill, a higher percentage of awareness exist in higher belts: 100 percent, 91.43 percent, 85.71 percent, and 83.33 percent of farmers in Belts IV, III, II, and I, respectively. Having merely heard of the graindrill represents only the initial stage--of the mental process--toward its adoption (3). Inquiries were made to ask farmers what advantages or characteristics graindrills have. Farmers were given the chance to give three or fewer characteristics. Table 4.32 summarized farmers' responses.

Table 4.31. Interviewed farmers' knowledge about the existence of graindrill techniques distributed by rain belts

Have you heard of a graindrill	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Yes	25	83.33	60	85.71
No	5	16.67	10	14.29
Total	30	100.00	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
64	91.43	30	100	179	89.5
6	8.57	--	--	21	10.5
70	100.00	30	100	200	100.0

Table 4.32. Interviewed farmers' knowledge about the advantages of using graindrill over the hand broadcast method

Do you know why graindrill is recommended to use	All farmers		
	Frequencies	Percent	Rank
To produce wheat in an organized row pattern	34	15.6	First
To increase wheat yield	28	12.8	Second
To save in seeds	27	12.4	Third
To save in labor	6	2.7	Fourth
To obtain easier harvest operation	3	1.3	Fifth
To cover all the field evenly	2	0.9	Sixth
Do not know why it is recommended	118	--	--

Sixty-six percent of the total 179 farmers who have heard about the graindrill do not know of any advantages or characteristics it has over the traditional hand broadcast method. They only know that it is used to place seeds inside the ground. The remaining 34 percent mentioned the six major advantages listed below:

1. Producing wheat in more organized lines (if farmers have watched the government wheat demonstration, they have noticed that wheat plants are grown in rows).
2. Increasing wheat yields.
3. Saving in use of seeds.
4. Saving labor.
5. Obtaining better harvest operations.
6. Covering all the field with seeds.

As indicated earlier, farmers' knowledge of the economic return and cost of applying graindrill is fundamental prior to making any adoption decision. As a small percentage of the farmers indicated some knowledge of the characteristics graindrills may have, more inquiry was directed to study farmers' expectation of the effect of the seed drill on wheat yield. Table 4.33 reports farmers' responses. Only eight farmers were able to formulate some yield rise estimate over yield from the hand broadcast method. Most of these eight farmers are found in Belt III, as shown in Table 4.34, where they have a graindrill and use it. Ten percent of the farmers interviewed think the graindrill will increase yield, although they were unable to make any quantitative estimates. Two percent of the

Table 4.33. Interviewed farmers' yield rise expectation from the adoption of graindrill

What is your percent wheat yield increase estimate from the use of graindrill	All belts frequencies	
	No. of farmers	Percent
6-15	5	2.5
16-25	1	0.5
26-35	--	--
36-45	--	--
46-55	1	0.5
Farmers think graindrill increases yield but unable to make estimate	20	10.0
Farmers think there is no increase in yield from the use of graindrill	1	0.5
Farmers think hand broadcast method is more efficient than the graindrill	4	2.0
Farmers heard about graindrill but do not know about its benefits	147	73.5
Farmers never heard of graindrill	21	10.5
Total	200	100.0

Table 4.34. Interviewed farmers' yield rise expectation from the adoption of graindrill distributed by belts

What is your percent yield increase estimate from the use of graindrill	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
6-15	--	--	--	--
16-25	--	--	--	--
26-35	--	--	--	--
36-45	--	--	--	--
46-55	--	--	--	--
Farmers think graindrill increases yield but unable to make estimate	--	--	--	--
Farmers think no increase in yield from graindrill	--	--	--	--
Farmers think hand broadcasting is more efficient than graindrill	--	--	--	--
Farmers heard about graindrill but do not know about its benefits	25	83.33	60	85.72
Farmers never heard of graindrill	5	16.67	10	14.28
Total	30	100.00	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
5	7.14	--	--	5	2.5
--	--	1	3.33	1	0.5
--	--	--	--	--	--
--	--	--	--	--	--
1	1.46	--	--	1	0.5
15	21.46	5	16.66	20	10.0
--	--	1	3.33	1	0.5
2	2.86	2	6.67	4	2.0
41	58.57	21	70.00	147	73.5
6	8.57	--	--	21	10.5
70	100.00	30	100.00	200	100.0

farmers think the hand broadcasting method is more efficient than the graindrill, and 0.5 percent of the farmers see no difference between the two practices. The great majority of the farmers (73.5 percent) indicated no knowledge of whether the graindrill increases the yield. The overall conclusion in this respect is that the great majority of wheat farmers lacks technical and economic knowledge about the graindrill. This may explain the near zero adoption rate of graindrill and the nonemergence of agribusiness services in this area. Other inquiries into economic returns the graindrill use may bring is in the saving of seeds. Agronomy specialists believe that with the proper use of grain, on the average, 2-4 kg of seeds could be saved per planted dunum when compared to land planted by the hand broadcast method (14). Farmers who think the graindrill could save seeds were asked how much they thought graindrill use could save. Table 3.35 indicates farmers' responses. Only 7.5 percent of the interviewed farmers were able to formulate some seed saving estimates to range from 3-5 kg per planted dunum. The great majority of farmers doesn't know whether graindrill use would save seeds or not. As in the case of yield rise expectation, we may conclude here that farmers lack knowledge of the operation of graindrill.

In addition to the economic returns from graindrill represented by yield increase and seed saving, farmers were asked to reveal their knowledge of the cost of using the graindrill. Since the majority of farmers have never used graindrill, and since those who used it were part of the agricultural cooperative, very limited data was

Table 4.35. Interviewed farmers' estimation of seed saving can be obtained from the use of graindrill over hand broadcasting distributed by rain belts

What is your estimate of seed saving graindrill can accomplish kg/dunum	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
2	--	--	--	--
3	--	--	--	--
4	--	--	--	--
5	--	--	--	--
6	--	--	--	--
Farmers think graindrill save in seeds but do not know how much	--	--	--	--
Farmers think hand broadcast method save more seed than graindrill	--	--	--	--
Farmers heard of graindrill but do not know about its advantages	25	83.33	60	85.72
Farmers never heard of graindrill	5	16.67	10	14.28
Total	30	100.00	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
--	--	1	3.33	1	0.5
3	4.29	2	6.67	5	2.5
3	4.29	1	3.33	4	2.0
2	2.86	2	6.67	4	2.0
1	1.43	--	--	1	0.5
12	17.14	--	--	12	6.0
3	4.29	2	6.67	5	2.5
40	57.14	22	73.33	147	73.5
6	8.57	--	--	21	10.5
70	100.00	30	100.00	200	100.0

expected. Farmers' responses are shown in Table 4.36. Only 7 percent of the interviewed farmers provided some numerical cost estimates, ranging from 160-250 fils per planted dunum. All these estimates came from farmers in Belts III and IV, and this cost represents what the agricultural cooperative branch charges wheat farmers for the use of the graindrill. This cost includes both the preseeding tillage to level off the ground and the fee for the use of the graindrill.

c. Farmers' attitudes, acceptance, and incentives with regard to the adoption of the graindrill

Farmers have very limited knowledge about the graindrill, as indicated above. Furthermore, it was realized that Jordanian wheat farmers have many reservations against the use of the graindrill. From the little information these farmers have about the operation of the graindrill, obtained through watching its result at the government demonstration plots, conversation with fellow farmers who have experience with it, or through their own experience with it, they developed sharp criticism. Foremost of these reservations is the fact that graindrills do not cover all the wheat field. As a result of placing seeds in rows, the graindrill leaves sizeable spacings (10-14 inches) between rows which farmers perceive as wasted space which could be utilized for planting seed had the proper hand broadcast method been used. In addition, these spacings allow weeds to grow between wheat rows, while with broadcasting, by

Table 4.36. Interviewed farmers' estimation of the cost of using graindrill on custom basis distributed by rain belts

What is your estimate the graindrill cost to use in J.D. fils/du.	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
160-200	--	--	--	--
210-250	--	--	--	--
260-300	--	--	--	--
Do not know	25	83.33	60	85.72
Never heard of graindrill	5	16.67	10	14.28
Total	30	100.00	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
8	11.43	--	--	8	4.0
2	2.86	3	10.00	5	2.5
--	--	1	3.33	1	0.5
54	77.14	26	86.67	165	82.5
6	8.57	--	--	21	10.5
70	100.00	30	100.00	200	100.0

seeding the entire field the wheat will compete with and inhibit weed growth. Wheat project advisors think that such farmer reactions to the shift from broadcast seeding to such spacing is quite normal. Regarding farmer perception of the wasted space between the rows, wheat specialists argue that farmers have a misconception of the actual land use and moisture optimum utilization of wheat plants. In fact, the space between rows is not being wasted since the roots are utilizing moisture from this space. Irbid farmers were asked under what conditions they would be willing to use grain-drills. Their responses are summarized in Table 4.37. The conditions farmers placed are grouped by six major classes. Only 12.5 percent of interviewed farmers reported unwillingness to use grain-drills under any conditions. However, the need of proof of the graindrill's effectiveness and efficiency in wheat production was the most mentioned condition. This condition simply implies that despite the negative attitude farmers have against the graindrill, they still feel a lack of knowledge and expressed their willingness to use it once clearly shown its benefits over the hand broadcast method. Farmers are very insistent on observing and watching other people try the technique to prove its efficiency. This requires more demonstration and extension service to explain in the field the advantages of the graindrill. The second condition in importance to wheat farmers is surprising to us: despite the reservation farmers have about the graindrill, they indicated willingness to use graindrills if available at the village on the custom

Table 4.37. Interviewed farmers' attitudes and acceptance about the adoption of graindrill

Under what conditions would you use graindrill	All farmers		
	Frequencies	Percent	Rank
Farmers would use graindrill if it proved to them it is efficient	87	29.29	First
Farmers would use graindrill if it is made available in the village on custom basis	76	25.58	Second
Farmers would use graindrill if their neighbors started to use them	54	18.18	Third
Farmers would use graindrill if its cost is competitive to that of hand broadcast method	43	14.47	Fourth
Farmers would use graindrill if they are financially capable of hiring custom graindrill operators	6	2.00	Fifth
Farmers would use graindrill if the government provides them free of charge	6	2.00	Fifth
Farmers would not use graindrill under any condition believing hand broadcasting is much better	25	8.41	--

basis. They have experienced difficulty in finding old farmers to do the hand broadcasting job for them and can no longer find cheap labor to render seeding services at 50-100 fils per dunum. Farmers expressed great concern about this problem and willingness to use the graindrill if available, more to solve this shortage problem than because of their belief in the tool. (iii) Twenty-seven percent of the farmers indicated willingness to use graindrill if their village neighbors use it. Farmers are risk averters and are very hesitant to start adopting a new input before seeing other farmers initiating it. (iv) 21.5 percent of the farmers indicated willingness to use the drill if its cost is competitive with hand broadcasting. Fewer farmers, 3 percent, indicated willingness to use (v) the graindrill if the government were to provide it free of charge and (vi) three percent of farmers expressed willingness to use it if they are financially capable of paying for its services. Apparently, those farmers perform the seeding by themselves and thus do not pay for seeding services. In addition, they are available in the village underemployed or may be completely unemployed.

4. Chemical Fertilizer

a. Farmers' current practices in the field of fertilization

Jordanian wheat farmers do not use fertilizers on any significant scale. It is estimated that commercial fertilizers are used on less than 1 percent of Jordan's wheat acreage. Thus, the use of chemical fertilizer is in the very initial stage of adoption by wheat farmers. This section is an investigation of wheat farmers' fertilization practices, their knowledge of fertilizers' effects on wheat yield and cost, and their attitudes toward the use of chemical fertilizers.

First of all, as organic fertilizers (manure) are important in the farmers' conception of how to increase land fertility, serious inquiry should be devoted to this manuring activity. Initially, farmers were asked about their current practices with chemical fertilization, including how often they applied inorganic fertilizer on their wheat fields during the past six-year wheat growing period. The selection of a period longer than one or two years was proposed to identify how often and how systematically wheat farmers used chemical fertilizer for their wheat in addition to measuring the adoption rate of chemical fertilizer. Table 4.38 reports the fertilizer adoption rate and the number of times fertilizers were used in six wheat growing seasons.

Significant findings are indicated by Table 4.38. 88.5 percent of interviewed wheat farmers have not used chemical fertilizers and apparently have never used them. 6.5 percent of the farmers

Table 4.38. Interviewed farmers' adoption rate of chemical fertilizers

How many times have you put chemical fertilizer on your wheat ground for the past six years	All belts frequencies	
	No. of farmers	Percent
None	177	88.5
One time	13	6.5
Two times	4	2.0
Three times	4	2.0
Four times	--	--
Five times	2	1.0
Total	200	100.0

used fertilizer once in the past six wheat seasons, and 2 percent, 2 percent, and 1 percent of Irbid farmers used inorganic fertilizers two, three, and five times, respectively. We can say that the general overall adoption rate of chemical fertilization is the summation of the above percentages, a total of 11.5 percent. However, systematic fertilizer application, i.e., applying fertilizer with every wheat growing season, was found to be practiced by only 1 percent of the Jordanian wheat farmers. Considering the effect of weather variability on farmers' decision to fertilize, the above statistics imply that 99 percent of dryland wheat farmers do not use chemical fertilizer in any significant way. This conclusion may be held if we assume that anytime--wheat growing season--the farmer decides to plant wheat is considered a suitable period for applying fertilizer. This appears an ideal assumption because Jordanian wheat farmers, who operate under dryland conditions and who look at fertilizer as an expensive type of investment, in order to apply fertilizer, must have a sufficient amount of moisture in the soil and have indication of a very wet rainy season if they are to have the incentive to use fertilizer. The decision to plant the wheat or not requires much less moisture. Farmers are used to planting every wheat season according to their crop sequence, except in the years which look very dry. In other words, when making a decision to grow wheat, the wheat farmer is taking much more risk than when he decides to use fertilizers. This means that only in the years of exceptionally good rainfall can farmers decide to apply fertilizer, while in the years of exceptionally poor rainfall, farmers may decide not to grow wheat.

In that fertilizer application under rainfed environment depends on the level of rainfall, we would expect fertilizer adopters to be located in higher and less erratic rainfall areas; in Belts III and IV. In addition to this environmental condition, we expect farmers in higher rainfall belts, as indicated earlier, to be more concerned about improving wheat culture practices and more knowledgeable about modern agricultural practice, and, consequently, to adopt chemical fertilizer more readily than farmers in lower rainfall areas. A breakdown of Table 4.38 according to rainfall belts is presented in Table 4.39. In lower rainfall belts, I and II, where farmers do not use chemical fertilizer, the adoption rate is zero. Farmers in these two belts maintained that they do not use fertilizer because the land is so rich, needing only moisture. They put much stronger emphasis on the availability of moisture for successful wheat harvest. It seems the arguments of Belts I and II farmers are sound within the environmental condition they live under; in other words, Belts I and II farmers are expected to realize the importance of fertilizer when they receive the precipitation necessary to bring positive economic returns from fertilizer application. In short, we may infer that within the environmental conditions of farmers' Belts I and II areas, their expectation of the wheat land productivity is much lower than that of farmers in higher rainfall areas, namely Belts III and IV. Although the adoption rate of fertilizer in Belt III is very low, 14.29 percent, it shows a significant difference from Belts I and II. As expected, Belt IV farmers report an even higher adoption rate than that of all the preceding, 43.33 percent.

A chi-square test between the adoption rate of chemical fertilizer and the rain belts shows a statistically significant relation (at the 99% level) between farmers in their rainfall areas and their fertilizer adoption rate.

Table 4.39. Interviewed farmers' adoption rate of chemical fertilizer distributed by rain belts

How many times have you put chemical fertilizer on your wheat ground for the past six years	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
None	30	100	70	100
One time	--	--	--	--
Two times	--	--	--	--
Three times	--	--	--	--
Four times	--	--	--	--
Five times	--	--	--	--
Total	30	100	70	100

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
60	85.71	17	56.67	177	88.5
4	5.71	9	30.00	13	6.5
3	4.29	1	3.33	4	2.0
2	2.86	2	6.67	4	2.0
--	--	--	--	--	--
1	1.43	1	3.33	2	1.0
70	100.00	30	100.00	200	100.0

i. The role of manuring activity in Jordanian wheat dryland farming Jordan dryland farmers, in general, place more value on the manuring application than on chemical fertilization. The manuring technique has been known to wheat farmers for hundreds of years, as it increases the fertility of the dryland soil. In the past, manure has been quite cheap and very easily obtainable for wheat farmers. Most of these farmers used to raise sheep and goats in addition to their wheat farming, so manure was available from their own animals. However, presently, manure is not as cheap or easily available to farmers as before, and most wheat farmers, particularly in higher rainfall areas, no longer raise animals. Despite these changing conditions of manuring, farmers still have stronger preference for the use of manures over inorganic fertilizers. One basic advantage manure has over chemical fertilizer, according to wheat farmers, is the longer durability of the effect of manure on wheat land productivity. Farmers believe a one-time application of manure is good and effective in increasing wheat yield for a number of years, ranging from 5-8 years, whereas chemical fertilizer is used up in only one planting season. Farmers' adoption rate of manure have been measured and summarized in Table 4.40. Nineteen percent of the interviewed farmers have used organic fertilizer one or two times in a period of six wheat growing seasons. This is a higher percentage rate of adoption for chemical fertilizer (11.5 percent). Availability and cost of manure may contribute to this higher rate. However, there are stronger factors which influence

Table 4.40. Interviewed farmers' adoption rate of organic fertilizer--manure

How many times have you put organic fertilizer on your wheat ground for the past six years	All belts frequencies	
	No. of farmers	Percent
None	162	81
One time	34	17
Two times	4	2
Total	200	100

the use of this organic fertilizer, including better knowledge, wider acceptance, and traditional attitudes which act positively in the farmers' decision to adopt new techniques.

To determine the distribution rate of manure use among the four rainbelts, see Table 4.41 which reports the adoption rate in each belt. A look at the farmers' adoption rate shows a very similar trend in the adoption of manure among belts as for chemical fertilizer. Almost no farmers in Belt I (96.67 percent) and Belt II (97.14 percent) use manure for their wheat production, although a higher rate of manure adoption is found among Belt III farmers (38.57

Table 4.41. Interviewed farmers' adoption rate of organic fertilizer--manure--distributed by rain belts

How many times have you put manure on your wheat ground for the past six years	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
None	29	96.67	68	97.14
One time	1	3.33	2	2.86
Two times	--	--	--	--
Total	30	100.00	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
43	61.43	22	73.33	162	81
23	32.86	8	26.67	34	17
4	5.71	--	--	4	2
70	100.00	30	100.00	200	100

percent) than among those in Belt IV (26.67 percent). This phenomenon can be attributed to the greater availability of manure in Belt III areas and, perhaps, to the relatively higher preference for chemical fertilizer by Belt IV farmers than in Belt III. An over-all evaluation of the application rate of both organic and inorganic fertilizer shows that for

Belt I, chemical fertilizer 0% + manure 3.33% = 3.33%

Belt II, chemical fertilizer 0% + manure 2.86% = 2.86%

Belt III, chemical fertilizer 14.29% + manure 38.57% = 52.86%

Belt IV, chemical fertilizer 43.33% + manure 26.67% = 70%

where Belts I and II have a near-zero adoption of both kinds of fertilizer; Belt III farmers show much significant increase with more than half of the farmers using some kind of fertilizer; and Belt IV farmers rank at the top of fertilizer adopters.

b. Farmers' knowledge about the effect of chemical fertilizer and yield rise expectation from adopting fertilization

The farmer's knowledge about the effect of fertilizer on his wheat land productivity as well as the cost to apply fertilizer is fundamental for his decision to adopt or not to adopt. The farmer needs to have some clear notion about the expected yield rise if he applies a certain amount of a specific kind of chemical fertilizer under a certain set of risks and probability assumptions. Asking a farmer about the expected yield he thinks would be obtained through the use of inorganic fertilizer is no easy task to carry out because an inquiry such as this would implicitly assume that he has some experience using chemical fertilizer and observing its effect on his fields. However, recognizing the fact that 88.5 percent of the interviewed farmers have no actual experience whatsoever in applying chemical fertilizers did not prevent this inquiry. It is believed that farmers who have not applied chemical fertilizer may still have some knowledge from observing demonstration fertilized plots or some progressive farmers in the village or at least having heard about fertilizer's benefits and cost from the acquaintances in the neighborhood. From our survey, it was recognized that almost all farmers (98.5 percent) are aware of the existence of the chemical fertilizer technique and its basic function in increasing soil fertility and improving the productivity of land. It was found that only 1.5 percent of the farmers do not believe in fertilizer. However, when farmers were asked about their own quantitative perception of fertilizer effect on wheat yield, i.e., asked to formulate an expected wheat yield estimate of possible increase with fertilizer application, only 32.5 percent of the farmers were able to make some estimate. Sixty-six percent indicated positive yield effect while unable to materialize their expectation in a more refined estimate. This high percentage can be attributed to the fact that 88.5 percent of the surveyed farmers have never used chemical fertilizer. The remaining 1.5 percent expressed no belief in fertilizer impact on wheat yield. All that counts is moisture. Table 4.42 reports farmers' yield increase expectation over nonfertilized wheat fields. The most frequent expectations are concentrated in the range of 21-50 percent. To study the variations between farmers in different rainfall belts with respect to their yield rise expectation, Table 4.43 was constructed. Ninety percent of the farmers in Belt I were unable to make yield increase estimates, and the remaining 10 percent think fertilizer has no effect on the wheat yield, believing rainfall is the only relevant factor. Belt II farmers are not better in estimating ability than those in Belt I, with 92.85 percent of Belt II farmers unable to give some estimate for the wheat yield. The remaining 7.15 percent have a yield increase expectation ranging from 21-50 percent. Farmers of Belt III show much better ability to estimate, as the adoption rate of fertilizer (14.29 percent) shows positive increase over the first two belts. 51.43 percent of these farmers provide yield rise estimate, mostly concentrated in the range of 21-50 percent. As the adoption rate rises to 43.33 in Belt IV, the yield expectation ability of farmers shows greater ability to make yield increase estimates. Eighty percent of Belt IV farmers provide estimates ranging from 21-100 percent.

A chi-square statistical test indicates a significant association (at the 99 percent level) between wheat farmers' expectations of the effect of chemical fertilizer on wheat yield and their rain belts. Apparently, farmers in higher rainfall belts were found to have higher yield increase expectation than those in

Table 4.42. Interviewed farmers' wheat yield rise expectation from the adoption of chemical fertiliz·:r

What is your estimate percent yield increase from the use of chemical fertilizers	All belts frequencies	
	No. of farmers	Percent
Zero	3	1.5
1-10	1	0.5
11-20	2	1.0
21-30	12	6.0
31-40	17	8.5
41-50	18	9.0
51-60	2	1.0
61-70	2	1.0
71-80	1	0.5
81-90	--	--
91-100	8	4.0
101-200	1	0.5
201-300	--	--
301-400	1	0.5
Do not know	132	66.0
Total	200	100.0

Table 4.43. Interviewed farmers' wheat yield rise expectation from the adoption of chemical fertilizers distributed by rain belts

What is your % wheat yield increase estimate from the adoption of chemical fertilizers	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Zero	3	10	--	--
1-10	--	--	--	--
11-20	--	--	--	--
21-30	--	--	1	1.43
31-40	--	--	2	2.86
41-50	--	--	1	1.43
51-60	--	--	--	--
61-70	--	--	--	--
71-80	--	--	--	--
81-90	--	--	--	--
91-100	--	--	1	1.43
101-200	--	--	--	--
201-300	--	--	--	--
301-400	--	--	--	--
Do not know	27	90	65	92.85
Total	30	100	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
--	--	--	--	3	1.5
--	--	1	3.33	1	0.5
1	1.43	1	3.33	2	1.0
7	10.00	4	13.33	12	6.0
9	12.86	6	20.00	17	8.5
13	18.57	4	13.33	18	9.0
1	1.43	1	3.33	2	1.0
1	1.43	1	3.33	2	1.0
1	1.43	--	--	1	0.5
--	--	--	--	--	--
2	2.85	5	16.67	8	4.0
--	--	1	3.33	1	0.5
--	--	--	--	--	--
1	1.43	--	--	1	0.5
34	48.57	6	20.00	132	66.0
70	100.00	30	100.00	200	100.0

lower belts.

Regarding the cost of fertilization, farmers were asked how much they think it costs, on the average, to fertilize a dunum of wheat land. Table 4.44 reports farmers' responses, showing that the great majority of the interviewed farmers, 85.5 percent, have no knowledge about the prices or the cost of fertilizer per dunum of land. Only 14.5 percent of the farmers provide a cost estimate. On the basis of the actual numbers of users of fertilizer, this low percentage can be understood since only 11.5 percent of the farmers have used fertilizer. It is worth noting that more farmers (34 percent) were able to furnish some yield rise estimate than could supply cost estimate (14.5 percent), indicating that many farmers have some perceived notion of the benefit of fertilizer but no knowledge of its cost. It is expected that farmers who provide the cost estimates are to be found in the belts which use fertilizers, namely Belts III and IV, as a breakdown of Table 4.44 by rain belts verifies. As presented in Table 4.45, farmers in Belts I and II did not give any cost estimates of fertilization, as was the case in the yield rise expectation. Farmers in these two belts have never used chemical fertilization. 21.43 percent of Belt III farmers furnish some cost estimates concentrated between 310-900 fils/dunum whereas 43.33 percent of Belt IV farmers give cost estimates ranging from 410-1,200 fils/dunum.

Table 4.44. Interviewed farmers' cost estimate of the adoption of chemical fertilizer

What is your cost estimate of using chemical fertilizer in Jordan fiis/dunum	All bents frequencies	
	No. of farmers	Percent
110-200	1	0.5
210-300	1	0.5
310-400	1	0.5
410-500	7	3.5
510-600	2	1.0
610-700	1	0.5
710-800	4	2.0
810-900	5	2.5
910-1,000	2	1.0
1,010-1,100	1	0.5
1,110-1,200	1	0.5
1,210-1,300	--	--
1,310-1,400	--	--
1,410-1,500	2	1.0
6,000	1	0.5
Do not know	171	85.5
Total	200	100.0

Table 4.45. Interviewed farmers' cost estimates of the application of chemical fertilizers distributed by rain belts

What is your cost estimate of using chemical fertilizer in Jordan fils/dunum	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
110-200	--	--	--	--
210-300	--	--	--	--
310-400	--	--	--	--
410-500	--	--	--	--
510-600	--	--	--	--
610-700	--	--	--	--
710-800	--	--	--	--
810-900	--	--	--	--
910-1,000	--	--	--	--
1,010-1,100	--	--	--	--
1,110-1,200	--	--	--	--
1,210-1,300	--	--	--	--
1,310-1,400	--	--	--	--
1,410-1,500	--	--	1	1.43
6,000	--	--	--	--
Do not know	30	100	69	98.57
Total	30	100	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
1	1.43	--	--	1	0.5
--	--	1	3.33	1	0.5
1	1.43	--	--	1	0.5
5	7.14	2	6.67	7	3.5
1	1.43	1	3.33	2	1.0
1	1.43	--	--	1	0.5
2	2.86	2	6.67	4	2.0
3	4.29	2	6.67	5	2.5
--	--	2	6.67	2	1.0
--	--	1	3.33	1	0.5
--	--	1	3.33	1	0.5
--	--	--	--	--	--
--	--	--	--	--	--
--	--	1	3.33	2	1.0
1	1.43	--	--	1	0.5
55	78.57	17	56.67	171	85.5
70	100.00	30	100.00	200	100.0

c. Farmers' attitudes, acceptance, and incentives toward the use of chemical fertilization

Jordan's dryland wheat farmers are, in general, nonfertilizer users, with the great majority of wheat farmers (88.5 percent) never having used chemical fertilizer, and 10.5 percent having used fertilizer erratically for the past few years. The remaining 1 percent of the surveyed farmers have used chemical fertilizer in a systematic way--every suitable wheat growing season. In the face of low Jordanian wheat yields and the slow adoption of improved practices, fundamental research needs to be done to understand why farmers even in higher rainfall areas do not use chemical fertilizer. It is also important to learn about farmers' attitudes and about conditions under which they will be ready to adopt the important input of fertilizer to improve wheat yield. Each interviewed farmer was asked to give three or fewer conditions under which he would use chemical fertilizers. Table 4.46 summarizes farmers' responses according to their frequency. Seven major conditions have arisen from these responses, each with different values to wheat farmers. The first ranking condition to farmers is the cost of fertilizer. Fifty-two percent of the interviewed farmers cast their vote to use fertilizer if, among other conditions, prices of fertilizer are much lower than the currently prevailing prices. Although the majority of wheat farmers indicated inability to furnish cost estimate of fertilizing, it seems farmers have a general notion that fertilizer is very expensive to use. What is considered a high cost

Table 4.46. Interviewed farmers' attitudes and acceptance toward the adoption of chemical fertilizer

Under what conditions would you use chemical fertilizer	All farmers		
	Frequencies	Percent	Rank
Farmers would use chemical fertilizer if its price is reasonably lower	104	29.00	First
Farmers would use it if they are financially capable to purchase chemical fertilizer	102	28.50	Second
Farmers would use it if proved effective to wheat yield	66	18.44	Third
Farmers would use chemical fertilizers if organic fertilizer cannot be found in village	30	8.38	Fourth
Farmers would use chemical fertilizer if rainfall season looked very good	26	7.25	Fifth
Farmers would use chemical fertilizer if it is available in the village	20	5.60	Sixth
Farmers would use chemical fertilizer if government provides it free of charge	10	2.80	Seventh

for fertilizing per dunum may be a value judgment. The author's belief that a cost of 500 fils or more can be considered according to the farmers' economic conditions as expensive will be clarified by the second condition. (ii) Fifty-one percent of the farmers indicated that if they are financially capable of buying chemical fertilizer, they would use it. A statement of conditions in these terms must be vague enough to be subject to economic analysis. However, such a condition as stated by farmers carries significant identification of the farmers economic condition. Because most Jordanian wheat farmers are very poor, allocating a sum of 25 J.D. (0.500 fils/du x 50 dunums) for fertilizer would take a very large portion of his family's budget, already beset by competing necessities for family consumption. Thus, in order to give the farmer incentive to spend (or sacrifice) 25 J.D., he must perceive a high rate of return and under certain conditions. Farmers simply cannot risk a great deal of money with the uncertainty of weather. (iii) If chemical fertilizer proved effective, as indicated above, farmers need to be assured of the positive high return from investing in fertilizer. Farmers are very conservative in taking risks, especially when they are subsistence level farmers; thus, any mistakes in spending some of their financial assets may mean financial hardship if not starvation. Therefore, farmers must witness and observe the effect of fertilizer by themselves in order to feel secure in allocating scarce resources to fertilizing. This condition may reflect the farmers' lack of adequate knowledge about the effect of fertilizer and its economic returns. (iv) If manure could not be found in the village, farmers would use chemical fertilizer. This condition simply sheds light on the farmers' evaluation of manure in preference to inorganic fertilizer. As indicated earlier, more farmers use manure (19 percent) than use chemical fertilizer (11.5 percent), and those 19 percent have higher preference for manure than for chemical fertilizer. (v) If the rainfall season looked very good, farmers would use chemical fertilizer. This is a very rational condition on the part of rainfall-dependent wheat farmers because rainfall is the decisive factor if fertilizer is to bring sufficient economic returns. Applying fertilizers under uncertain weather conditions represents a high risk to farmers, who can be characterized as risk averters. Hence, farmers who are very knowledgeable about the effect of fertilizer and who are willing to use it will expect a good rainfall season. (vi) If chemical fertilizers are available in the village, 10 percent of the farmers indicated their wishes for agribusiness agents to initiate their business in the villages and furnish chemical fertilizer and other inputs. Finally, five percent of the farmers expressed their wishes for the government to furnish fertilizer free or at a very nominal price in order to encourage the use of chemical fertilizer and to help farmers sustain their economic production. This desire reflects both the high expectation of what the government could do and the poverty conditions which prevail in the rainfed agricultural areas.

5. Chemical Spraying

a. Current farm practices of chemical spraying for weed control

Jordanian wheat farmers have faced the problem of weeds since they first began to raise wheat; it seems as if they live with this weed problem which, although identified, has had little concrete effort toward solving. Jordanian farmers in general are aware of the harm weeds bring to the wheat yield in terms of competition with wheat for moisture and early depletion of the soil moisture before the wheat planting season starts.

Furthermore, farmers are aware of the problem weeds create in the form of decreased market price for the wheat when weed seeds are mixed with it at harvest. In fact, the latter has a greater tangible effect on farmers' evaluation of the weed problem than its effect on wheat yield. The quality of wheat determines its price in the bargaining process between wheat farmers and merchants, who has a strong argument for offering a much lower price (20 percent) if he finds strange materials and weed seeds are in with the wheat.

Yet, in the face of this weed problem, farmers do very little to cope with it. Hand weeding, mechanical weed control, and chemical spraying are practiced on a very small scale. Between the harvest season of such a winter crop as lentils and the planting season of wheat, there are five months (June-October) in which weeds grow, and most of the farmers do nothing until the seeding season starts. At this time, they till their land shallowly to cover the seeds and in the process cut off the weeds. Most wheat farmers have changed their seeding time until after the rainfall season starts in order to kill by the sole tillage operation the weeds expected to appear after the rain. Table 4.47 reports seeding time with respect to the rainfall season. Farmers mentioned that in the past they used to seed in the dust, "affeir," but the table shows that over 60 percent of the wheat farmers now plant after the rain in order to reduce the weeds. However, the seeding time is determined by farmers according to other conditions such as the ground topography, the type of soil, or the amount of rainfall throughout the winter season. Hand weeding is not practiced between the crops, although a few farmers indicated they do some hand weeding through the wheat growing season, using some family members and cheap hired labor. However, hand weeding as a practice is diminishing because of the increase in labor wages and because most of the members (boys) of the farming family work in the nonfarm sector or go to school.

How much chemical spraying is being adopted, how farmers perceive the value of chemical weed control technique, and their attitudes and willingness to use it are the major points investigated in this section.

Table 4.48 reports the adoption rate of chemical spraying among the interviewed farmers. Only 17 percent of wheat farmers use chemical spraying, while 83 percent have never used it. This is a considerable low adoption rate for chemical weed control, indicating that the weed problem exists continuously among a great proportion of the

Table 4.47. Interviewed farmers' responses with respect to the time pattern of seeding season distributed by rain belts

When do you sow your wheat seeds	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Before the rain	30	100	12	17.14
After first rain	--	--	1	1.43
After enough rain	--	--	47	67.14
Before the rain in the hilly areas and after enough rain in the Plains area	--	--	10	14.29
After enough rain if the rainy season came early and before rain if rain came late	--	--	--	--
Total	30	100	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
12	17.14	10	33.33	64	32.0
4	5.71	6	20.00	11	5.5
37	52.86	14	46.67	98	49.0
9	12.86	--	--	19	9.5
8	11.43	--	--	8	4.0
70	100.00	30	100	200	100.0

Table 4.48. Interviewed farmers' adoption rate of chemical spraying

Do you spray on standing wheat	All belts frequencues	
	No. of farmers	Percent
Yes	34	17
No	166	83
Total	200	100

wheat farms. As discussed above, wheat farmers in higher rainfall areas are more concerned about improving their wheat production conditions and more progressive in accepting new farming practices than those farmers located in lower rainfall belts. It is believed that more farmers in higher rainfall areas are concerned about the weed problem and act accordingly by using chemical spraying. A breakdown of all the belts' adoption rate of chemical weed control by the four rain belts is presented in Table 4.48 and summarized in Table 4.49. This table shows very interesting results with respect to this adoption rate. We find that farmers in Belts I and II have never used chemical weed control techniques; that is to say, the

Table 4.49. Interviewed farmers' adoption rate of chemical spraying distributed by rain belts

Do you spray on standing wheat	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Yes	--	--	--	--
No	30	100	70	100
Total	30	100	70	100

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
18	25.71	16	53.33	34	17
52	74.29	14	46.67	166	83
70	100.00	30	100.00	200	100

adoption rate is zero for Belts I and II. As we go toward higher rainfall areas, farmers show positive actions and the adoption rate becomes positive. 25.71 percent of farmers in Belt III are chemical spray users, and in Belt IV, over half of the farmers, 53.33 percent, use chemical weed control. A chi-square statistical test between farmers' adoption rate of chemical spraying and rain belts showed statistically significant association (at the 95 percent level) between farmers in different rainfall areas and their chemical spraying adoption rate.

b. <u>Farmers' knowledge about the effect of chemical spraying and yield rise expectation from adopting chemical weed control technique</u>

A great majority of farmers in all dryland areas are fully aware of the existence of the chemical spraying technique to control weeds. As Table 4.50 shows, 96.5 percent of the interviewed wheat farmers have heard of the chemical spraying technique. As proposed earlier, the degree of awareness of new practices is higher in the areas which receive greater rainfall. Table 4.51 shows that in Belts III and IV the "awareness" rate is 100 percent but less in Belts II and I which show 98.57 percent and 80 percent awareness, respectively. In general, farmers indicated good knowledge about the negative effect of weeds on wheat plants; they understand that weeds do compete with the wheat plants for the limited moisture available in the soil and know, therefore, that the existence of weeds represents a threat to productivity. Farmers understand that the ultimate effect of

Table 4.50. Interviewed farmers' knowledge about the existence of chemical spraying technique

Have you heard of chemical spraying to control weeds	All belts frequencies	
	No. of farmers	Percent
Yes	193	96.5
No	7	3.5
Total	200	100.0

spraying is to increase wheat yield through killing the weeds and preserving moisture. As shown in Table 4.52, 95.5 percent of wheat farmers indicated clear understanding of the positive effect of chemical spraying on wheat yield. One percent of the farmers believed there is no positive increase in the wheat yield by spraying, and the remaining 3.5 percent of surveyed farmers had never heard of the chemical spraying technique. A closer look at farmers' responses within each rain belt shows that all farmers in Belts III and IV indicated positive yield increase expectation from spraying, against only 73.33 and 98.57 percent of the wheat farmers in Belts I and II, respectively, as shown in Table 4.53. How much

Table 4.51. Interviewed farmers' knowledge about the existence of chemical spraying technique distributed by rain belts

Have you heard of chemical spraying to control weeds	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Yes	24	80	69	98.57
No	6	20	1	1.43
Total	30	100	70	100.00

	Belt III frequencies		Belt IV frequencies		All [illegible] freq[illegible]	
	No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
	70	100	30	100	193	96.5
	--	--	--	--	7	3.5
	70	100	30	100	200	100.0

Table 4.52. Interviewed farmers' knowledge about the effect of chemical spraying on wheat yield

Do you think spraying on standing wheat would increase the yield	All belts frequencies	
	No. of farmers	Percent
Yes	191	95.5
No	2	1.0
Never heard of spraying	7	3.5
Total	200	100.0

increase in the wheat yield can be accomplished by spraying an average weed infested wheat field is a significant area of investigation to study the farmers' expectation of the economic returns he would get from spraying. Table 4.54 reports farmers perceived expectations of yield increase from sprayed over nonsprayed fields. A high percentage of wheat farmers was unable to formulate a yield rise estimate because of spraying but believe that spraying the wheat field will have positive yield effect. This inability to give a quantitative yield increase can be attributed to the fact that the farmers are nonadopters of spraying indicated above, 83 percent of the farmers have never used chemical spraying on their

Table 4.53. Interviewed farmers' knowledge about the effect of chemical spraying on wheat yield distributed by rain belts

Do you think spraying would increase wheat yield	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Yes	22	73.33	69	98.57
No	2	6.67	--	--
Never heard of spraying	6	20.00	1	1.43
Total	30	100.00	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
70	100	30	100	191	95.5
--	--	--	--	2	1.0
--	--	--	--	7	3.5
70	100	30	100	200	100.0

Table 4.54. Interviewed farmers' yield rise expectation from the application of chemical spraying on wheat fields

What is your percent yield increase estimate of chemical spraying over nonsprayed fields	All belts frequencies	
	No. of farmers	Percent
Zero	2	1.0
1-10	1	0.5
11-20	6	3.0
21-30	13	6.5
31-40	14	7.0
41-50	8	4.0
51-60	1	0.5
61-70	--	--
71-80	--	--
81-90	1	0.5
Farmers believe spraying increases yield but unable to make quantitative estimates	147	73.5
Do not know if spraying increases wheat yield	7	3.5
Total	200	100.0

farms. A yield increase in the range of 11-50 percent was mentioned by the majority of farmers who provided some quantitative rate.

A breakdown of Table 4.54 according to the rain belts is presented in Table 4.55, which makes some meaningful comparison between farmers in different rainfall belts with respect to their expectation of the spraying effect on the wheat yield. It is believed that farmers in higher rainfall areas are more capable of formulating their own estimates and have higher yield rise expectations than those in lower belts. Although 80 percent of the interviewed farmers in Belt I have heard of chemical spraying, and 73.33 percent of them believe it will increase wheat yield, none of these farmers were able to provide any estimate of how much the yield can be increased. This is because these wheat farmers have not applied chemical sprays and have not seen agricultural demonstrations in this belt area showing villagers the effect of this technique. In Belt II, the great majority of farmers, 98.57 percent, believe positively in the effect of spraying on the wheat yield. However, only one farmer (1.43 percent) was able to give an estimate of perceived increase in wheat yield (21-30 percent) with spraying. 91.14 percent of farmers were unable to make any estimate, as in the case of Belt I farmers. Farmers in Belt III indicate better knowledge of expected yield increase with spraying, with 35.71 percent of this belt's farmers believing yield can be increased in the range between 11-50 percent. The highest proportion of farmers formulating a quantitative rate is among farmers in Belt IV who feel that an increase

Table 4.55. Interviewed farmers' yield rise expectation from the application of chemical spraying on wheat fields distributed by rain belts

What is your percent yield increase estimate from spraying	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Zero	2	6.67	--	--
1-10	--	--	--	--
11-20	--	--	--	--
21-30	--	--	1	1.43
31-40	--	--	--	--
41-50	--	--	--	--
51-60	--	--	--	--
61-70	--	--	--	--
71-80	--	--	--	--
81-90	--	--	--	--
Farmers believe spraying increases yield but unable to make quantitative estimate	22	73.33	68	97.14
Do not know if spraying increases yield	6	20.00	1	1.43
Total	30	100.00	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
--	--	--	--	2	1.0
--	--	1	3.33	1	0.5
5	7.14	1	3.33	6	3.0
5	7.14	7	23.33	13	6.5
9	12.86	5	16.67	14	7.0
5	7.14	3	10.00	8	4.0
1	1.43	--	--	1	0.5
--	--	--	--	--	--
--	--	--	--	--	--
--	--	1	3.33	1	0.5
45	64.29	12	40.00	147	73.5
--	--	--	--	7	3.5
70	100.00	30	100.00	200	100.0

in the range of 21-50 percent can be achieved by spraying. Farmers in this belt have the highest expectation and more knowledge and concern about the problem of weeds than these in lower rainfall belts. The need for controlling weeds is stronger in lower rainfall areas because moisture is scarcer and fluctuates more sharply, and any moisture preservation has greater impact on wheat yield.

A chi-square statistical test between farmers' yield rise expectations and their rain belts shows a statistically significant relation (at the 95 percent level) between these factors.

In addition to investigating farmers' expectation of the beneficial effect of adopting chemical spraying on wheat yield, it is equally essential to inquire about farmers' knowledge and perception of the cost of spraying. Farmers, as profit maximizers, desire to obtain information about both the expected cost and the return from adopting any improved input they decide to use. Table 4.56 reports farmers' responses about cost of spraying per dunum of wheat land. The majority of farmers (77.5 percent) indicated no knowledge of the total cost of spraying per dunum, while the remaining farmers furnished some cost estimates most of which fall in the range of 160-300 fils per dunum. A breakdown of Table 4.56 according to rainfall belts is presented in Table 4.57. Farmers in Belts I and II have no knowledge of the cost of spraying. 34.29 percent of the Belt III farmers indicate some knowledge of the cost of spraying, ranging from 160-350 fils per dunum, and the remaining farmers, 65.71 percent, indicate no knowledge of

Table 4.56. Interviewed farmers' estimates of chemical spraying cost

How much do you think it costs to spray in Jordan fils/dunum	All belts frequencies	
	No. of farmers	Percent
60-100	2	1.0
110-150	2	1.0
160-200	6	3.0
210-250	24	12.0
260-300	9	4.5
310-350	2	1.0
Do not know	155	77.5
Total	200	100.0

spraying cost. Seventy percent of the Belt IV farmers give some cost estimates, which range from 110-350 fils per dunum, with only 30 percent of the farmers not knowing the actual or estimated cost of spraying. The farmers' knowledge about the cost of spraying relates very closely to their knowledge about the expected yield increase from spraying. Farmers in Belts I and II indicated no knowledge of either expected yield increase or cost of spraying,

Table 4.57. Interviewed farmers' estimates of chemical spraying cost by rain belts

How much do you think it costs to spray in Jordan fils/dunum	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
60-100	--	--	--	--
110-150	--	--	--	--
160-200	--	--	--	--
210-250	--	--	--	--
260-300	--	--	--	--
310-350	--	--	--	--
Do not know	30	100	70	100
Total	30	100	70	100

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
2	2.86	--	--	2	1.0
--	--	2	6.67	2	1.0
3	4.29	3	10.00	6	3.0
14	20.00	10	33.33	24	12.0
4	5.71	5	16.67	9	4.5
1	1.43	1	3.33	2	1.0
46	65.71	9	30.00	155	77.5
70	100.00	30	100.00	200	100.0

while similar proportions of farmers in each of Belts III and IV indicated knowledge about the cost and return from spraying.

c. Farmers' attitudes, acceptance, and incentives toward chemical spraying adoption

The strongest impression to be gained from farmers' responses regarding the adoption of six improved inputs is that there is general good feeling for chemical spraying by all farmers in all the rainfall areas. Although Jordanian wheat farmers, as well as all traditional farmers in the world, are risk averters by nature, one of the psychological factors that encourages wheat farmers to adopt an input is their being able to see the effect and result of this input in his own fields. The stronger the evidence and the clearer the effect, the faster and easier the adoption of the input will be. When the results are directly and unmistakably attributable to this input application, the farmer is easily convinced to adopt the new input if he has the financial capacity to do so. The chemical spraying technique seems to fit all the above conditions. Farmers can see that the weeds which infest the fields are killed after being sprayed. No factors other than the spraying can be attributed to controlling the weeds. A wheat project advisor has noted that chemical weed control is the first improved practice in wheat production to receive general acceptance by wheat farmers. On those interviewed farmers whom we classify as "spraying non-adopters" (83 percent), we concentrate our investigation. Farmers were asked to mention as many as three conditions under which they would be willing to use chemical spraying. Table 4.58 reports responses which are tabulated by frequency of which each condition was mentioned. All the conditions mentioned by farmers fall into seven general conditions.

(i) The availability of spraying custom services in the village is the most frequently mentioned condition by spray nonadopter farmers. 57.23 percent of those farmers indicated willingness to use the spraying technique pending the availability of some agribusiness agents to furnish spraying services on a custom basis. Farmers believe that spraying is a more complicated task than they could accomplish on their own; that is, the mixing and application time require some skills they do not have. In addition, spraying requires sprayers, which the farmer does not own and which may be beyond his financial capacity even for a small sprayer.

(ii) Under great weed infestation of their fields, 42.77 percent of the farmers indicated the willingness to spray. This kind of argument reflects farmers' expectation and awareness of how great a damaging effect the weeds may bring into the wheat productivity and how much weed infestation is believed to be "very much" in order for the farmers to consider them a problem requiring action. The writer has observed a great many weeds in wheat fields which farmers did not consider having high weed infestation problems. This low evaluation of the magnitude of the weed problem can be understood within the context of the past history of wheat farming

Table 4.58. Interviewed farmers' attitudes and acceptance of chemical spraying application

Under what conditions would you use chemical spraying	All farmers		
	No. of farmers	Percent	Rank
Farmers would use chemical spraying if spray custom services are available in village	95	33.00	First
Farmers would use chemical spraying if weeds were very much in their fields	71	24.65	Second
Farmers would use chemical spraying if they are financially capable of purchasing chemical spray	64	22.22	Third
Farmers would use chemical spraying if its cost is relatively low	25	8.68	Fourth
Farmers would use chemical spraying if it proved effective for controlling weeds	5	5.21	Fifth
Farmers would use chemical spraying if government provides spraying	11	3.82	Sixth
Farmers would use chemical spraying if their neighbors start using chemical spray	7	2.43	Seventh

before mechanical tillage appeared. More wild weeds used to grow in the wheat fields, but the tractor tillage operation started the great number of weeds has undoubtedly been reduced. Thus, when farmers compare the present weed situation with the past, they feel existing weeds are no serious concern.

(iii) With financial ability for chemical spraying, farmers indicated willingness to use it, although their financial incapacity inhibits them from transferring their willingness into action to control their weeds. This simply reflects the general economic condition of wheat farmers, among whom poverty is dominant. Many Jordanian wheat farmers live on a subsistence level, and the allocation of resources between consumption needs and wheat production is subject to sharp competition.

(iv) With relatively low cost spraying, farmers might use chemical spraying. Farmers view the prevailing cost of spraying by the cooperative or the very few agribusiness sprayers (at an average cost of 150-300 fils per dunum) as expensive. If a farmer has 50 dunums to spray and the cost is 200 fils per dunum, it means he has to pay (200 x 50) 10 J.D. for the services. For the wheat farmer, 10 J.D. are hard to come by, and it would be difficult to spend them on spraying.

Other conditions mentioned by fewer farmers included the proved effectives of spraying on weed control, the availability of free government-provided spraying services, and the use of spraying by neighbors.

6. Clean Summer Fallowing

a. <u>Farmers' current practices in the field of summer fallowing</u>

Before investigating farmer practices in this area, a brief discussion of summer fallowing is in order. Clean summer fallow practice is recommended strongly for adoption in rotation with wheat in areas which receive an average annual rainfall of between 200-350 mm. It is believed that areas of Jordan which have annual precipitation of between 200-350 mm can be adapted to a summer fallow system of farming, comparable to that now used in the Pacific Northwest of the United States (35). It is advocated that, through a well-planned and conducted summer fallow program, the wheat production of Jordan could unquestionably be greatly increased, and the hazards of crop failure could be reduced. In low rainfall areas and in seasons of low rainfall, much wheat dryland is allowed to lie idle because long experience has shown farmers that yields do not repay the cost of production. This practice is called traditional fallowing in contrast with the recommended clean summer fallowing. Traditional fallowing implies farmers' practice of letting the land lie idle during the dry year, with weeds not controlled and much of the potentially conserved moisture wasted. Through proper and more timely tillage operations and with better mechanized control of weeds during the fallow year, it is hoped the valuable portion of the rainfall (30-50 percent) which comes during the idle season can be stored and conserved so that it will be available for wheat during the crop year. If moisture is lost through faulty summer fallow practices or weed growth, the purpose of such a practice is defeated (35). Thus, the major goal of having proper summer fallow practice is to conserve moisture and to hold it near the soil surface so that wheat can be seeded into moist soil in the fall before the normal rains and thus be assured of a satisfactory stand. To accomplish this goal, a specific system of summer fallow tillage operation needs to be designed according to Jordan's soil and weather conditions to maximize rainfall infiltration, minimize soil water losses, control weeds, and leave the surface in a satisfactory condition for seed drilling (14).

According to the definition of clean summer fallow practice above, Jordanian dryland farmers can be characterized in general as summer fallow nonadopters. However, traditional fallowing is practiced erratically and unsystematically in all the Jordanian drylands for a variety of conditions, including weather, topography, and economic reasons. Discussions and interviews with several wheat farmers in all rain belt areas indicated that Jordanian farmers may leave part of their land idle some years because of several factors. (i) Financial incapacity may inhibit farmers from leaving parts of their farms idle and, in this case, cultivate the best part of the land. (ii) Farmers are forced to leave idle the parts of their land which topographically do not allow the use of mechanized tilling, i.e., land which is mountainous, rocky, and full of stones. (iii) With a late and dry rainfall season, farmers may decide not to cultivate all or part of their lands because, as mentioned above, past experience has taught farmers the high risk of crop failure. Therefore, farmers minimize the risk by deciding not to grow wheat and during poor years leave land without any tillage operation until the next wheat planting season.

With respect to clean summer fallow practice, farmers were asked how many times they have fallowed their land--or part of it--during the last six years. Table 4.59 reports farmers' adoption rate of summer fallowing. Only a total of 4 percent of the farmers interviewed use the clean summer fallow practice, and the great majority (96 percent) have never used it. This 4 percent is divided among Belts II, III, and IV. In order to understand farmers' current practices in the field of fallowing and the economic considerations it involves, a look at the customary crop sequence they follow on their farms is in order. Table 4.60 summarizes farmers' cropping rotations. In most of the Jordanian drylands, wheat is grown in rotation with other crops. The largest percentage of crop sequence (30 percent) is wheat-lentils-summer crops. Next in importance is the crop sequence of wheat-lentils, which 23.5 percent of surveyed farmers use on their land. 20.5 percent of the interviewed farmers grow wheat and barley annually. This annual grain practice is concentrated mostly in the marginal areas which receive on the average of 250 mm of rain or less annually. Wheat-summer crop sequence is practiced by 16 percent of the Irbid farmers. Summer cropping quickly appeals to wheat farmers as it provides high cash crop returns, as discussed below. Six percent of

Table 4.59. Interviewed farmers' adoption rate of summer fallowing distributed by rain belts

How many times have you fallowed your land in the past six years	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
None	30	100	67	95.71
One time	--	--	--	--
Two times	--	--	3	4.29
Three times	--	--	--	--
Total	30	100	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
66	94.29	29	96.67	192	96.0
--	--	--	--	--	--
1	1.43	1	3.33	5	2.5
3	4.28	--	--	3	1.5
70	100.00	30	100.00	200	100.0

Table 4.60. Interviewed farmers' cropping rotation

What is your crop sequence	All belts frequencies	
	No. of farmers	Percent
Wheat-wheat and wheat-barley	41	20.5
Wheat-lentils	47	23.5
Wheat-lentils-summer crop	60	30.0
Wheat-lentils-summer fallow	5	2.5
Wheat-summer crop	32	16.0
Wheat-summer fallow	3	1.5
Wheat-lentils in part of land and wheat-summer crop in other part	12	6.0
Total	200	100.0

the respondents indicated two patterns of cropping rotation followed on their fragmented land, growing wheat-lentils on one piece and wheat-summer crop on the other piece. The smallest percentage of crop sequence is found among farmers practicing summer fallow, along with wheat and lentils. 2.5 percent of interviewed farmers follow wheat-lentils-clean summer fallow, and 1.5 percent follow wheat-fallow rotation. Thus, we find only 4 percent of Irbid farmers who practice summer fallowing more systematically on their land. This very small percentage should not be misleading in evaluating the fallow practice for there are great areas of land lying idle every year because of weather, topography, and the economic conditions of wheat farmers. Farmers in different rain belts vary greatly with respect to their crop practices. Table 4.61 reports crop sequencies in each belt.

i. Rainfall Belt I: Less than 250 mm of rain All wheat farmers in this marginal land grow wheat and barley annually. Barley is considered an important crop for feeding animals. Animal production, mostly sheep and goats, occupies an important economic position in these marginal areas. In the years of late and low rainfall, farmers may decide not to plant all or part of their land because of the high risk of crop failure. Farmers understand the economics of wheat production under different sets of weather patterns. In the years of drought, farmers leave the land idle, uncared for, and wild grass and broadleaf weeds grow savagely during the traditional fallow year. As indicated above, annual wheat and barley cropping does not mean that all the lands are utilized. A sizeable part of this area (25-30 percent) is not cultivated, except in very good rainfall years because of its topographical characteristics, as hilly and rocky, but in those rare, exceptionally good years, farmers are motivated to plant all these lands.

Table 4.61. Interviewed farmers' cropping rotation distributed by rain belts

What is your crop sequence	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Wheat-wheat and wheat-barley	30	100	11	15.71
Wheat-lentils	--	--	--	50.00
Wheat-lentils-summer crop	--	--	1	1.43
Wheat-lentils-summer fallow	--	--	3	4.29
Wheat-summer crop	--	--	10	14.29
Wheat-summer fallow	--	--	--	--
Wheat-lentils in part of land and wheat-summer crop in other part	--	--	10	14.29
Total	30	100	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
--	--	--	--	41	20.5
12	17.14	--	--	47	23.5
30	42.86	29	96.67	60	30.0
1	1.43	1	3.33	5	2.5
22	31.43	--	--	32	16.0
3	4.29	--	--	3	1.5
2	2.86	--	--	12	6.0
70	100.00	30	100.00	200	100.0

ii. Rainfall Belt II: 250-300 mm There are variations between farmers in this belt with respect to their cropping rotations. This discrepancy is attributed to several factors, such as variation in the amount of rainfall level within the same belt, between farm soil conditions, and between farmers themselves with respect to their knowledge, expectation, and efforts in the cultivation of land. Wheat-lentils is the major crop sequence adopted by over 50 percent of this belt's farmers. Farmers raise wheat on one piece of their fragmented land and lentils on the other; the next year they rotate, as shown in Graph 4.1.

Land / Year	Piece one	Piece two
First year	Wheat	Lentils
Second year	Lentils	Wheat

Graph 4.1. Two-year crop sequence pattern, wheat-lentils

15.71 percent of Belt II farmers grow wheat and barley annually, as in Belt I. This practice is more dominant in areas of 250 mm of rain which is closer to the first belt in their climatic and soil characteristics than to Belt II. 14.29 percent of the farmers follow wheat-summer crop rotation. They grow wheat on one piece of fragmented land and a summer crop such as watermelon, tomatoes, etc. on the other piece. In the second year, they rotate, as illustrated in Graph 4.2. Farmers following this pattern try to maximize the economic return obtained from their land.

Lane Year	Piece one	Piece two
First year	Wheat	Summer crop
Second year	Summer crop	Wheat

Graph 4.2. Two-year crop sequence, wheat-summer crop

Wheat is vital for their diet, while the summer crop provides a high cash crop. A detailed economic analysis of summer fallow vs. summer cropping is forthcoming in the next chapter. 14.29 percent of the farmers in Belt II follow an interesting pattern in utilizing their land resources. They grow wheat-lentils on part of their land and summer crop-wheat on the other part of their land, as shown in Graph 4.3. Only 4.29 percent of Belt II farmers include summer fallow practice in their crop sequence where they

Land Year	Piece one	Piece two
First year	Wheat	Summer crop
Second year	Lentils	Wheat

Graph 4.3. Two-year crop sequence, wheat-lentils, wheat-summer crop

follow wheat-lentils-summer fallow sequence, as illustrated in Graph 4.4, and the remaining 1.43 percent of Belt II farmers follow

Year / Land	Piece one	Piece two	Piece three
First year	Wheat	Lentils	Summer fallow
Second year	Lentils	Summer fallow	Wheat
Third year	Summer fallow	Wheat	Lentils

Graph 4.4. Crop sequence and summer fallow

tri-annual cropping rotation, wheat-lentils-summer crop. Here the farmer has his land fragmented in three or more pieces so that he grows one crop in each part, as illustrated in Graph 4.5. This crop sequence requires more moisture than Belt II receives and is more commonly practiced in Belts III and IV, as discussed below.

Year / Land	Piece one	Piece two	Piece three
First year	Wheat	Lentils	Summer crop
Second year	Lentils	Summer crop	Wheat
Third year	Summer crop	Wheat	Lentils

Graph 4.5. Tri-annual cropping rotation, wheat-lentils-summer crop

iii. <u>Rainfall Belt III: 300-400 mm</u> This belt has environmental conditions for wheat production rotating with another winter crop, mainly lentils, and a summer crop, mostly watermelon. The majority of farmers cultivate their land annually.

94.29 percent of Belt III farmers do not fallow their land, and only 5.71 percent practice summer fallowing. In terms of crop sequence, the largest percentage of Belt III farmers (42.86 percent) follow a three-year cropping rotation, wheat-lentils-summer crop, and 31.43 percent of Belt III farmers follow a two-year crop sequence, wheat-summer crop. 17.14 percent follow a wheat-lentils sequence, and a small percentage, 2.86 percent, of farmers grow wheat-lentils on part of their land and wheat-summer crop on another part of their land. Those farmers (5.71 percent) who practice summer fallowing are represented by 1.43 percent who follow wheat-lentils-summer fallow, and 4.29 percent who use the wheat-summer fallow system.

iv. <u>Rainfall Belt IV: Over 400 mm</u> Farmers in this area enjoy higher level of precipitation than do all the preceding belts. Farmers utilize their land every year by producing wheat, along with another major winter crop, lentils, and a summer crop, watermelon. 96.67 percent of Belt IV farmers follow tri-annual cropping rotation, wheat-lentils-summer crop, and only 3.33 percent practice summer fallowing, along with wheat and lentils rotation (wheat-lentils-summer fallow).

b. Farmers' knowledge of the effect of summer fallowing and yield rise expectation from the adoption of the summer fallowing technique

The clean summer fallow technique which is promoted and recommended with strong emphasis for introduction to Jordan dryland areas of 200-350 mm is not unknown to wheat farmers in principle (24). Although the adoption rate is close to zero (4 percent), the great majority of wheat farmers have quite a clear notion about the practice, its purpose, and advantages. Farmers were asked if they had heard of the clean summer fallow practice. The responses are found in Table 4.62. All the interviewed farmers are aware of the existence of the summer fallow practice for the purpose of conserving moisture during the fallow year. Regarding the positive effect of summer fallowing on wheat yield, farmers know that the ultimate goal of this practice is to increase wheat yield through the process of preserving moisture of the fallow year. As Table 4.63 indicates, 96 percent of the surveyed farmers have positive expectations of the effect of summer fallowing on wheat yield. Only 4 percent of them do not believe in fallowing, again indicating that "all that counts is immediate rainfall." Those few farmers are found in Belt I, as shown in Table 4.63, where they grow wheat annually. Farmers were asked to formulate some yield rise expectation perceived from adopting the summer fallow practice. Table 4.64 summarizes farmers' yield increase estimates. The majority of farmers (84 percent) provide a numerical rate of wheat yield increase

Table 4.62. Interviewed farmers' knowledge about the summer fallow technique

Have you heard of summer fallow technique	All belts frequencies	
	No. of farmers	Percent
Yes	200	100
No	--	--
Total	200	100

over nonsummer fallowed plots. To study variation in different rain belts with respect to farmers' yield rise expectation, a breakdown of Table 4.64 into rain belt groups is reported in Table 4.65. Only 40 percent of Belt I farmers furnish some yield increase estimates, which concentrate in the range of 20-59 percent over nonfallowed plots, while 36.67 percent believe positively in the effect of summer fallow on wheat yield but could not perceive any quantitative rate of increase, and the remaining 23.33 percent of this belt's farmers do not believe this technique could increase the wheat yield.

Farmers in Belt II were more capable of formulating some yield increase estimates. This area is of major focus for recommending summer fallow practice by the wheat project advisors. 87.14 percent

Table 4.63. Interviewed farmers' knowledge about the effect of clean summer fallow on the wheat yield distributed by rain belts

Do you think that summer fallow would increase the wheat yield	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Yes	23	76.67	69	98.57
No	7	23.33	1	1.43
Total	30	100.00	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
70	100	30	100	192	96
--	--	--	--	8	4
70	100	30	100	200	100

Table 4.64. Interviewed farmers' yield rise expectation from the adoption of clean summer fallowing

How much percent yield increase you believe summer fallow can bring	All belts frequencies	
	No. of farmers	Percent
Zero	1	0.5
10-14	1	0.5
15-19	1	0.5
20-24	7	3.5
25-29	46	23.0
30-34	49	24.5
35-39	1	0.5
40-49	1	0.5
50-59	42	21.0
60-69	5	2.5
70-79	4	2.0
80-99	1	0.5
100-199	7	3.5
200-above	2	1.0
Farmers believe summer fallow increase yield but unable to estimate	24	12.0
Farmers do not believe in summer fallow to increase wheat yield	8	4.0
Total	200	100.0

Table 4.65. Interviewed farmers' yield rise expectation from the adoption of clean summer fallowing distributed by rain belts

How much percent yield increase you believe summer fallow can bring	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Zero	--	--	--	--
10-14	--	--	--	--
15-19	--	--	--	--
20-24	2	6.67	--	--
25-29	5	16.67	20	28.57
30-34	2	6.67	23	32.86
35-39	--	--	--	--
40-49	--	--	--	--
50-59	3	10.00	13	18.57
60-69	--	--	1	1.43
70-79	--	--	1	1.43
80-99	--	--	--	--
100-199	--	--	1	1.43
200-above	--	--	2	2.86
Farmers believe summer fallow increase yield but unable to estimate how much	11	36.67	8	11.43
Farmers do not believe in summer fallow to increase wheat yield	7	23.33	1	1.43
Total	30	100.00	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
1	1.43	--	--	1	0.5
1	1.43	--	--	1	0.5
1	1.43	--	--	1	0.5
3	4.28	2	6.67	7	3.5
13	18.57	8	26.67	46	23.0
15	21.43	9	30.00	49	24.5
1	1.43	--	--	1	0.5
1	1.43	--	--	1	0.5
19	27.14	7	23.33	42	21.0
3	4.28	1	3.33	5	2.5
2	2.86	1	3.33	4	2.0
--	--	1	3.33	1	0.5
5	7.14	1	3.33	7	3.5
--	--	--	--	2	1.0
5	7.14	--	--	24	12.0
--	--	--	--	8	4.0
70	100.00	30	100.00	200	100.0

of the farmers provides yield rise expectation concentrated mostly in the range of 25-59 percent; 11.43 percent of Belt II farmers who could not provide a yield rate perceived some increase; and only 1.43 percent of the farmers expressed no belief in the effect of summer fallowing on wheat yield. Those few believe wheat yield depends only on the immediate rains which fall in the winter season of the wheat growing year.

All farmers in Belt III believe that summer fallowing would increase wheat yield, and 92.86 percent give yield increase estimates, mostly concentrated around a range of 20-59 percent. Similarly, all wheat farmers in Belt IV believe positively in the effect of summer fallowing on the wheat yield, and all Belt IV farmers were able to provide some increase rates. Most of these estimates are concentrated in the range of 20-59 percent increase over the yield of nonsummer fallowed plots. In terms of general knowledge about summer fallowing, the variation between belts' farmers is minimum, especially between Belts II, III, and IV. Most of these farmers believe a yield rise in the range of 20-59 percent could be obtained.

In terms of farmers' knowledge of the cost of the summer fallow practice with respect to the tillage operation, the majority of farmers in all the belts do not know since they have no experience in summer fallow (only 4 percent practiced summer fallow), and cost estimates were hard to obtain because cost depends on how many times farmers must till throughout the fallow year. In the government summer fallow demonstrations, the average number of tillages was from five to seven times.

c. <u>Farmers' attitudes, acceptance, and incentives toward the adoption of the summer fallow practice</u>

Perhaps, the most challenging element in this improved input adoption research is in the area of summer fallow practice. As noted above, this practice has been recommended by wheat experts after a reasonable period of study of Jordanian rainfed wheat farming and after finding similarities of growing conditions between the Pacific Northwest of the United States where summer fallow practice is very common and Jordan where similar progress in wheat improvement is hoped for. This technique is recommended in areas which receive an average annual precipitation of between 200-350 mm. In this study, these areas are Belt I, less than 250 mm; Belt II, 250-300 mm; and Belt III, 300-400 mm.

If we want to judge the degree of knowledge wheat farmers have of an improved practice by the adoption rate of this improved practice, we may say Jordanian farmers have minimum technical and economic knowledge about the effect of summer fallowing on the wheat yield since only 4 percent of the farmers interviewed practice summer fallowing. But the fact is that wheat farmers know a great deal about the technical and economic effect of the clean summer practice on wheat yield. Ninety-six percent of the interviewed farmers think that summer fallow would increase wheat yield, and a great majority of these farmers were able to perceive a wheat yield increase using clean fallowing. Eighty-four percent provide yield rise estimates ranging from 20-59 percent. Thus, farmers are substantially knowledgeable about the summer fallow technique. Predicting the adoption rate of an improved input by the extent to which farmers believe in its positive effect, it is possible to say that the majority of wheat farmers adopt summer fallow since 96 percent believe positively in its effect on wheat yield. However, in actuality, only 4 percent of the Irbid farmers use summer fallow practice. If farmers perceive that a sizeable yield increase can be achieved as the wheat specialists do, an interesting inquiry would be to study why farmers then do not follow summer fallowing along with their wheat production practice, as has been suggested and recommended with much enthusiasm by the wheat project advisors. Farmers were asked to mention under what conditions they would be willing to practice summer fallowing. Table 4.66 summarizes farmers' responses. 71.5 percent of surveyed farmers expressed no intention of practicing summer fallowing under any condition. 18.5 percent of the interviewed farmers stated they would practice fallowing only if the rainfall season was very poor and late. Two percent of the Irbid farmers expressed willingness to practice summer fallowing only if the neighbors in the same area did so. Here some negative externalities appear when farmers in the same area raise different crops for different seasons. For example, if one farmer grows wheat and the rest of the farmers grow summer crops, at the time wheat plants

Table 4.66. Interviewed farmers' attitudes and acceptance toward adopting summer fallow practice

Under what conditions would you use clean summer fallowing	All belts frequencies	
	No. of farmers	Percent
Under no conditions, farmers prefer to plant lentils and summer crops over summer fallow practice	88	44.0
Under no conditions, farmers need wheat and straw every year, whatever little the crop	45	22.5
Under no conditions, farmers do not believe in summer fallowing	3	1.5
Under no condition, it may rain very good	7	3.5
Farmers would practice summer fallowing only if rainfall season was late and low	37	18.5
Farmers would practice summer fallowing if all the neighbors in the area follow same practice	4	2.0
Farmers would fallow if they are financially able to support themselves in the fallow year	8	4.0
Farmers practice fallowing	8	4.0
Total	200	100.0

emerge in the fields, the rest of the area's farms are not growing anything because summer crops are grown later in the year. This situation would encourage shepherds to allow their animals to graze on the wheat, while if the whole area was grown in wheat, they would not dare allow their animals to eat this crop. This is a case in which the wheat area can be protected by collective growing. Farmers indicate willingness to fallow under the condition that neighbors in the same area fallow during the same year. If one farmer decides to fallow this year while the rest of the wheat farmers cultivate their farms with wheat, the next year when the first farmer cultivates his fallowed land with wheat and the rest of the area grows another crop which rotates with wheat, his farm will be threatened by grazing animals since his wheat would be the only plants in the whole area. The remaining 2 percent said they would fallow if they were financially able to leave their land or part of it without utilization. The majority of farmers (44 percent) who would not practice fallowing under any conditions indicate that the economic return from summer crop or another winter crop far surpasses the increase in wheat yield obtained from the fallow practice the preceding year. 22.5 percent of the farmers indicate they would practice fallowing under no condition because they need the annual crop of wheat and tibin (straw) however small the yield. 3.5 percent of the interviewed farmers state that under no condition would they fallow because of the probability of a good rainfall season in that fallow year, which would cause a real loss to farmers since there is good rain only once in every three to five years. A cross-sectional analysis of farmers' conditions for practicing fallowing in different rainfall areas will reveal farmers' evaluation of summer fallow practice with other economic variables that may interact, leading him to accept or reject the practice. Table 4.67 represents farmers' conditions in each belt. A general observation of all belts indicates that over 50 percent of the farmers in each belt refuse to fallow under any condition.

i. Belt I 50 percent of the farmers expressed no willingness to adopt fallowing because they annually need wheat and straw for animal production, a major economic activity shared with wheat in this lower rainfall area. The value of wheat is twofold, as the food diet for farmers and the straw (tibin) for animals; thus, however low the yield is, it produces two components of food for farmers and their animals. Their small concern for the poor wheat yield, on the average of 40 kg, stems from the fact that wheat farmers apply only the minimum inputs required for wheat production, namely seed. It seems farmers are satisfied with an average yield. Even with a crop failure, their animals will still graze on the wheat plants. 6.67 percent of the farmers indicate unwillingness to fallow simply because they feel very good rain may fall in the year they decide to fallow, causing greater loss of one good year's season which comes only once in every five years or more. 36.67 percent of the farmers replied they would fallow if the rainfall season was

Table 4.67. Interviewed farmers' attitudes and acceptance toward adopting summer fallow practice distributed by rain belts

Under what conditions would you use clean summer fallowing	Belt I frequencies	
	No. of farmers	Percent
Under no conditions, farmers prefer to plant lentils and summer crops over summer fallow	--	--
Under no conditions, farmers need wheat and straw every year, whatever little the crop	15	50.00
Under no conditions, farmers do not believe in summer fallowing	2	6.67
Under no conditions, it may rain very good	2	6.67
Farmers would practice summer fallow only if rainfall season was low and late	11	36.67
Farmers would practice summer fallow if all neighbors in the area follow the same practice	--	--
Farmers would fallow if they are financially able to support themselves in the fallow year	--	--
Farmers practice fallowing	--	--
Total	30	100.00

Belt II frequencies		Belt III frequencies		Belt IV frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
10	14.28	49	70.00	29	96.71
21	30.00	9	12.86	--	--
1	1.42	--	--	--	--
5	7.14	--	--	--	--
22	31.43	4	5.71	--	--
4	5.71	--	--	--	--
4	5.71	4	5.71	--	--
3	4.28	4	5.71	1	3.33
70	100.00	70	100.00	30	100.00

late and poor. In this case, the probability of crop failure is already high enough so the farmer has decided not to plant. The remaining 6.67 percent of the wheat farmers in Belt I indicated disbelief in the clean fallowing system for conserving moisture, believing that only the immediate rainfall at the wheat planting season is what accounts for a successful wheat season.

ii. Belt II 30 percent of the farmers indicated no economic means to practice fallowing. Immediate and continuous need for a crop would make farmers cultivate their land annually. 7.14 percent express no intention to fallow for fear it might rain well during the year they decided to fallow. 5.72 percent of the farmers indicate willingness to adopt fallowing if they are financially able to support themselves during the fallow year. 14.28 percent of the farmers believe that the economic return from lentils is higher than that the ultimate effect of summer fallow on wheat yield would bring. 31.43 percent of the farmers indicate willingness to fallow only in the case of a poor rainfall season which might bring crop failure. In this year, they might decide to till the land and leave it idle until the next wheat season. Finally, 5.71 percent of the wheat farmers indicate willingness to fallow if all farmers in his area agree to fallow. As explained above, the problem of externalities appears. If a farmer decides to fallow one year and grow wheat the next year, while his neighbors grow wheat and a summer crop or lentils the next year, his farm would be the only field grown in wheat while other areas may not have anything growing since time of planting crops differs. This means his land would be unprotected by his neighbors' fields so that sole green field would attract animals to come and eat the wheat plants. On the other hand, if all the area was planted with wheat, the shepherd would not allow his animals to eat the plants.

iii. <u>Belt III</u> 70 percent of the farmers are unwilling to fallow because they believe the economic return maximization would encourage farmers to follow a crop sequence of wheat-lentils-summer crop which by experience has brought the optimum return. Farmers are aware that fallowing would bring on the average of a 20-50 percent wheat yield increase over nonfallowed land. However, the economic return from summer cropping is worth much more than this yield increase. For example, if farmers perceive an average 40 percent wheat yield increase by fallowing (the wheat project specialist estimates a 30-50 percent wheat yield increase) and assuming the average nonfallow land wheat yield is 80 kg/dunum

$$\frac{40}{100} \times 80 = 32 \text{ kg/dunum increase from fallow}$$

$$32 \times 50 = 1.600 \text{ J.D./dunum}$$

is the total value obtained from fallowing, while a dunum of land planted in a summer crop brings a net cash return averaging between 7-10 J.D. Thus, as the rational producer seeks to maximize his economic return, he would refuse the summer fallow practice. The same conclusion is drawn by wheat farmers in Belt IV, with 96.67 percent of the farmers in this belt indicating unwillingness to practice summer fallowing since a higher cash return is obtainable from the land than from the increase in wheat yield from fallowing.

V. FINDINGS OF THE STUDY BY MAJOR RAIN BELTS AREA

1. Rainfall Belt I: Less Than 250 mm

a. General description of Belt I

Belt I land area occupies a narrow line on the west fringe of the Jordanian desert, receiving a maximum average of 250 mm of rainfall annually. This marginal land witnesses more sharp year-to-year fluctuation in the level of rainfall than any other area in Jordan. Farmers call this area land "tenthly" land--Ashria--which symbolizes the farmers' expectations of getting one exceptionally good rainfall season in every ten-year period.

The total grain producing area is estimated to be between 400,000 and 600,000 dunums. This wide range in acreage estimate is due mostly to the fact that, as rainfall is highly variable from one year to the next, the grain acreage expands and contracts with the amount of rain this area receives.[1] Table 5.1 reports the total cultivated area of wheat distributed by districts under three rainfall conditions--good, average, and poor. On the average, Belt I occupies one-fifth of the total dryland wheat growing area but

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[1] In addition to weather variability effect on the cultivated area, we find the agricultural statistics differ between government sources. For example, the Working Paper (March 1974) estimated the area to be around 416,000, while Agricultural Zoning (March 1974) determines that the total area is about 608,000 dunum.

Table 5.1. Estimated wheat acreage and production in Belt I under three weather conditions and distributed by government districts[a]

Districts	Good year	
	Total wheat cultivated area in dunums	Total production of wheat in tons
Irbid	100,000	7,000
Amman	150,000	10,500
Balqa	--	--
Karak	170,000	12,000
Maan	80,000	5,600
Total	500,000	35,100
Average wheat yield in kg/du	70	

[a]Source: (26).

Average year		Poor year	
Total wheat cultivated area in dunums	Total production of wheat in tons	Total wheat cultivated area in dunums	Total p production of wheat in tons
80,000	2,400	70,000	700
120,000	3,600	100,000	1,000
--	--	--	--
140,000	4,200	110,000	1,000
70,000	3,100	60,000	600
410,000	12,300	340,000	3,300
30		10	

only produces 16,900 tons or 8 percent of the total wheat production. Thus, the wheat lands with less then 250 mm produce a smaller proportion of total wheat than its proportionate share of total area. In other words the average yields in this marginal rainfall area are low.

Belt I	National
Wheat area	20%
Wheat production	8%

According to Jordanian government estimates, wheat yield in Belt I even in an average rainfall year is only 40 kg per dunum, as contrasted with the national average of 70 kg (26). In a good rainfall year, the yield rises to 70 kg; whereas in a poor year, it falls to near zero, 10 kg, which is a crop failure. Data collected from this belt's farmers indicate some discrepancies between farmers' estimates of their wheat yield and government estimates. Table 5.2 reports the responses of interviewed farmers about their wheat yields. The majority of farmers, 87 percent, estimate their wheat yield in a good year to be between 80-125 kg per dunum, while government statistics, as shown in Table 5.1, estimate yield at around 70 kg. In an average rainfall year, the majority of farmers, 97 percent, estimate the yield in the range of 30-60 kg; whereas the government estimate is around 30 kg. The government's method

Table 5.2. Farmers' wheat yield estimates under different rainfall conditions

Wheat yield in kg/dunum	Belt I Farmers' Yield Estimates					
	Good year		Average year		Poor year	
	No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
Zero	--	--	--	--	30	100.
20-29	--	--	1	3.33	--	--
30-39	--	--	4	13.33	--	--
40-49	--	--	22	73.33	--	--
50-59	--	--	3	10.00	--	--
60-79	3	10.00	--	--	--	--
80-99	13	43.33	--	--	--	--
100-124	13	43.33	--	--	--	--
159-149	1	3.33	--	--	--	--
Total	30	100.00	30	100.00	30	100

of estimate is still very imprecise, as it divides the total estimated wheat production over total estimated wheat acreage.

Most of the people who live in this area on the fringe of the desert are settled tribes, Bedouins. For many generations they lived only in tents. Early in the formation of the state of Jordan (1920s) the government encouraged these tribes to settle in certain areas and build permanent houses. By granting free land to individual families they were encouraged to engage in farming in addition to livestock raising. Livestock was the major economic activity of the Bedouins before the 1920s and is still important economically and culturally. Despite the fact that some of the villagers own large holdings of land, they are not wealthy. This marginal land has neither high productivity nor high market value. Most of the wheat grown in this belt is utilized for family consumption by farmers in this area. In fact, most of the wheat produced in Belt I does not enter the wheat market. Wheat farmers' decisions to produce are probably not much affected by wheat market conditions. The main purpose for producing grain (wheat and barley) is to live to satisfy the farmer's family. Wheat is a major diet component and in that area there are no substitutes. If grain cannot be obtained the wheat grown will be used to sustain their animals. But this is a lower value use than for grain and hence bread.

b. <u>Wheat production and improved inputs adoption</u>

The farmers know the environmental conditions of their area are harsh and uncertain. They are aware that the weather brings a good rainfall season once every five to seven years, still they grow wheat and barley every year, in hope because they cannot predict which year will be good. Only in extremely dry seasons when rains do not come until after planting season do most foresee crop failure and decide not to cultivate. The reason they plant wheat annually even at great risks, effort and cost is because it is necessary for survival. From their experience, farmers have found that on average, they get 40 kg per dunum, and with this very low yield (4.2 bu/acre), farmers are still living on and cultivating these lands. They seem to be content and satisfied. The most distinguishing feature of this belt is that the very extensively cultivated wheat, farmers use the most minimum input possible to obtain wheat, only seed and shallow tillage to cover. Thus, it appears that farmers are minimizing risk of losses. The farmer is well aware that there is a good chance, perhaps over 50%, that he will have an unfortunate wheat growing situation, that is, he may be faced with crop failure, zero yield, or 10 kg of wheat per dunum, which is only his seed. This amount does not by any means allow him to harvest, so he turns his animals loose to eat the wheat plants. Thus, he salvages something in animal products from wheat but the value may be below the break-even point that is equal to his variable cost represented in seeds and tillage.

In the preceding chapter, the overall adoption rate of six improved inputs for each of the four rainfall belts was studied. Table 5.3 summarizes the adoption rate of all inputs in Belt I area. A zero adoption rate for each practice prevails in the area, reflecting an important finding: that very traditional wheat cultivation practices are prominent in this dry area.

i. Tillage operation In this belt was found the highest percentage of wheat farmers who own and operate their own tractors among all the four belts. Still only 20 percent of the farmers owned tractors, and all of them, 100 percent, indicated they did not till their land prior to seeding time. This simply means that even those farmers who have the lowest operating costs because they own and operate their tractors themselves do not conduct more tillage practice and do not prepare seedbeds. Of course, those farmers who must hire tractors are even less interested in seedbed tillage practices because they have more costs of hiring a custom-tractor operator. Either farmers do not want to risk higher operating costs than absolutely necessary or they are ignorant of the importance of having better seedbed preparation for wheat yield. The writer believes that risk, cost and ignorance are responsible for poor tillage practice. However, in general farmers are aware that more tillage would improve their land productivity. Ninety percent of the farmers were able to suggest specific different tillage operations which they thought would improve wheat yield. Heading these

Table 5.3. Summary of Belt I adoption rate of improved inputs

No. of practice	Improved inputs	Adoption rate
1	Proper tillage practices	0
2	Improved seeds--cleaned and treated known domestic variety	0
3	Use of graindrills	0
4	Chemical fertilization	0
5	Chemical spraying	0
6	Clean summer tillage	0

recommendations are increasing the number of tillages during the year, tilling the land from both directions--crossed tillage, deeper tilling than the current tillage system does, removing stones from the field, and levelling off the ground. Some suggested tillage practices are thought to be fundamental and recommended by wheat specialists. The logical conclusion is that for most farmers, the meager tillage practices can by no means be attributed solely to the farmers' lack of knowledge. They would like to till better and believe it is best for their land, but due to their poverty conditions and the low return in additional wheat yield, relative to the cost, they abstain from implementing these tillage changes. In other words, although farmers recognize the fact that they employ very poor tillage operations and can suggest better tillage changes, they still perceive the economic returns from wheat yields to be insufficient to merit better action. One-third of the farmers were able to perceive some yield increase rate in the range of 25-35 percent over that of traditionally farmed plots. It is possible to calculate roughly the marginal cost and marginal return if we assume 30 percent is the wheat yield increase over that of an average field. This means a 12 kg per dunum increase ($\frac{30}{100}$ x 40), which means a reduction in purchased wheat of 0.600 J.D. marginal return per dunum (12 x 50 fils/kg). To obtain this increase through proper tillage practices however would mean conducting additional tillage practices at an average cost per tillage of about 0.300 fils per dunum. If the probability of crop failure is 50% one tillage is equal in cost to the expected return. If two additional tillages are needed the marginal cost is much higher than the marginal return (0.900 - 1.200 mc vs. 0.600 mr). Given the poor subsistence conditions of these marginal land farmers, it is predictable that under no conditions will farmers improve their minimized tillage operation.

ii. Improved seeds All farmers use seeds from their own stored wheat stock. The wheat seeds planted are neither cleaned of dirt, weed seeds, or other impurities nor treated with fungicides to protect the crop from smut disease, which many farmers indicated their wheat suffers from. The great majority of farmers, 87 percent, do not know the varieties of wheat they use, other than that it is "domestic." It is realized that the wheat they plant is a mixture of different kinds and cannot be traced to one single variety. Farmers of this area lack the knowledge to evaluate and understand the importance of planting cleaned and treated seeds of known varieties. Eighty percent of the farmers were unable to perceive a yield rise estimate obtainable from using cleaned and treated seeds. However, all farmers expressed willingness to buy and pay higher prices for higher yielding varieties. Introduction of semidwarf varieties in this rain belt area is doubtful since they require more moisture than this belt receives.

iii. Graindrill All the farmers use the traditional hand broadcasting method of seeding. At the seeding season, farmers in the neighborhood get together to help each other in broadcasting the seeds. A majority of farmers have heard of the graindrill but do not know about its advantages or why it is recommended over the traditional seeding method. However, it is believed that the use of the graindrill can be adopted in the plains area of this belt faster than in any other belt since farmers have no reservations against its organized row pattern of seeding, as is the case in higher rainfall belts. In addition, all farmers use a mechanized tillage system and combines in the good harvest season. Farmers expressed willingness to use a graindrill if neighbors started using it, and some agribusiness seed drilling services were made available in the village at reasonably low fees since most of the farmers do the seeding by themselves at no cost.

iv. Chemical fertilization Belt I farmers use neither chemical fertilizer nor organic type for their wheat production. The adoption rate for chemical fertilizer is zero and for manure only 3 percent. Farmers believe that their dry land cannot dissolve the fertilizer and that it may have a negative effect on wheat yield because of insufficient moisture. It does not seem technically and economically, that this belt area should be recommended for introduction of chemical fertilizer.

v. Chemical spraying to control weeds No chemical spraying is used by farmers to control weeds grown in standing wheat. The adoption rate of spraying is zero. The majority of farmers, 80 percent, is aware of the existence of the chemical spraying technique to control weeds and of its ultimate effect in increasing yields, but none of the interviewed farmers was able to estimate any yield increase nor had any idea of its cost. Farmers expressed willingness to spray if there were some agribusiness custom services available in the village. This stipulation reflects farmers' concerns about their weed problems, although they still feel unable to conduct the spraying by themselves, as the process of mixing the chemicals and exact application time appears somewhat complicated for them. As the problem of moisture sufficiency is more severe to wheat production in this belt than in all other belts, encouraging farmers to use a spraying technique only in those years of good early rains may be a major improvement in wheat production practices.

vi. Summer fallowing   Wheat and barley are grown annually on part of the available farmland. The proportion of all land cultivated in wheat by the farmer is determined by weather, topography, and the financial capacity of the farmer. The better the weather, the larger the proportion of his land the farmer is willing to cultivate. In a relatively wet season, the farmer tries to plant even the hilly and rocky part of his land. However, in an average rainfall year, the farmer usually abandons the part of his land which is more mountainous, full of stones, shallow and hard to cultivate. In a poor year he may not plant at all or only in some selected spots where moisture runoff collects from other fields. Farmers may also be hindered in cultivation of all their land by financial restraints. Although the most extensive pattern of farming that is the lowest cost per dunum prevails in this belt, the only inputs applied are seeds and covering the seed with shallow tillage. Some farmers are still constrained from sowing more land because they are financially unable to pay even the tillage service fees for all their land. Hence, many farmers leave part of their land idle for the year and if it rains with no tillage operation, weeds and wild grasses grow rampant in the fields. No systematic fallowing tillage to control weeds is adopted to any measureable extent. However, the majority of wheat farmers, 77 percent, believes a summer fallow practice to control weeds and save moisture would have positive effect on the wheat yield. Forty percent of the Belt I farmers estimated a yield rise to range from 20-35 percent. Despite the general positive attitudes toward summer fallow techniques, most farmers steadfastly refuse to practice summer fallowing. If it rains they need all their land in wheat, no matter how small the yield is. The wheat straw is essential for feeding animals. Perhaps because of their poverty, they cultivate annual crops but more likely summer fallow does not pay. No experience or experiments are available to accurately judge.

c. Economic evaluation of possible improvement of wheat production in Belt I

Wheat is grown by very extensive methods in this area, that is, by cultivating large areas, applying only a few seeds and minimun tillage to cover the seed.

It is believed that most of the wheat grown in this belt is consumed in the village by the farmers' households without entering the market. This land area, which receives less than 250 mm of precipitation annually, is considered by agronomists[1] and Jordanian government officials as an uneconomic region for wheat production. The level of moisture is not enough to sustain efficient

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[1]Jordanian and American agronomists on wheat project.

wheat yield. From government statistics, we find that only 8 percent of Jordan's wheat production comes from this area, which represents 20 percent of the total cultivated area of wheat, estimating wheat yield at 30 kg/dunum (26). In addition to this extremely low yield, severe year-to-year fluctuation in wheat production exists in this belt because of sharp variations in the annual amount of precipitation. In reviewing the generally low national average of wheat yield, the Jordanian government has found one of the major contributing factors to be the planting of wheat in this marginal land. Government officials suggest reducing wheat production in this area and recommend utilizing this dryland in the following pattern.

(i) The area receiving average annual precipitation in the range of 150-200 mm--approximately 200,000 dunum--is to stop producing wheat and should convert the area into natural grazing land for livestock production. The government put this plan into law by enacting Agricultural Law Number 20, 1973. To better enforce the law, officials suggest not giving agricultural loans to farmers planting wheat because of the high risk of crop failure in this area (26).

(ii) The area which receives 200-250 mm, about 216,000, is to stop producing wheat and to plant it only in barley, encouraging farmers to grow barley by giving them short-term loans only for production.

Farmers in these villages are resisting such law and place much higher value on wheat production, in spite of all the fluctuation in production and the uncertainty they face each year. The farmers depend on production of wheat for their survival. It is very probable that farmers will not accept the government program voluntarily and will not stop producing wheat. To produce grass and barley seems likely to reduce farmers level of living already at a very low level. Some people in this area would probably have to migrate if they could not grow wheat.

All farmers interviewed said they would continue producing wheat. They emphasized the fact that they need wheat for their own food and that their land is the basic source for this food. Preventing farmers from producing wheat would mean families in the area would have to buy wheat from the market. They say they will refuse to do this under any condition.

Government officials and wheat agronomists view the Belt I wheat yield's 30-40 kg per dunum in an average year as a crop failure. It seems to the planners that resources are wasted in Belt I but farmers insist on growing wheat. They seem more satisfied with continuing their yielding wheat than changing to other crops and occupations.

This leads to an analysis of what is meant by "crop failure" and how it is measured.

For Belt I farmers, 40 kg/du is not crop failure for wheat grown extensively with only the seeds and with shallow tillage which just places the seeds under the soil surface.

Farmers appear to be maximizing their returns from their land under the given set of conditions or assumptions,

(1) given technology of wheat dryland production

(2) given weather environment

(3) given economic condition of

   (a) wheat farmers

   (b) wheat production inputs

Farmers optimize the return from their land through the minimization of their wheat production costs. To get on the average 40 kg of wheat per dunum, farmers put 6 kg of seeds. and covered it with shallow tractor tillage and the rest of farming practices are done by the farmers themselves such as hand broadcasting the seeds and harvesting by hand sickle. The land rent and the labor wage are minimal because of the marginal nature of the land and the unemployed labor in these very villages.

If wheat production activities are expected to continue, possible selective practices can be improved to increase wheat yield.

Wheat farmers of Belt I were asked to evaluate six inputs

Better tillage

Improved seeds

Graindrills

Chemical fertilization

Chemical spraying

Summer fallowing

All farmers in Belt I considered the most important practice to be better tillage, improved seeds, and fallowing but none of the farmers mentioned graindrills, chemical fertilizer, or chemical spraying.

From Section 2, farmer knowledge and yield expectation can be summarized, as Table 5.4 reports.

Based on the above analysis of this belt area, the following practices are recommended:

I. Proper and more tillage practices to level off the ground and to keep it clean from weeds.

II. Improved seeds using

1. Cleaned and treated seed. Farmers' poor varieties of seed can be improved since cost of cleaning and treating seeds is very minimal. Farmers should be taught, through the Extension Service, the value of cleaned and treated seed.
2. Higher yielding varieties are not recommended for this rainfall area.

III. The graindrill can be recommended and adopted successfully since farmers have no reservations about its use expect the government to make it available in the plains area and to show farmers how to use it.

IV. Chemical fertilizer is not recommended because of insufficient moisture.

V. Chemical spraying technique can be of potentially significant value in controlling weeds and preserving

Table 5.4. Belt I interviewed farmers' yield rise expectation from the application of improved inputs

Improved inputs	Percentage of farmers who gave quantitative yield increase rate	Percentage range of yield increase rate
Proper tillage practice	33	25-35
Improved seeds--cleaned and treated domestic varieties	20	20-40
Graindrills	0[a]	--
Chemical fertilizers	0	--
Chemical spray	0	--
Summer fallow	40	20-35

[a]None of Belt I farmers were able to provide quantitative yield rise expectation from graindrill, chemical fertilizer and spraying.

some scarce moisture. This requires

1. Extension services

2. Government-supported agribusiness

VI. Clean summer fallowing may not be economically adoptable, as it requires several (5-7) tillage operations in the fallow years, and may not increase yield by high proportion.

However, to assess the late government proposal of converting this area into natural grazing land for the production of livestock. The assumption is that farmers behave rationally in their economic decision making as they try to optimize their economic returns from the limited land resources they own. It is believed that farmers respond quickly to a change if they witness a tangible evidence in readily comparable circumstances of a higher and new economic opportunity to employ their land resources. For the government to enact a law prohibiting wheat growing and convert the farmers' land into grazing area for livestock production will seem not appealing to wheat farmers. Farmers already raising animals along with their wheat production. However, in order to introduce animal production on a large scale to this area, the government must initiate natural grazing projects in several selected areas. Once these projects show success for livestock production and demonstrate high cash returns, it is expected that farmers will be encouraged and respond to shift their land resources from wheat production to animal production. Evidence in other dryland areas in Jordan, namely, the steep and higher rainfall area, shows that farmers are shifting their land utilization from wheat production into olive trees planting and vegetable growing because of the higher returns from these crops.

As farmers in dry areas produce more meat and less wheat, they should be able to buy the desired wheat from the market as cash income becomes more available.

In addition, a large proportion of families in this area have one or more of their sons in the army and they get wheat and other foods at a low price. All this will encourage farmers to accept new utilization of their land resources as proved to them more profitable and feasible.

2. Rainfall Belt II: 250-300 mm

a. General description of Belt II

This belt is the major wheat producing area in Jordan. Besides favorable rainfall level, 95% of the land, is plains. The area is very suitable for wheat cultivation, with modern farm machinery. Only 5 percent is mountainous and rocky, and more recommended for the planting of fruit trees and forests (26). The total cultivated area in the belt is estimated at 1,568,610 dunums of which 674,500 dunums of 43 percent is left idle (25). The majority of the remaining area of 894,110 dunums is planted to wheat and barley. Wheat is more important than barley and occupies about 80% of the grain land. Average wheat acreage in Belt II amounts to 700,000 dunums per year or about 33 percent of Jordan's wheat producing area. Table 5.5 reports the rather significant difference in total wheat area cultivated under three rainfall conditions--good, average, and poor. On the average, this belt produces approximately 45,000 tons of wheat annually or about 33 percent of the national wheat crop. It is estimated by government officials that the wheat yield is about 117, 70, and 50 kgs for good, average, and poor rainfall years, respectively. However, in a 1974-75 survey by the author, farmers' own estimates of wheat yields are higher than these government estimates. As Table 5.6 shows, different farmers' estimate different yield in both good and average years. But as a whole the survey estimates higher than the government estimate. For the poor year, farmers estimates tend to be lower than government statistics indicate. Such discrepancies are logical. A farmer estimates his land's wheat yield from how many bags of wheat he gets at harvest. The government estimates are derived by dividing the total production of the area by the total estimated acreage. The variation of individual farmers' estimates would be greater than that of an area to variation among farmers.

In general, Belt II's wheat yield resembles the national average of Jordan, which is estimated at 70 kg/dunum. 33 percent of the total area of wheat produces 33 percent of the national wheat crop, as shown below.

Table 5.5. Estimated wheat acreage and production in Belt II under three weather conditions distributed by government districts[a]

Districts	Good year		Average year		Poor year	
	Total wheat cultivated area in dunums	Total production of wheat in tons	Total wheat cultivated area in dunums	Total production wheat in tons	Total wheat cultivated area in dunums	Total production wheat in tons
Irbid	250,000	25,000	240,000	17,000	230,000	9,200
Amman	200,000	18,000	180,000	13,000	170,000	6,000
Balqa	50,000	5,000	45,000	4,000	40,000	2,000
Kanak	200,000	18,000	180,000	9,000	160,000	4,800
Maan	50,000	2,000	45,000	1,300	40,000	800
Total	750,000	68,000	690,000	44,300	640,000	22,800
Average wheat yield in kg/du	90		64		35	

[a]Source: (26).

Table 5.6. Farmers' wheat yield estimates under different rainfall conditions

Wheat yield in kg/dunum	Belt II farmers' yield estimates					
	Good year		Average year		Poor year	
	No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
Zero	--	--	--	--	55	78.57
20-29	--	--	--	--	11	15.71
30-39	--	--	--	--	1	1.43
40-49	--	--	8	11.43	3	4.29
50-59	--	--	6	8.57	--	--
60-79	--	--	9	12.86	--	--
80-99	--	--	18	25.71	--	--
100-124	22	31.43	4	5.72	--	--
125-149	6	8.57	24	34.29	--	--
150-174	16	22.86	1	1.43	--	--
175-199	4	5.71	--	--	--	--
200-249	21	30.00	--	--	--	--
250-299	1	1.43	--	--	--	--
Total	70	100.00	70	100.00	70	100.00

Belt II	National
Wheat area	33%
Wheat production	33%

Most farmers of this area own fragmented pieces of land, that is, their total holding is in three noncontiguous parcels. Some farmers have land in the eastern edge where land is marginal as well as in Belt II. Others have some land also in the western area where better rainfall and better soil characteristics prevail. In Belt II the typical farmers' economic conditions are not much better than in Belt I. The majority of farmers are very poor and they have high expectations of how much the government should help them in providing agricultural materials and services. Land is somewhat more valuable and production higher than in Belt I but the holdings are not large enough in most cases to produce beyond subsistence except in good years.

b. Wheat production and improved input adoption

Belt II is fortunate to have better precipitation and more easily farmed topography than Belt I. The average annual rainfall of 250-300 mm allows wheat to be produced in over five years out of 10 and more efficiently and in rotation with another winter crop, usually lentils. This crop sequence, wheat-lentils, is more able to properly nourish the family and better sustain the farmer's economic life. Both crops can bring cash returns for production above family need. Many farmers raise livestock in addition to wheat and lentils, but livestock is relatively less important than in Belt I. Farmers' wheat cultivation practices are also very traditional and differ little from those of Belt I farmers. Table 5.7 reports farmers' adoption rates of the six improved inputs.

Apparently, Belt II farmers' practices are very similar to practices in Belt I, except cleaned and treated seeds are widely used. Farmers showed much concern and conviction in using cleaned and treated seeds. Even those not using cleaned and treated seeds were aware of the practice and thought it valuable.

Table 5.7. Summary of Belt II adoption rate of improved inputs

No. of practice	Improved inputs	Adoption rate in percent
1	Proper tillage practices	0.00
2	Improved seeds--cleaned and treated known variety	67.14
3	Use of graindrills	0.00
4	Chemical fertilization	0.00
5	Chemical spraying	0.00
6	Clean summer fallowing	0.00

i. Tillage operation The adoption of seedbed preparation is zero. The majority of farmers used mechanical tillage through either their own tractor or custom operators. None of the farmers had heard of or accepted the use of a shallow rapid tillage system. The preference for deep summer tillage is dominant among Belt II farmers. Surprisingly, the majority of farmers, 85 percent, would accept a collective tillage system in which all lands would be tilled and planted as one if it could improve their tillage operation with no extra cost. Almost all farmers, 99 percent, believe a change in tillage practice would have salient effect on the productivity of their land. Seventy percent of farmers think wheat yield can be increased in the range of 15-35 percent by proper tillage practices. Ranking at the top of the farmers' suggestions is increasing the number of tillages, conducting crossed tillage, removing the stones from the ground, and tilling deeper in summer.

ii. Improved seeds About half of the farmers used a known domestic wheat variety, either Horani Nawawi, or F8. Furthermore, 67 percent of the farmers used cleaned and treated seeds. The majority of farmers believe that through the use of cleaned and treated seeds of a known variety, a yield increase in the range of 10-40 percent can be realized. However no farmers in the sample had heard of higher yielding semidwarf varieties. It is true that under Belt II weather conditions, it is unlikely that any current Mexipak type of variety would be recommended. All seem to require more moisture than this area receives or else irrigation. The majority of farmers, 86 percent, expressed willingness to purchase at "whatever the price" an improved variety which could increase their land productivity by 20 percent.

iii. Graindrill With the large plains areas this belt has, there is a good potential for the adoption and spread of the seed drill technique. The farmers of this belt seem to have no reservations or prejudice against the use of graindrill, as do farmers in higher rainfall areas. Currently, all farmers use the traditional hand broadcasting method of seeding. However, the majority of farmers seem to be aware of the existence of the graindrill and have some notion of its advantages in producing wheat in organized rows, increasing yield, and saving seeds and labor. However, none of the farmers was able to formulate quantitative yield rise estimates, or the rate of seed saving, or the cost of using the drill. They have no experience. Grain drills have not been seen nor have the results of use been visually compared with hand broadcasting by the farmers of Belt II. Farmers expressed willingness to use the graindrill if they knew more about it and its basic function, and if it is proved suitable for their land, if the graindrills are available for use in the village, if the cost of seed drilling is competitive with hand broadcasting. There are many ifs but all seem natural and logical steps in adoption.

iv. Chemical fertilization Neither chemical nor organic fertilizers are applied in this area. Perhaps, the low moisture level and other factors discourage farmers to apply fertilizer. Ninety-four percent of the farmers had no knowledge of how much chemical fertilizer can increase their yield, nor how much it costs to apply it. Nevertheless, farmers expressed willingness to use chemical fertilizer if it proved effective and would be priced low enough so they could afford to purchase it.

v. Chemical spraying Farmers of this belt indicated they had a serious problem with weeds. In years of early rainfall the weeds started before the wheat. Farmers knew that mixing of weed seeds and wheat reduces both yield and the crop sale price. No chemical spraying was reported. The estimated adoption rate for chemical spraying in Belt II is zero. However, 99 percent of the farmers are aware of the existence of chemical spraying technique to control weeds and believe that with spraying weeds can be controlled successfully, thereby increasing the wheat yield. However, none of the farmers were able to formulate a quantitative yield increase estimate associated with spraying. Farmers expressed willingness to use chemical spraying if some agribusinesses were available in town to provide spraying services on a custom basis and if the government would support them financially to facilitate the hiring of agribusiness sprayers.

vi. Summer fallowing The majority of wheat farmers, 66 percent, follow the wheat-lentils crop sequence in their dryland farming; 15 percent, who apparently live on the lower edge of the rainfall belt, near the 250 mm border, grow wheat annually; 14 percent plant wheat-summer crop, while the remaining 4 percent practice summer fallowing with the cropping rotation wheat-lentils-fallow. Hence, almost no farmers, 96 percent, practice summer fallowing, although it is recommended very strongly for this belt area by wheat specialists and is said to improve average wheat yield and reduce the year-to-year variation in yield and production. It is interesting to note that 99 percent of the farmers believe in summer fallowing and think it can increase wheat yield. Eighty-seven percent of the farmers gave yield increase estimates, ranging 25-60 percent over nonfallow wheat fields. However, farmers expressed unwillingness to follow the summer fallow technique despite their knowledge of its advantages because the return from planting lentils is much higher than the increase in wheat yield resulting from summer fallowing.

c. Economic evaluation of wheat production in Belt II and possible improvement of wheat production

This belt represents one-third of the national wheat producing area and output. Nevertheless, over 600,000 dunums (or 43%) of cultivated land is not utilized. Whether this land is developeable is not known. Jordanian officials look at this area belt with great interest and hope project and development programs can increase wheat in this area.

The Ramtha area, represented by four villages, is a very important wheat region. It represents an extension of the famous Syrian wheat lands, the Hourani Plains. In addition to its large area, the topography and soil conditions permit the use of power mechanization, and its level of annual precipitation is favorable for wheat.

Although Belt II has better potential for wheat production than does Belt I, adoption rates of improved practices are not significantly above those in Belt I. Only the application of cleaned and treated seeds by 67 percent of the farmers in Belt II shows and difference from a zero application rate. Farmers in both belts seem receptive to but uninformed and at an early stage in their evaluation of improved inputs. Farmers in Belt II indicated the most important improvements for wheat production expansion are more and better tillage, treated, cleaned and improved seeds, and crop sequence involving lentils and summer fallowing in that order, Farmers did not volunteer the practices of graindrill, chemical spraying, or fertilization as important practices to expand output. Table 5.8 summarizes farmers' knowledge and expectations of the effect of each of the six improved inputs on wheat yield. Many farmers gave quantitative yield increase estimates which they perceived possible with the use of proper tillage operation, improved seeds, and summer fallowing. However, none of the farmers were able to give yield increase estimates for the use of graindrill, chemical spraying, or chemical fertilization. Apparently they are much less acquainted with these

Table 5.8. Belt II interviewed farmers' yield rise expectations from the application of improved inputs

Improved inputs	Percentage of farmers who gave quantitative yield increase rate	Percentage range of yield increase rate
Proper tillage practices	70	15-35
Improved seeds--cleaned and treated domestic varieties	100	10-40
Graindrill	0[a]	--
Chemical fertilizers	0	--
Chemical spray	0	--
Summer fallow	87	25-60

[a]None of the Belt II farmers were able to provide quantitative yield rise expectations from the application of graindrills, chemical fertilizer and spraying.

three practices.

Farmers in this belt were found to have high expectation of what the government must provide to help sustain their economic life. They expected the government to provide them with agricultural materials and services either free or at very low cost. Farmers indicated strong desire and need for government encouragement. In their poverty condition it is likely they cannot afford risk in adopting new practices without government guarantees.

The most recommended practices in Belt II are similar to those recommended for Belt I: proper tillage practices, more widely spread adoption of improved seeds, the application of graindrill, and the application of chemical spraying. If farmers' expectations are correct the practice of clean summer fallowing has little economic prospect for adoption. Farmers seem to make rational decisions. By producing annually, they seem to be maximizing their economic returns. Farmers believe even a proper summer fallow system would increase the wheat yield by only about 35 percent over annual cropping. As a result, 86 percent refuse to practice summer fallow and the remaining 24 percent would not plant only if the early portion of the rainfall season was very poor. It seems that farmers in Belt II perceive the return from lentils to be higher in cash return the than a 35 percent yield increase in wheat by fallowing. The farmers are probably right as a simple economic calculation will illustrate. The net yield increase expects from clean summer fallow is $\frac{35}{100} \times 70$ = 24.5 kg/dunum, and 50 fils/kg = 1.225 J.D./dunum for summer fallow. A dunum planted in lentils in contrast brings a cash crop of 3 J.D./du. Looking at summer fallow wheat in a different way, a crop of 94.5 kg of wheat which is possible once every two years by summer fallowing, would average 47.25 kg/du annually. Yet farmers report and expect even in a poor rainfall belt a level of production of this level, even without the adoption of summer fallow. It costs approximately 1.500 J.D./dunum for five tillage operations during the fallow year, which are recommended by wheat advisors in order to store 30-50 percent of the fallow year's moisture. But the 24 kg of wheat expected would have a value of 1.4 J.D./dunum. Thus, on the basis of economic cost and return, farmers will not be rewarded to engage in summer fallow practices even without lentils. Since they must give up lentils also to summer fallow there is no interest at all in summer fallow.

3. Rainfall Belt III: 300-400 mm

a. General description of the Belt III

This area is the Western Plains, and considered the best area for the production of wheat in Jordan. It is classified according to agricultural development plans as "agricultural lands" (31). It receives more reliable amounts of rainfall than the two preceding belts, I and II, averaging to 300-400 mm annually. In addition, this area is endowed with still better soil. The topography of wide plains permits the use of mechanical power in agricultural practices. This is the best land and we find government attention has been focused on improving this area's productivity. Some wheat project advisors view this area as equivalent of the Pacific Northwest wheat area of the United States. In Eastern Oregon wheat drylands receive annual precipitation in the vicinity of 300-400 mm and produce, with a clean summer fallow system, 240 kg per dunum, three times as much as Jordan's Belt III yields. Probably the potential for water storage is greater in Oregon because of cooler weather, deeper soil of coarser texture.

The total wheat cultivated of Belt III area is estimated at 610,000 dunums (26), or 29 percent of Jordan's total, producing approximately 50,000 kgs of wheat, or about 40 percent of the total wheat. The productivity of this area is clearly above the average for Jordan; the proportion of total production is greater than the proportion of cultivated area.

Table 5.9 reports that the total wheat producing area in Belt III is very similar under three rainfall conditions. Wheat yield estimates, given by the Agricultural Research and Extension Department, are measurably lower than the farmers' estimates collected by the author through the summer in 1974-75. Table 5.10 summarizes farmers' reports about their wheat yield. These estimates, in a good rainfall year concentrate in the range 100-300 kg/dunum, while the government estimated yield at 117 kg. In an average rainfall year, farmers estimate a year ranging from 50 to 175 kg, which gives an average of 100 kg. However, the government estimates production at 70 kg per dunum. It should be mentioned that variations within this belt area are subtle but quite noticeable since not all the villages in this rainfall belt are suited for wheat production.

Belt III	National
Wheat area	29%
Wheat production	40%

Table 5.9. Estimated wheat acreage and production in Belt III under three weather conditions distributed by government districts[a]

Districts	Good year		Average year		Poor year	
	Total wheat cultivated area in dunums	Total production of wheat in tons	Total wheat cultivated area in dunums	Total production of wheat in tons	Total wheat cultivated area in dunums	Total production of wheat in tons
Irbid	300,000	36,000	300,000	21,000	250,000	12,500
Amman	250,000	30,000	250,000	17,500	200,000	10,000
Balqa	40,000	5,000	40,000	3,200	40,000	2,400
Kanak	50,000	5,000	50,000	4,000	50,000	2,000
Maan	4,000	400	4,000	300	4,000	200
Total	644,000	76,400	644,000	46,000	544,000	27,100
Average wheat yield in kg/du	117		71		50	

[a]Source: (26)

Table 5.10. Farmers' wheat yield estimates under different rainfall conditions

Wheat yield in kg/dunum	Belt III farmers' yield estimates					
	Good year		Average year		Poor year	
	No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
Zero	--	--	--	--	17	24.29
20-29	--	--	--	--	27	38.57
30-39	--	--	--	--	3	4.29
40-49	--	--	1	1.43	17	24.28
50-59	--	--	11	15.71	--	--
60-69	--	--	14	20.00	1	1.43
70-79	--	--	3	4.29	--	--
80-89	1	1.43	5	7.14	1	1.43
90-99	--	--	4	5.71	--	--
100-124	22	31.43	20	28.57	4	5.71
125-149	5	7.14	4	5.71	--	--
150-174	6	8.57	5	7.14	--	--
175-199	4	5.71	--	--	--	--
200-249	21	30.00	3	4.28	--	--
250-299	11	15.71	--	--	--	--
Total	70	100.00	70	100.00	70	100.00

The most salient differences between villages occur because of their topographical conditions. Three out of the seven villages visited in this belt are characterized by steepness and rockiness.[1] Two of those three villages with rocky land but which receive higher precipitation have been increasingly planted to vegatables and fruit trees,[2] rather than wheat. This trend is likely to continue, and seems desirable as higher returns to farmers and more valuable food can be obtained from these crops than from wheat. Sharp variations exist among villages due to different topographical characteristics in the 300-400 rainbelt. A village with steep land and rugged rocky area,[3] had farmers who depended more on livestock production and followed more traditional farming practices than in the other villages. Older inhabitants, and less well-informed farmers were found in steep rocky areas. Villages with plains area[4] well adapted to wheat were more likely to have people aware and informed about improved inputs for wheat.

Most of the wheat farmers own fragmented pieces of land located mainly in two major areas, one around their town, with higher rainfall average and better soil, and the other in the eastern land where lower

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[1]These villages are Kafkafa, Burma, and Jarash.

[2]Burma and Jarash areas.

[3]Kafakafa.

[4]Howara.

rainfall and soil quality prevail. Many wheat farmers in Belt III were engaged in nonfarming activities such as owning and operating small mills, small grocery stores, and tillage service tractors.

b. Wheat production and improved input adoption

With more rainfall more intensive wheat cultural practices show better potential. Wheat improvement is more possible in Belt II through the adoption of new practices and use of more input than in the preceding two belts. Table 5.11 reports field investigation results with respect to farmers' application of the package of six recommended inputs.

Actually the adoption rates of all the improved inputs, except that of improved seeds, is low, but Belt III reveals sharp increases in adoption relative to Belts I and II where only classical traditional wheat practices are followed.

i. Tillage operation Farmers of this belt do not differ from farmers in the other rainfall belts with respect to their tillage practices. Ninety-seven percent of the farmers do not till their land for seedbed preparation, and the 3 percent of the farmers who prepare their seedbeds do so because of their use of the graindrill, which requires that the ground be properly tilled. As indicated above, farmers try to minimize their tillage operation in order to reduce the cost of wheat production. Most farmers wait until sufficient rain has fallen before starting seeding, then

Table 5.11. Summary of Belt III adoption rate of improved inputs

Number of input	Improved inputs	Adoption rate in percent
1	Proper tillage practice	2.86
2	Improved seeds--cleaned and treated known domestic variety	75.71
3	Use of graindrills	4.29
4	Chemical fertilization	25.71
5	Chemical spraying	14.29
6	Clean summer fallowing	5.71

till the fields to cover seed and kill emerging weeds. The majority of the farmers, 97 percent, use mechanical power for tillage, mostly through hiring tractor-custom operators. A majority of the farmers had heard of the shallow rapid tillage system and indicated unwillingness to use it, as they prefer deep tillage practice. However, with respect to collective tillage system, the majority of farmers, 73 percent, accepted the idea and indicated readiness to adopt it if neighbors in the same area agree to. Despite the fact that all farmers try to minimize their tillage operation, they also believe a change in current tillage practices will increase their yield. Heading farmers' approvals of tillage suggestions are increasing the number of tillages conducted prior to and after the planting season, crossed tilling, deeper tilling, and removing stones from the fields. Sixty percent of the farmers were able to perceive some yield increase estimates under proper tillage practices. The majority of these estimates fall in the range of 15-55 percent increase over the current yield. In general, it can be concluded that the land of this belt is more cared for than that in the formerly discussed belts because of the nature of the dominant crop sequence, wheat-lentils-summer crop. With the planting of a summer crop, mostly watermelons, farmers till their land at least three times.

ii. Improved seeds About half of the farmers use a known local variety, mostly the Horani Nawawi and F8 types. The remainder showed no knowledge of their wheat varieties believed to be mixtures of different kinds of seeds. However, regarding the practice of cleaning and treating the seeds before planting, we find such a practice most prevalent where about 75 percent of the farmers use such a process and believe wheat yield can be increased in the range of 10-50 percent. Higher yielding varieties are rarely known among farmers. Only a very small percentage of the wheat farmers, 8 percent, have heard of higher yielding varieties and do not know much about them. The majority of farmers, 70 percent, indicated willingness to pay whatever price necessary for higher yielding varieties.

iii. Graindrills Almost all farmers, 95 percent, use the traditional method of seeding, hand broadcasting, with only 5 percent using the graindrill. However, 90 percent of the farmers are aware of the existence of the graindrill technique and know about its advantages over the hand broadcast method. For example, many farmers know that the graindrill can save seeds and labor and improve wheat yield, but the majority of farmers were unable to estimate its effect on wheat yield or seed saving. Because of the availability of one graindrill at the Irbid Agricultural Cooperative Station, many farmers had noticed the pattern of production in rows and developed reservations about its use; however, farmers are willing to adopt it if proved effective and more available in the village.

iv. Chemical fertilization Eighty-six percent of the farmers have never used chemical fertilizers, and only 14 percent have used them erratically for the past six years. Organic fertilizer is more widely used, with 39 percent of the farmers having used it once or twice in the past six years. The high preference for organic fertilizer stems from the fact farmers believe it has a more lasting effect on wheat fields than does the chemical fertilizer. Most farmers think that over a period of four to seven years, land can benefit from an application of manure once, but that chemical fertilizer has a one-season effect on the ground. Farmers, in general, believe chemical fertilizer can increase yield, although only 50 percent were able to give a yield increase estimate in the range of 20-50 percent increase over a nonfertilized field. Farmers expressed the desire to use chemical fertilizer at a price low enough for them to be financially able to purchase.

v. Chemical spraying All interviewed farmers are aware of the existence of the chemical weed control technique; however, only 25 percent of the farmers use it. The majority of wheat farmers believe in the effect of chemical spraying on controlling weed growth, thereby increasing wheat yield; only 36 percent were able to perceive yield effect, in the range of 10-50 percent over yield of a nonsprayed field and estimate its cost in the range of 160-300 fils per dunum. Farmers indicate their willingness to use the spraying technique if custom-spray services exist in the village. Farmers feel they lack the technical knowledge necessary to prepare and mix the chemical and apply it at the proper time.

vi. Summer fallowing Clean summer fallowing is rarely practiced by wheat farmers, with only about 6 percent of the farmers including it in their cropping rotation (wheat-lentils-fallow). The highest proportion of farmers, 44 percent, follow a tri-annual rotation of wheat-lentils-summer crop, followed by the biannual rotation, wheat-summer crop, practiced by 32 percent of the farmers and wheat-lentils by the remaining 18 percent. All farmers believe yield could be increased through the clean summer fallowing, and 93 percent of them were able to estimate a yield increase rate in the range of 20-70 percent, as opposed to that of nonfallow fields.

Despite this high expected rate of increase from fallow practice, only 6 percent practice fallowing, while the remainder prefer to grow lentils and summer crop which bring much higher economic return than the yield increase from fallowing.

c. <u>Economic evaluation of possible improvement of wheat production in Belt III</u>

Farmers in this belt area have stronger desire toward improved inputs and are more knowledgeable about the effect of the whole set of improved inputs. As indicated previously of this section, the area is favored with more suitable environment for growing wheat than are the rest of the dryland areas, with better topography, soil conditions, and annual precipitation. Apparently, farmers respond to such a qualified area by adopting improved inputs, although still in the early stage of the adoption process. As Table 5.11 reports the adoption rates of each input, farmers are aware of the recommended package and more capable of perceiving yield increase effect from the different inputs. Table 5.12 reports farmers' estimates of wheat yield increase from each of the six improved inputs, indeed indicating farmers' expectations to range rather well between 10-50 percent in most of the practices, other than for the graindrill, for which few farmers, 12 percent, were able to estimate a yield rise of about 10-15 percent, and for the fallowing practice, for which 93 percent of Belt III farmers perceive yield increase from 20-70 percent. Except for the clean summer fallow practice, all the

Table 5.12. Belt III interviewed farmers' yield rise expectation from the application of improved inputs

Improved inputs	Percentage of farmers who gave quantitative yield increase rate	Percentage range of yield increase rate
Proper tillage practice	60	15-55
Improves seeds--cleaned and treated domestic varieties	60	10-50
Graindrills	12	10-15
Chemical fertilizer	50	20-50
Chemical spray	35	10-50
Summer fallow	93	20-70

elements of the improved input package are recommended for this belt. Proper tillage operation, cleaned and treated seeds, also genetically improved seeds may show positive response from farmers with an adequate moisture and fertilizer supply. The graindrill can be widely adopted if found to be available in the village, despite the fact that many farmers have reservations against its application. Because farmers lack the technical knowledge of wisdom of placing seeds in organized row patterns, farmers can be convinced and encouraged to use it since they find difficulties in hiring skilled hand broadcasters who are more expensive. Thus, the scarcity of these old skilled workers for the job may encourage farmers to adopt the graindrill if it is made available in the village at reasonable fees between 150-300 fils/dunum. This rate is similar to what cooperatives charge their members for the use of the graindrill. Chemical fertilization and chemical spraying should have better potential, as farmers are very much concerned about their yield. However, they need to be supported by having these materials available and provided at a lower price. However, the summer fallow practice can under no condition be encouraged because of its low economic return in contrast with summer crops and lentils, as has been stressed repeatedly throughout this study.

4. Rainfall Belt IV: Over 400 mm

a. General description of Belt IV

The total land area of this belt is estimated at 2,242,000 dunums, although the cultivated land is only about 874,380 dunums or 39% of the total land. Wheat acreage occupies only 180,000 dunums, which represents only 9 percent of the national wheat growing area. The average total production is 17,000 tons annually or about 14 percent of the aggregate production. From the above statistics, it can be inferred that the average wheat yield of this area is higher than the national average. The proportion of this belt's total production is greater than the proportion of the belt's wheat cultivated area, as illustrated in the following table.

Belt IV	National
Wheat area	9%
Wheat production	14%

Table 5.13 reports the total wheat producing area of Belt IV distributed by districts under three rainfall conditions--good, average, and poor years. Wheat acreage does not vary between these different weather (rainfall) years, as the general level of precipitation does not fall enough to affect the farmer's decision to reduce the cultivated area. However, wheat land productivity does vary with the level of rainfall between the years, as shown in Table 5.13. The wheat yields in good, average, and poor rainfall years are estimated at 146, 90, and 75 kgs per dunum, respectively. However, farmers' wheat yield estimates show a higher average than government estimates. Table 5.14 reports farmers' responses of their wheat yield, indicating their yield in good, average, and poor years to be 200-249, 100-124, 40-69 kg/dunum, respectively.

Topographically, this area is characterized by quite steep fields. The high amount of rainfall has caused considerable soil erosion. In large areas of this belt, fields are in general stony and irregular in shape, taking the form of long narrow lines, which makes mechanical farming very difficult. Wheat is grown in the drier part of this zone where land is flat or gently sloping. In

Table 5.13. Estimated wheat acreage and production in Belt IV under three weather conditions distributed by government districts[a]

Districts	Good year		Average year		Poor year	
	Total wheat cultivated area in dunums	Total production of wheat in tons	Total wheat cultivated area in dunums	Total production of wheat in tons	Total wheat cultivated area in dunums	Total production of wheat in tons
Irbid	90,000	13,500	90,000	9,000	90,000	7,300
Amman	70,000	10,500	70,000	6,300	70,000	4,900
Balqa	20,000	2,400	20,000	1,600	20,000	1,400
Kanak	--	--	--	--	--	--
Maan	--	--	--	--	--	--
Total	180,000	26,400	180,000	16,900	180,000	13,600
Average wheat yield in kg/du	146		90		75	

[a]Source: (26).

Table 5.14. Farmers' wheat yield estimates under different rainfall conditions

Wheat yield in kg/dunum	Belt IV farmers' yield estimates					
	Good year		Average year		Poor year	
	No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
Zero	--	--	--	--	2	6.67
20-29	--	--	--	--	4	13.33
30-39	--	--	--	--	1	3.33
40-49	--	--	--	--	14	46.67
50-59	--	--	--	--	4	13.33
60-69	--	--	1	3.33	2	6.67
70-79	--	--	1	3.33	--	--
80-89	--	--	3	10.00	2	6.67
90-99	--	--	1	3.33	1	3.33
100-124	--	--	16	53.33	--	--
125-149	--	--	2	6.67	--	--
150-199	6	20.00	5	16.67	--	--
200-249	16	53.33	1	3.33	--	--
250-299	--	--	--	--	--	--
300-349	8	26.67	--	--	--	--
Total	30	100.00	30	100.00	30	100.00

the more rainy areas, where the elevation is higher and land is steep, fruit trees and forests are the most common choices for land utilization (25). In an effort to improve national wheat production, the government suggests transferring these wheat cultivated areas gradually from wheat into orchards (26).

b. Wheat production and improved input adoption

This belt receives higher rainfall amounts than all other belts. In some plains areas with this high level of precipitation, higher wheat yields are possible, with more efficient economic utilization of the land resources through following an optimum cropping rotation, discussed below. Table 5.15 summarizes the adoption rate of improved input in this belt area. Other than the use of the graindrill rate, the adoption rates of improved practices are higher than are all those in the preceding three belts.

i. Tillage operation   Farmers in this belt, as in other belts, try to minimize their tilling cost by reducing the number of tillages to the minimum. No seedbed preparation is conducted by any farmers. All the farmers, 100 percent, use mechanical power for their tillage operation through the hiring of agribusiness tractor operators. Ninety-three percent of the farmers had not heard of a system of rapid shallow tillage and expressed unwillingness to use it, but regarding the second suggested technique, the collective tillage system, the same percentage of farmers, 93 percent, would accept it. These feel they really need some technique

Table 5.15. Summary of Belt IV adoption rate of improved inputs

Number of input	Improved inputs	Adoption rate in percent
1	Proper tillage practice	00.00
2	Improved seeds--cleaned and treated known domestic variety	100.00
3	Use of graindrills	00.00
4	Chemical fertilization	53.33
5	Chemical spraying	43.33
6	Clean summer fallowing	3.33

for overcoming the prevailing problem of the small and oddly shaped--long and narrow--pattern of holdings, "Jazo." Ninety-seven percent of the farmers believe a change in the currently tilling practices should raise their land productivity. Among these changes suggested by farmers are increasing the number of tillages, crossed tilling, levelling off the ground, and removing stones from the ground. Forty-five percent of the farmers were able to formulate some yield rise estimates in the range of 15-35 percent from implementing the above tillage practices.

ii. Improved seeds The most prominent improved input adoption occurs in the use of cleaned and treated seeds. All farmers, 100 percent, indicated they plant seeds after screening, cleaning, and treating with fungicides to protect their crop from smut disease. Sixty percent of the farmers were able to estimate yield increase through the use of such improved seeds. They believe an increase ranging from 20-60 percent gained over traditional wheat field yield. Although in this higher rainfall area, a genetically improved variety with higher yielding potential can be grown successfully. Few farmers, 13 percent, were found to be aware of the existence of such types. Almost all the farmers indicated willingness to purchase a higher yielding variety if it is available.

iii. Graindrills All farmers, 100 percent, use the hand broadcast method in planting seed and have heard about the existence of graindrill. Farmers are aware of the general pattern of the graindrill operation in placing the seeds in organized rows but think the hand broadcast method is more efficient as it covers the whole field, while the drill leaves spacings between rows and allows for more weed growth in these unplanted portions. However, farmers are willing to use the graindrill if it can be demonstrated to be more efficient and better than the traditional practice and if available in the village on a custom basis.

iv. Chemical fertilization With the availability of sufficient moisture, it is expected farmers would tend to use more fertilizer than would the farmers in the preceding three belts. The results of the field study indicated that a relatively good rate of chemical fertilizer adoption prevails in this belt area. Forty-three percent of the farmers have used chemical fertilizer once or more during the past five years. The risk of not receiving higher yield from applying fertilizer is minimized, so farmers are expected to have higher expectation and stronger desire to use fertilizers. Inorganic fertilizer is used by 27 percent of the wheat farmers. The majority of wheat farmers, 80 percent, believe that chemical fertilization could increase wheat yield between 20 and 100 percent over that of nonfertilized fields. Farmers who are not using fertilizer expressed desire to use it if priced reasonably low and if they were financially able to purchase it.

v. Chemical spraying This practice ranks next in adoption rate, following the use of improved seeds, with 53 percent of the farmers spraying weeds. It is expected at higher rainfall, weeds will have better environment for growth. All farmers interviewed believe strongly in the chemical weed control technique and are aware of its ultimate effect in increasing the wheat yield. Sixty percent of the farmers gave a quantitative expectation of the chemical spraying effect on wheat yield, falling in the range of 20-50 percent increase over yield on nonsprayed fields. Farmers try to minimize the weeds through the tillage operation, as they wait until enough rain falls before starting to seed and till the planted fields to cover the seeds, at the same time as killing the old and newly emerging weed plants. More farmers are willing to spray if there were some agribusiness agents in the village who would furnish the spraying services on custom basis.

vi. Summer fallowing Almost all farmers, 97 percent, follow the tri-annual cropping rotation of wheat-lentils-summer crop. Although all farmers believe that if the land rested for one year, they would get higher yields, estimated to range between 20-100 percent. Neither farmers nor wheat specialists would suggest or accept the summer fallow practice in this higher rainfall area since wheat project advisors suggest following the clean summer fallow system only in areas receiving rainfall between 200-350 mm. Ninety-eight percent of the farmers stated that under no condition would they fallow because they obtain much higher economic returns from lentils and summer crops than from the increase in yield resulting from fallowing.

c. Economic evaluation of possible improvement of wheat production in Belt IV

Despite the fact the topography of land in this belt is steeper and the landholdings are in narrow fields, the possibility of increasing the wheat productivity in its plains area is much higher than in any other belt, with the adoption of the selective set of practices. With the existence of a high rate of annual precipitation, an integrated package of genetically improved seeds--higher yielding varieties--plus adequate fertilizer with better tillage and weed control operation will undoubtedly bring higher yield response. There are 180,000 dunums of dryland which permit the use of mechanical power for cultural practices. This area can be utilized intensively to bring high production increase rate to fulfill a sizeable portion of the country's needs for wheat. Such an endeavor requires government effort to solve one of the greatest obstacles to wheat cultivation, i.e., the shape of farm holdings. Historically, farmers have owned very narrow and long shaped pieces of land, hindering their capacity for proper tillage or applying any improved inputs. One of the suggested solutions mentioned earlier is a collective tillage operation. Farmers seem willing to try it, but undoubtedly such an operation would require government or public groups like cooperatives to adopt and initiate it. Farmers are very aware of the effect of each input, as illustrated in Table 5.16, which reports farmers' yield expectation for each of the six improved inputs.

Despite the fact that Belt IV enjoys a higher level of moisture than do the rest of the belts, poverty and subsistence living are prevalent among the majority of farmers. It is felt that farmers of this area are very eager to improve their economic welfare through improving their land productivity, although lacking the financial ability to do so. In short, three measures are

Table 5.16. Belt IV interviewed farmers' yield rise expectation from the application of improved inputs

Improved inputs	Percentage of farmers who gave quantitative yield increase rate	Percentage range of yield increase rate
Proper tillage practice	45	15-35
Improved seeds--cleaned and treated domestic varieties	60	20-60
Graindrills	3.33	15-25
Chemical fertilizers	80	20-100
Chemical spray	60	20-50
Summer fallow	100	20-100

essential to improve farmers' economic conditions: providing recommended inputs at prices reasonable enough so they can be used, making agribusiness input furnishing agencies available in the villages, and supporting farmers financially with loans to enable them to transfer their desires into action.

VI. ECONOMIC ANALYSIS OF AGRIBUSINESS ROLE IN JORDAN'S WHEAT PRODUCTION

Agribusiness may be defined as a class of private enterprise activities that furnishes inputs and services to agriculture or markets and that processes products of agriculture. Agribusiness contributes to agricultural development by permitting specialization, higher quality and lower cost associated with specialization, making available the economies of large-scale machines to small farms, and providing specialized services not affordable by small farms. Furthermore, agribusiness can quickly introduce new productive techniques and improved inputs. To improve the national wheat yield and general wheat production conditions, groups of factors must be obtained in an integrated fashion to bring a positive shift in the level of Jordanian wheat production. Among these sets of factors are the improvement of knowledge and expectations of wheat farmers of the recommended modern practices in wheat farming. It is also necessary to make these improved inputs and services available to farmers at prices and conditions which encourage their adoption. Hence, the capacity of agribusinesses in providing materials and services to wheat farmers at easy terms of payment, reasonable prices, and with efficient application is substantial in achieving wheat improvement in Jordan.

This chapter is a study of the current prevailing private agribusiness activities in Jordan, their role in providing services, agricultural materials and equipment, and an overview of the problems they encounter in their operations. Also included is a study of the services currently provided by the Jordanian government to wheat farmers and the effect of its intervention in the agricultural inputs market.

1. Current Agribusiness Services Prevailing in Wheat Dryland Areas

Although most wheat production is by traditional agricultural practices in Jordan, there are some agribusiness firms who perform custom services. A field study was conducted by interviewing agribusiness custom operators to identify the nature of their activities and the problems they face in furnishing these services. The following are the major hired agribusiness activities prevailing in Jordan's rainfed agricultural areas.

a. Tractor tillage custom services

Rainfed agriculture uses custom tractor services mainly in the plains of Jordan. Farms in steep rocky areas do not use custom tractor services. The field survey showed that 98 percent of the farmers use mechanical power on the level fields where tractors can safely be operated. Only 5.5 percent of the farmers owned their tractors and did the tilling themselves. A large majority, 92.5 percent, hired custom tractor operators.[1] Hence, custom tractor

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[1] See Chapter IV, Tillage section.

operators were very common in the dryland areas, and farmers face no problems in availability of these tractor services from agribusinesses. Tractor operators can be found in almost every village. These agribusinessmen may be wheat farmers themselves who own tractors of their own but also provide custom tillage services to their fellow farmers in their own and surrounding villages. Some tractor men are full-time operators who provide custom tillage as their sole business activity, devoting all their working days to selling tillage services. These tractor operators cannot be considered a professional group with expert knowledge of the tillage business. They are rather more tractor drivers. They lack professional knowledge of alternative tillage methods and have little idea of the most effective tool for each specific tillage, type of soil, or crop. Those agribusinessmen have a very limited range of services in terms of the tillage equipment at their disposal. All the tractor operators interviewed (wheat farmers verified this) have only two implements for all kinds of tillage operations: disc plows or malboard plows. Current tillage practices by custom operators seem confined to two main tillage operations, a shallow tillage after seeding to cover or a summer time deep tillage. The main purpose of the shallow tillage is to cover seeds under the soil surface. The most common tool used for this purpose is the 10-disc plow, and the average charge is from 150-300 fils per dunum. The purpose of tillage after harvest in the summer and deep is to open the ground for sun and clear off the weeds. The customary charge runs between 250-300 fils/du.

Tractor operators indicated that they work under very competitive conditions. There are many operators and those from surrounding villages compete to get a chance to do the work and offer their services to farmers, below total cost. The result is low profit or no return to capital investement. The quality of tillage operations is poor. The field study[1] indicated poor tillage practices were very dominant in all dryland areas. The ground was not evenly turned, the weeds were not all cut or turned under. The plows did not scour and the fields were left ridged and with many spots where the furrow was unfilled.

Wheat farmers are tillage cost minimizers. The tillage for seedbed preparation is conducted by farmers, and fields are full of weeds, stones, and not levelled. The farmers place the blame for this poor tillage on the custom tractor operators. Farmers argue that tractor operators should know better but insist on doing the work in a way that results in poor tillage, following the easy path in tilling the ground and refusing to change the direction of tillage practiced over many years. In most cases, the tools used are inappropriate for the purpose of tillage or the type of land. In contrast the operators indicated willingness to change the direction of tillage and do a better job if they are paid more, but

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[1]See Chapter IV, Tillage section.

starting a new direction or doing a better job takes more time, consumes more fuel, and may create a breakage hazard for their equipment because of the rough or rocky soil. Operators claim farmers are to blame for poor tillage because they are unable or unwilling to pay more. Perhaps their poor financial situation causes them to pay little and get poor tillage.

b. Seeding services

Wheat seeding is done by hand broadcasting in the great part of Jordan's dryland area. The field study findings[1] show that 98.5 percent of interviewed farmers use the traditional hand broadcasting method of seeding, and that only 1.5 percent use graindrills. With respect to the hand broadcast method, farmers usually either do the seeding by themselves or hire a custom seeding man skillful in this kind of job. Usually, older people are perceived to be more skillful in broadcasting the seeds evenly to cover all the field. Actually hand seeding is a type of agribusiness service conducted by old farmers, usually poor and with only a small piece of land themselves or none at all. Seeding services were charged on the basis of the number of dunums to be seeded. Charges range between 50-100 fils per dunum. Farmers today face difficulty in finding and hiring custom seeders. There is a shortage of people who offer seeding services, and consequently, the fee charged is rising.

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[1]See Chapter IV, Graindrill section.

The graindrilling technique is quite new to Jordanian farmers, and the reaction of wheat farmers is mixed.[1] There are a few graindrills being used in some high rainfall areas mainly on the demonstration plots of the Ministry of Agriculture. There are no private agribusiness graindrilling services provided as of 1974-75. There are two graindrills at the agricultural cooperative branch in Irbid, and the demand from the members of the cooperative exceeds the capacity of these two drills. Despite reservations, farmers expressed willingness to use graindrills if they were available in the village at the right time. Because of difficulty in hiring hand broadcasters the graindrill becomes an attractive alternative. The graindrill will have fast and wide adoption in the next few years. Farmers probably remember that tractors and combines met with resistance at the start, but over 95 percent of the dryland farmers have now adopted both.

A custom graindrilling business seems natural but there might be some risk involved for private enterprise. The introduction of private services faces an uncertain attitude; now because farmers expect the government to provide graindrills there is acceptance by farmers but a shortage of available, timely well executed services from graindrills. Therefore, it seems the government might take some measures to encourage private agribusinesses to offer this

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[1]For a more detailed discussion of farmers' knowledge, expectation, and attitudes toward graindrills, see Chapter IV, Graindrill section.

service, perhaps by providing credit or subsidizing the price of imported graindrills. Currently graindrills cost approximately 600 J.D. on the market. Another very important factor would be to promise not to give free graindrill services to some farmers.

c. Chemical spraying services

Weeds are a persisting problem in the rainfed wheat areas of Jordan. All interviewed farmers indicated desire to control weeds, and some try to reduce weeds by mechanical tilling, hand pulling and a few use the chemical spraying technique. However, all farmers show knowledge, awareness, and positive attitudes toward the spraying technique.[1] Yet the adoption rate is low; only 17 percent of interviewed farmers used chamical spraying. The greater proportion of farmers did not use chemical spraying but indicated willingness to use it. Most said custom spray services did operate in the village. If they did they would use them. Agribusiness role in the field of chemical weed control has two phases: (1) making chemicals such as 2, 4-D available in stores accessible to wheat farmers and (2) providing spraying services to wheat farmers. Agribusiness stores reported there is no shortage of reasonably priced chemicals for weed control. The sales price of chemicals range from 0.800-1.500 per liter; a liter of 2, 4-D would spray 7-10 dunums of land. Thus, the estimated cost of chemicals for a dunum of wheat is in

[1]For more detailed discussion, see Chapter IV, Chemical spraying section.

the range of 70-150 fils. There is no problem of availability of chemicals. Of course the agribusiness stores are located in urban and rural cities not in villages, but this seems not to be an obstacle. Agribusiness companies promote the use of chemicals by wheat farmers through sending salesmen with technical knowledge to the villages to meet with farmers and provide them with information about the advantages of chemical weed control, prices, and techniques for use. Agribusiness companies try to sell their chemicals through colored posters on the store fronts, informative advertisements in newspapers, and by personal contact to explain the advantages of chemicals in controlling weeds and saving wheat crops. These advertisements usually appear at the proper time for spraying and are intended to be reminders to wheat farmers.

However, farmers are not spraying. Spraying services are not provided effectively by the private sector. There are very few agribusiness people who actually provide spraying services to wheat farmers. The spraying technique calls for a certain amount of special knowledge and skill to perform it cheaply and effectively. It requires proper mix of chemicals applied at the proper rate and at the proper time. It seems farmers are inhibited by these requirements to do it themselves. Interviewed farmers indicated stronger desire to hire custom sprayers rather than purchase the chemicals and apply them themselves. Most wheat farmers are illiterate, can not read labels or directions and have little knowledge of measures of how to mix, identify height of weeds and when and how much to spray. There is a lack of spraying tools at the farmer's disposal and some bad experiences in maintaining sprayers. Research indicated the existence of very few custom sprayers in the Irbid region. One sprayer interviewed gave some good insights into the problems he encountered in business. One was collection for services rendered. The financial capacity of wheat farmers is low and to pay for spraying services before harvest is difficult. Paying after harvest is also not easy because most farmers sell no wheat. This agribusinessman charges 250 fils for each dunum and indicated that he makes only 50 fils net return on each dunum after spraying tractor and chemical costs. Yet, despite this low charge, farmers have difficulty in paying. Many ask to pay later at harvest season and not all pay. Some feel they should pay only if the crop is good.

d. Combine harvesting services

In recent years, combine harvesting has become a dominant practice in the dryland wheat plains of Jordan. Wheat farmers adopted this technique very rapidly, due to the many direct advantages they gain over the traditional hand sickle harvesting. Among these advantages are (i) a smaller loss and waste of wheat, (ii) a cleaner seed harvest because the combine avoids mixing seeds with dirt or weed seeds, (iii) a faster operation, and (iv) a lower cost. It is estimated that 90 percent of the wheat fields in the plains areas are being harvested with combines. But on hilly and rocky ground where it is difficult for the combine to operate, farmers use hand pulling and sickle cutting, and thus benefit from the resulting straw for feeding their animals. All the combine harvesting is done by agribusiness custom harvesters. These agribusiness combine operators may be farmers themselves or special full-time combine and/or tractor custom operators. Pay is on the basis of number of dunums harvested. Combines are owned and operated by private businessmen who make such operations their full-time careers during the harvest season but may work at other occupations in other seasons. Interviews with wheat farmers indicated no complaints about custom combine operators. The farmers showed much more satisfaction with combine harvesting than with tractor tilling.

2. Current Agricultural Input Markets

This section studies the present operation of agribusiness firms which furnish wheat farmers with needed agricultural materials and equipment. The center of major input selling activities is located in Amman, where all agribusiness companies have their headquarters. Some of these companies have branches in Irbid and other cities in Jordan. However, it was noted that there are absolutely no agribusiness firms in any village of rural Jordan. This means farmers who want to purchase any kind of agricultural materials must go to either a rural city such as Irbid or to Amman where more agribusiness firms sell agricultural materials. Interviews were conducted with almost all the agribusiness firms in both Irbid and Amman.

a. <u>Amman agribusiness input market</u>

There are six major firms which deal with importing and selling agricultural materials. Most of these firms deal with a large variety of agricultural materials, except large agricultural equipment such as tractors or graindrills, which are handled by other firms, as explained below. The following are the major activities of the agribusiness firms in Amman.

i. <u>Import of agricultural materials</u> Most of the inputs the firms sell are bought abroad. Usually, the Jordanian firm asks for samples from the exporting company before it makes its final purchase order. After the firm studies the economic feasibility of the product and its effectiveness to farmers, it must obtain import approval from the Ministry of Agriculture, which may conduct experiments on these samples through the agriculture research department to verify their effectiveness before issuing any approval. The Ministry of Health must also approve all agricultural chemical imports before the firm gets an importing license from the Ministry of Commerce.

ii. <u>Sales of agricultural materials</u> Interviewed managers of these firms indicated that most of their business is related to materials needed for vegetable, fruit tree, and other nongrain agriculture. For dryland wheat farming, most of these companies sell fungicides, herbicides, fertilizers, and small sprayers. With respect to chemical spraying, all companies sell a wide variety of weed killers, and the prices are very similar between these competing firms. As indicated above, the price of chemicals ranges from 0.800-1.500 J.D./liter, which can spray 7-10 dunums. Thus, the cost of chemical spraying is 80-200 fils per dunum, provided the farmer performs the spraying. All interviewed managers indicated that wheat farmers' purchase of chemicals for spraying is much greater than of fertilizer; they believe this higher rate of adoption is due to the direct and immediate results brought about by spraying. Sales of fungicides are also increasing, as the majority of wheat farmers recognize how easy and cheap they are to use and what direct effect is represented in protecting wheat plants from smut disease, which the majority of Jordanian wheat farmers have suffered from in the past. The sales price of fungicides is 0.350 J.D./kg. This quantity--one kilogram--is mixed with 500 kg. Hence, the ratio of mixing 1:500 indicates the cheapness of treating the weeds. For example, for the wheat farmer who cultivates 100 dunums of land, fungicides would cost him no more than 0.500 J.D. for treatment of all the required seeds. However, sales of fertilizer suffer setbacks because of shortages in supply and the high boost in fertilizer prices in the world market and also because of government intervention in the local market by selling directly to farmers at reduced prices. The current market sales price is 64 J.D. per ton of Ammonium phosphate fertilizer and for compounds of super phosphate fertilizer, 125 J.D./ton. The average rate of application, according to one interviewed manager, is 10 kgs of compound fertilizer per dunum of land. This amount is enough to increase yield by 30 percent of 50 kg of wheat per dunum in higher rainfall areas. The economic return is 50 fils/kg x 50 = 2.500 J.D.; thus, the net return expected is 1.250/du (2.50-1.25).

With respect to the sales of agricultural equipment, such as tractors, graindrills, combines, and tillage equipment, there is only one large company which concentrates all its business activities in importing and selling agricultural equipment. As exclusive agent in Jordan for John Deere products, this company sells mostly their products. There are also three other major import companies who deal with importing and selling agricultural equipment, along with their automobile business, including Ford, General Motors, and Volvo car sales.

b. <u>Irbid city agribusiness input market</u>

There are few agribusiness stores which sell agricultural materials in the city Irbid. Some of these stores are branches of the big importing companies with headquarters and major operations in the capital, Amman. These stores are similar to their parent organization in Amman in terms of the kinds of goods they sell. The above discussion of the general operation of the agribusiness companies in Amman applies to this other level of the agricultural input market.

c. Problems encountered in the agribusiness input market

Interviewed managers of major agribusiness input firms pointed out the role of the Jordanian government in the input market and the emerging role of new agricultural cooperatives as the two major concerns which have an effect on their business activities. The Jordanian government has been selling some economic aids which are received in the form of agricultural material and equipment to farmers at a lower price than the market price levels. This has severe impact on agribusinesses which operate to make profit but are unable to compete with government low prices. For example, tractors were sold by the government at 1,700 J.D. per tractor, although the market value was more than 4,000 J.D.; thus, government prices are lower by more than 50 percent than those on the private market. Second, small sprayers were sold at 12 J.D. while their market price was 30 J.D. These government sales at such low prices certainly discourage the private agribusinesses from importing and selling such kinds of equipment. A similar situation exists with respect to fertilizer. Western Germany sends chemical fertilizer as part of its economic aid to Jordan, and the government, through the agricultural cooperatives sells it at a much lower price level than the market price of fertilizer. Even the exclusive agent for the German fertilizer in Jordan was under no condition able to compete with government prices. Thus, the subsequent effect was to stop import and sale of fertilizer.

> When the government intervenes in certain business activities, such as sales of fertilizers, the private sector loses its interest.[1]

For a long time the government has sold materials received as foreign aid, but it has recently decided to purchase and resell directly in the agricultural input market. In 1974 there was a public importation of about 12,000 tons of fertilizer from Kuwait which the government sold at a price of 61.210 J.D. per ton. At the same time, the private market price was around 70 J.D., about 15 percent higher than the government price because of the government's loss or subsidy. This led some agribusiness firms to stop dealing in fertilizer but others decided the government might not provide as good service and continued their business. However, if private businesses stop dealing in fertilizer and the government does not plan to continue purchasing and selling fertilizer, then in some seasons, Jordan's farmers may not have any fertilizer. If farmers are not able to find fertilizer in the local market they will say it is a result of government intervention policy. The government argues that it wants to sell fertilizers cheaply to encourage farmers to use them and so increase national food production. The government target is to enter the fertilizer market only temporarily to give farmers incentive to use fertilizer, i.e., to create demand for fertilizer and once this is achieved, to withdraw from the market and let private enterprise handle this

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[1]One agribusiness manager.

business. The problem is the private business may not survive the subsidy phase. The importing companies believe there should be a better method than the government subsidy to implement this very important policy of encouraging farmers to use fertilizer. They suggest that the government let the private sector import and sell fertilizer. If the government decides fertilizer prices should be lower than the prevailing market price, it can do so simply by allowing more companies to sell. If the total purchasing cost is 62 J.D./ton, the government could ask the agribusiness firm to lower the price to 60 J.D., accept not more than 3 J.D. net profit in exchange for a 5 J.D./ton subsidy. If the government pays the difference, 5 J.D. (62 + 3 - 60 = 5), for each ton of fertilizer sold, both the wheat farmers' 2 J.D. (62-60) and the agribusiness 3 J.D. (65-62), it can satisfy both buyers and sellers.

In addition to direct and indirect government intervention in the agricultural input market, all interviewed agribusiness managers expressed concern over the creation of agricultural cooperatives. They possibly present a threat to their businesses because cooperatives are subsidized and may choose to import and deal directly with foreign exporting companies. This would be especially critical if the cooperatives are granted special licenses to import that involves special subsidies. Some managers believe cooperation should exist between agribusiness firms and cooperatives. Perhaps joint ventures would bring mutual benefits to both sides. Cooperatives may be able to collect large orders or credit for agricultural materials and equipment. Cooperatives could then sell to agribusiness firms, with their long-time import experience and flexibility in handling business, may be able to be more efficient and offer better prices and technical advice to farmers and even to the newly emerging cooperatives on some products.

3. The Role and Effect of the Jordanian Government in the Agribusiness Input Market

Jordan's government has been playing an increasing role in the agricultural inputs market and in national wheat production development. In the three-year economic development plan for 1973-75 and all the preceding national plans, the government placed greater emphasis on improving wheat production through encouraging the adoption of recommended improved inputs and by conducting more agricultural demonstrations to show farmers the importance and effect of better farm management and application of improved inputs. These inputs include improved seeds, graindrills, proper seedbed preparation, fertilization, chemical spraying, and summer fallowing. In addition to the major wheat development project which was started eight years ago,[1] the government is also carrying out more responsibilities and conducting more activities to increase wheat production. Among these activities are (i) support of the newly emerging agricultural cooperatives in dryland areas with all financial and

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[1] See Chapter II.

economic means needed; (ii) direct intervention in the input market by importing and selling chemical fertilizer at reduced prices; (iii) extension of agricultural loans; and (iv) provision of improved seeds, spraying, and seed cleaning services.

As indicated previously, Jordan has witnessed a somewhat late cooperative movement. The first existence of agricultural organization was in 1957 in the form of a savings and loan organization for the purpose of providing cash loans to farmers. This was developed into a more conventional type of agricultural cooperative in 1970, with the support and direct role of the Jordanian government. In the past few years, the government has seemed to sponsor this movement and strengthen its role, which the government hopes it will take as a leading growth means for improving dryland wheat production practices. The government set up the central cooperative organization and appointed local managers in the cooperative branches in rural cities. Furthermore, most recently, in the middle of 1975, the government decided to set up a separate body of organization within the agricultural cooperative to provide services and inputs only for wheat production.

The village farmers have mixed feelings about the cooperative and are uncertain about whether to participate in its activities or not. The field study shows that about 11.5 percent of the total number of interviewed farmers were members of agricultural cooperatives, while 88.5 percent do not belong to the cooperative. Table 6.1 reports the distribution of cooperative membership among the

Table 6.1. Rates of cooperative membership among interviewed farmers distributed by rain belts

Are you a cooperative member	Belt I frequencies		Belt II frequencies	
	No. of farmers	Percent	No. of farmers	Percent
Yes	--	--	6	8.57
No	30	100	64	91.43
Total	30	100	70	100.00

Belt III frequencies		Belt IV frequencies		All belts frequencies	
No. of farmers	Percent	No. of farmers	Percent	No. of farmers	Percent
10	14.29	7	23.33	23	11.5
60	85.71	23	76.67	177	88.5
70	100.00	30	100.00	200	100.0

four rainbelts. The greater number of those nonmembers indicated the reason for not joining was that cooperatives in their village or nearby villages did not exist, although many of them expressed willingness and desire to participate if any cooperative were to be established in their village. However, the greater proportion of farmers in villages where cooperatives have been in existence refrained from participation in its activities, giving the following reasons in interviews: (i) farmers do not like to commit themselves to any organization, (ii) farmers feel they do not need cooperative services, (iii) they cannot afford to pay its fees and other expenses for membership, and finally, (iv) they do not know its conditions, regulations, or services. Farmers who said that they do not want to participate in cooperative activities because they feel they do not need its services, perceive wheat farming as merely sowing the seeds and covering them by shallow tillage. Hence, within their knowledge about their very traditional wheat farming practices, it seemed certain that the farmers feel no need for cooperative service.

However, for modern wheat production, there are more sophisticated input applications which can be best employed by a system of collective operations, as in proper tillage and chemical spraying. These operations may be most suited to the nature of cooperative organization. Thus, farmers need to increase their awareness of the requirements for achieving higher wheat yield, namely the adoption of better and more effective inputs in order to create a desire on the farmer's part to participate in cooperative activities.

In conclusion, the writer observed that many interviewed farmers--mostly the older and illiterate ones--either become suspicious or afraid of belonging to cooperatives because they feel they cannot understand the rules or keep up with its requirements. Some of these farmers feel that cooperatives are "just not for them" but are helpful for those farmers who are capable of participating, who are aggressive, literate, and rich. The current agricultural services provided by cooperatives are still modest and on a small scale. These services include providing short, medium, and long-term loans through the Agricultural Credit Corporation, tractor tillage services, improved seeds on a loan basis, graindrilling, and chemical spraying services.

i. Direct market intervention by importing and selling chemical fertilizers at reduced prices Jordan's government intervention policy in the agricultural input market is less clear and unsystematic than its role in the output market. The Ministry of Agriculture occasionally sells the chemical fertilizer which it receives as economic aid from some foreign countries. In addition, it has recently, in 1975, imported a large quantity of ammonium phosphate fertilizer which it sold to farmers at a subsidized price. This activity was undertaken by the Agricultural Credit Corporation--ACC--which decided to sell this fertilizer to farmers, both for cash and kind loans through the agricultural cooperatives. A financial manager of the ACC indicated in an interview that, because it was recognized that the use of fertilizer is not popular among Jordanian farmers since there is a very low demand for it, the ACC undertook this direct import with the purpose of supplying farmers with fertilizer at reasonable prices and on credit terms. Through this approach, it hoped to encourage farmers to become more aware of the importance of fertilizer and to use it more systematically. The ACC hopes that once farmers reach the stage of mature awareness of the role and significance of fertilizer and start demanding it more steadily, it will have served its basic function in creating demand for fertilizer. When this is accomplished, the ACC will pull out of the fertilizer business and ask the private agribusiness sector to take over the responsibilities of importing and selling fertilizer. The ACC policy received sharp criticism from private agribusinesses as mentioned above. Farmers, especially in rainfed areas, may continue to require fertilizer at a subsidized price level, which means the government may have to provide subsidies for it, especially since world fertilizer prices are climbing. Past experience has shown that farmers have high expectations of government aid, particularly if they have previously received such assistance. In addition, private agribusiness may not be willing to participate under this government strategy of "stop and wait until steady demand" is created. This may be especially true in the wheat dryland production sector, which fluctuates from year to year because of the variability of weather conditions. A more balanced strategy seems to be needed to sustain the advancement of agriculture by maintaining a policy which invites the private agribusiness sector to participate. The benefits of its long-time import experience and flexible arrangement should be fostered instead of being forced to stop selling fertilizer until a steady demand is created for fertilizers in Jordan.

ii. Extending agricultural loans During the survey of wheat farmers conducted for this study, it was observed that poverty and subsistence living conditions are one of the real obstacles to the adoption of improved agricultural inputs. Undoubtedly, there is a real need for agricultural credit facilities. The ACC provides three kinds of agricultural loans: short, medium, and long term. However, through interviews with wheat farmers, it is realized that many of them who are in real need for loans refrain from applying because of their perceived notions of the interest rates they must pay on the loans. "Interest rate" as a concept carries a religiously unacceptable connotation of usury which is prohibited in the Islamic religion. Farmers seem to have a misconception about interest rates as a cost of borrowing. The agricultural cooperatives have been having interesting experiences in this connection. Interviewed cooperative managers indicated that when the terms "service charge" and "capital cost fee" are used instead of "interest rate," farmers are very receptive and will accept this arrangement. This is indeed more common after the cooperative workers explain to each farmer why they need to charge some fees to cover the cost of borrowing from the fund. Agricultural credit is very much needed, and more flexible policy arrangements to use more credit to increase their financial capacity so they are able to purchase recommended inputs.

iii. Providing improved seeds, chemical spraying, and seed cleaning services The government provides two kinds of improved seeds: cleaned and treated seeds from selected domestic wheat varieties, chiefly Horani Hawawi and F8. The government distributes these improved seeds to wheat farmers through the cooperative organization in a form of loan-in-kind to be repaid from the farmers' wheat at the harvest season. In addition to this program of distributing cleaned and treated seeds, genetically improved seeds which are suited to Jordan's dryland weather and soil conditions are being produced at large government agricultural stations. Deir Alla No. 2 is the major genetically improved seed; it is a cross between the local variety, Horani Nawawi and the Turkish variety 1110/T. In addition to these programs, the Ministry of Agriculture, through its facilities in rural cities, provides farmers with seed cleaning services and spraying services at a nominal fee to cover only the cost of chemicals.

VII. ECONOMIC ANALYSIS OF AGRIBUSINESS ROLE IN JORDAN'S WHEAT MARKETING, MILLING AND BREAD MAKING

1. Jordan's Internal Wheat Marketing

This section is a study of the economic activities pertaining to the flow of wheat from the farm from all levels of wheat marketing: village, rural city, and terminal city wholesale markets. In Jordan, as in many less-developed countries, a predominantly large proportion of the grain production never leaves the farm but is retained for domestic consumption, seed, and feed (22). The proportion of the crop which is marketed as surplus to individual producers varies widely from producer to producer to year to year. It is difficult to estimate accurately, the quantity which will be retained each year by farms because it depends on a variety of factors: such as the size of the farm relative to the size of the family, the state of the stock or carry over of the farmer, the past, prevailing and expected weather conditions. The farmers' decisions in selling or storing his crop may also be another important factor on the farmer's financial condition. There is an urgency to sell the crop if he is desperate but he may store if he can afford it. Farmers usually sell in the spring after a new crop is assured unless the price is rising.

It can be safely determined that most of the wheat produced in Belt I does not enter the wheat market. Wheat farmers in Belt I raise wheat annually, but typically keep a stock of wheat equal to three more years because of the high incidence of recurrent drought in this area. Stocks in any other belt area are generally smaller since less crops are more secure.

A practical example of the marketed surplus decision at the farm level can be made by looking at an average farmer with 100 dunums cultivated in wheat. If the wheat yield is 80 kg per dunum, and the farm family consists of ten members there will be a marketable surplus. The total harvested wheat is 100 x 80 = 8,000 kg. The total annual requirement for the family at the national average per capita consumption of 180 kg is 180 x 10 = 1,800 kg. If the farmer has just had a poor year he may decide to store enough wheat for two years which would mean 1,800 x 2 = 3,600 kg. His seed requirement at an average seed rate of 10 kg per dunum will total 10 x 100 x 2 years = 2,000 thus, the total wheat retained or stored is 5,600 of 8,000 kg, i.e., 3,600 kg for family consumption and 2,000 for seeding. This would leave marketed surplus of 8,000 - 5,600 or 2,400 kg. In general terms, the larger the acreage, the larger the proportion marketed as surplus. The larger the risk the less marketed. The lower the yield the less marketed, the better the year last year the more marketed. Only for the few commercial wheat producers in each region is all their wheat channeled into the rural or terminal city wholesale wheat markets.

Before studying the market structure of wheat, a study of the wheat farmer as seller and how he formulates his decision in marketing is needed. After the harvest season, the farmer may decide to sell wheat for cash needs if no other source of income[1] can provide it for him.

In this instance, a farmer usually faces a different alternative in selecting wheat buyers, for there are village and rural city wheat wholesalers, as well as some middlemen, who may offer to buy his wheat. The farmer will try to maximize his return by exploring all the possible purchasers before making his decision to sell to a particular dealer. The farmer usually takes a sample of his wheat to the city grain wholesale market and offers his sample to each wholesale merchant, asking for a bid. After visiting and bargaining with almost every merchant in the market, "Al Souqe," he sells his wheat at the highest price offered.

Farmers usually prefer not to sell their wheat immediately at harvest time because they are aware of the generous supply condition and the depressed seasonal market price of wheat. They know that the price of wheat is lowest at the harvest season and try to store their marketable surplus of wheat for at least five months after the harvest (June until the beginning of the winter season). As soon as October, there are some signs of the weather conditions and probability of the rainfall season. To the wheat farmer, the crucial consideration in marketing, storing, and cultivating decisions

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[1]Other sources of income is referred to one of his other sources of income as his son's income from nonagricultural employment sector and other farmer businesses at his grocery shop.

is the next year's rain which determines production. If rains come early and generously and weather conditions look very promising, farmers are encouraged. They plant more wheat and are hopeful of a good wheat harvest the next year and are willing to release more wheat. But if the rains are late and meager, indicating a dry season and a poor wheat harvest next year, farmers will hold more wheat. First they expect a higher price and greater need to store for family consumption.

All the above conditions are clear cases in economic theory of production and marketing under free market conditions--nongovernmental intervention. However, since September 1973, Jordan's government has intervened in internal wheat trade through a price support program. It offered to buy wheat at 55 J.D. per ton, meaning, in a good rainfall season when many farmers decide to sell their wheat, the price of wheat is expected not to fall below 55 J.D.--the price support level. Thus, if the market price shows a decline below such a price support level, farmers would rather sell to the Ministry of Supply at 55 J.D./ton. However, the mechanism has not functioned smoothly, the complications are in the government purchasing procedure, discussed below.

Jordan's internal wheat marketing structure consists of three market levels, village wholesale markets, rural city wholesale markets, and urban-terminal city wholesale markets.

a. Village wholesale wheat market

In rural Jordan, there are no open or public marketplaces or auctions for wheat trade at the village level. However, in most of the wheat producing villages, there are usually more than one wheat merchant. Each has his own store and buys wheat from farmers in the villages and surrounding areas. Usually wheat merchants have small shops close together in one part of town. Village wheat merchants exhibit the following characteristics and the village wheat trade activities are about as follows.

i. Purchase of the wheat from village farmers Only a small proportion of the surplus marketed from a village is sold at the village market, as most of it is sold at the rural city wholesale grain market. This is due to the fact that there are only a few wheat merchants in each village, each with small financial capacity. Actually local wheat merchants sell often to local consumers. The village merchants, who are usually part-time wheat farmers, approach their neighbors to solicit wheat deals. If a farmer has some interest to sell some wheat, both will offer and counter offer or bargain for a price agreeable to both. In addition to the bargaining power or relative ability to forego the trade of the two parties, the wholesale price offered recently in the village and the price of wheat currently prevailing at the rural city market and the quality and freedom from dirt and impurities of the wheat also affect the price.

ii. Transportation responsibility of the wheat from the farm site to the merchant's store In most cases, wheat merchants assume the responsibility of bringing the wheat from the farm to his store, which farmers usually prefer because it is more difficult for farmers than merchants to hire trucks and workers to load the wheat.

iii. Storage of wheat at the village market There is no standard period during which merchants keep wheat in their possession before selling it; the time varies measurably, depending on the market supply and demand conditions. Interviewed village merchants indicated a range of 10 days to two months before selling the wheat. Wheat is stored inside the merchant's store or perhaps in a room of his store in bags stacked on each other and laid on a wooden pallet to protect from dampness or rot. They also hope pallets or platforms will prevent mice from reaching the wheat.

iv. Sales of wheat in the village wholesale market Village wheat merchants sell their wheat to different groups of buyers. The merchant establishes business relations with the rural city merchant and sells wheat to them or sometimes works as a middleman between them and farmers for a commission at the rate of 0.500-1 J.D. per purchased ton of wheat (about 2%). Other customers of the village wheat merchants are households of livestock producers or other non-wheat growing families. Anyone out of wheat may come to these village merchants for wheat purchases. Village merchants indicated that a profit margin of 1 to 2 J.D. per ton of wheat is what they usually reap from a wheat trade.

b. Rural city wholesale grain market

There are five major wheat producing regions in Jordan identified by governmental districts: Irbid, Amman, Balqa, Karak, and Maan. In each district, there is at least one city which is the major wheat trading center of the district. Amman, Madaba, Irbid, Karak, and Maan districts, respectively. As this field study concentrated on the Irbid region, a study of the city of Irbid's wholesale grain market is included. Irbid is considered the commercial center of the northern region of Jordan. Most of the wholesale, especially retail and major agricultural trade activities of this district take place in Irbid. Irbid ranks third in population among Jordanian cities, following Amman and Zarqa. Amman and Zarqa are governmental, manufacturing and urbanized service centers for the country, but Irbid is located in the heart of the dryland wheat plains, near the Syrian border. Irbid exists to serve some famous Hourani wheat plains which also extend to Syria. Irbid has long been a significant trading center for wheat. Irbid's grain merchants have traditionally been very active in internal and external grain trade. As a result of governmental restriction on international wheat trade, the size of Irbid wheat transactions has been reduced. In 1973 the government took responsibility for meeting the milling needs of wheat with imported subsidized wheat.

Irbid's wholesale wheat merchants still handle more wheat than those in urban cities. In rural Irbid inhabitants still grind and bake bread and continue to buy wheat for daily consumption.

The wholesale grain market of Irbid is in the central business district, and about 80 merchants have established shops and are daily engaged in grain and field crop trade. Each grain merchant owns and operates his own warehouse and shop, one next to another. Each shop usually contains 100 kg bags of grain stacked separately wall to wall and floor to ceiling by variety in the rear part of the shop. Each has a large scale, a small desk and maybe a telephone for the merchant's use. Each owner usually hires one or two helpers who work on a monthly basis and help the merchant with the handling of the wheat and business.

Following are the major characteristics of Irbid's wheat market, collected from the interviewed wheat merchants and the author's observations.

i. Wheat purchases in Irbid wholesale market According to merchants interviewed, most of the wheat is purchased directly from farmers. Farmers with samples of their wheat visit the wholesalers to inquire about prices. The wholesalers themselves travel to villages to visit farmers and solicit their wheat business. The price agreed upon is determined by a variety of factors. The season of the year of the transaction is an important one. At harvest time, many farmers have wheat to offer for sale.

Consequently, the quantities supplied far exceed the quantities demanded. The merchants can't or don't want to store all that is offered, bringing a fall in prices. The bargaining power of the wheat merchant is higher than that of the farmer at harvest. A second factor involved is the kind of wheat. Hard wheat is considered the best quality. It's storable for several years and is preferred for milling and processing. So hard wheat demands higher prices than does the soft type. Soft wheat can be identified by less translucence and by biting and is sold at cheaper prices because of its mild characteristics which prove deficient in flour milling. One of the most significant determinants of the market value of wheat is its purity. Wheat which contains dirt, weed seeds, and other impurities especially barley has a lower value, perhaps as much as 20 percent lower than that of clean wheat. This kind of wheat is not as good for bread and is called commercial wheat and can be purchased at 40-45 J.D. per ton, while clean wheat, "Mawwani," can be purchased at 55-60 J.D. per ton. Most of the purchased commercial type of wheat is used for feeding livestock and poultry. Interviewed farmers and merchants indicated that commercial wheat is usually harvested by hand sickle, while clean "Mawwani" wheat is a combine-harvested wheat. The clean wheat is also associated with planting cleaned and treated seeds of known variety.

The current weather and the prospect of the next wheat season also has an effect. If the winter appears to indicate a good wet season, the price of wheat will fall, as more farmers sell wheat. Thus there is a consequent fall in the price of wheat. Another factor is the recent government-announced price support program. The Ministry of Supply, for the last two wheat seasons, 1974 and 1975, offered a price of 55 J.D. per ton plus 1 J.D. per ton for handling to buy the commercial type of wheat. Although this price is by no means meant to set the upper limit for wheat prices at the wholesale level, it seems to have been used as a guideline for bargaining between buyers and sellers. Many merchants hesitated to pay over 55 J.D.'s for fear they would not be able to sell to the government. Farmers were unhappy because they thought they should be paid more than 55 J.D.'s.

ii. The role of intermediaries--middlemen--at the wholesale Irbid market There is a small number of middlemen who operate between the wheat farmers in the villages around Irbid wheat area and the wholesalers in Irbid at the grain market. These middlemen usually do not possess a shop or warehouse or even own wheat but only buy for a commission or fee paid by wholesalers usually at the rate of 0.500-1 J.D. per ton of wheat. These intermediaries visit the village farmers seeking wheat deals, asking for wheat samples, and bargain for a price. If wholesalers accept the wheat samples and show interest in the offer price, the middleman concludes the deal. They are sort of scouts or finds for the wheat merchants of the wholesale market.

iii. Wheat transportation from farmers' homes to wholesalers' stores in Irbid In any wheat trade bargaining between farmers and wholesalers, the terms of delivery appear a very distinctive item to be clarified. In most cases, however, the wheat merchant accepts the responsibility of bringing the wheat from the farmer's home to his store. Apparently, the task of transporting wheat is more difficult for farmers to undertake than for the merchant. All the trucking business is concentrated in the business district of the city where merchants have easy access to it, so the merchant, along with his hired workers, can manage to go to the village to load the purchased wheat.

iv. Wheat sale at the Irbid wholesale grain market The wholesale grain customers consist of several groups: (1) small wheat merchants from areas with poor wheat who occasionally buy large quantities of wheat for the purpose of transporting to a village to sell in smaller quantities to households; (2) wholesalers in other city markets who may trade with Irbid's wholesalers; (3) Irbid area households who do not grow wheat but have strong preference for homemade bread; and (4) Ministry of Supply, which is a recent customer entering the internal trade market only since September 1973. The Ministry of Supply buys commercial wheat from both farmers and wholesalers. A detailed analysis of the role of the Jordanian government in the wheat marketing follows.

Traditionally, commercial millers were the largest group purchasing from wholesalers. However, government intervention in the wheat subsector by providing the major mills with all their wheat requirements has meant that mills no longer buy any wheat from merchants. Interviewed wheat wholesalers in the Irbid grain market emphasized that their income from wheat trade has been minimal in the last few years. Merchants usually only add a margin of 1 J.D. per ton above the purchased price to their sales price.

c. Urban city--terminal--wholesale wheat market

Terminal wholesale markets are generally situated in large urban centers where part of the produce is sold for local consumption, and the rest is forwarded to other consuming centers (22). Amman is the major urban center of the country, with the largest concentration of population which has increased substantially since the 1967 war. Furthermore, the city is linked with the second largest city, Zarqa, through the establishment of the industrial area in the 20 miles which separate the two cities, forming a twin city area, Amman-Zarqa. Most of the Amman-Zarqa population consumes bread through purchases from commercial bakeries.

A large grain wholesale market is located in the business district of Amman where about 100 grain merchants operate. This market seemed the most affected by the Jordanian government's intervention in the wheat subsector through its importation of wheat, the provision of the wheat at subsidized prices to the major millers, and the control of the price of flour and bread. This market is populated with rather underemployed wheat merchants.

i. <u>Purchases of wheat at Amman wholesale grain market</u> Most of the flow of wheat to the Amman wholesale market comes from the Balqa and Amman wheat producing areas, either from farmers' visits to merchants or wheat merchants' visits to the farmers, soliciting for a wheat deal. In both cases, market competition plays the principal role in price determination. Wheat merchants indicated the behavior of the farmer as a wheat seller in marketing his wheat. The farmer visits literally all the merchants in the area and carefully studies the market conditions before he decides to sell his wheat. Similarly, wheat merchants visit many wheat farmers before making final purchasing decisions. Hence, competitiveness exists on both supply and demand sides of the market.

ii. <u>The role of middlemen in purchasing wheat</u> There is a small but decreasing number of middlemen who offer their services for a commission fee, usually paid by the merchant, at the rate of 0.250-0.500 J.D. per ton of wheat.

iii. <u>Transportation of wheat to Amman market</u> When wheat farmers and wholesalers engage in bargaining for a price, traditionally terms of delivery are spelled out before the final agreement on the price is concluded. In the Amman market, farmers and merchants usually bargain on the basis of either the delivery of the wheat to the merchant's store, "Wasel," by the farmer or the packing of the wheat in bags and loading into a truck by the merchant from the farmer's place, "Matroh." But most farmers, as in the case of the Irbid market, prefer that the merchant come to pick up the wheat from his farm. The cost of transportation of wheat depends on the distance, but, on the average, a shipment of wheat from the Madaba area--the major source of wheat for the Amman market--to Amman costs in the range of 0.800-1.500 J.D. per ton.

iv. Storage of wheat at the wholesaler's store   The average period of wheat storage by wholesalers varies from one week to three months, depending on the market situation. Wheat is usually stored in the inner part of the store, stacked in layers of bags. Interviewed merchants mention some losses in wheat, occurring because of mice and the poor condition of the bags.

c. Sales of wheat at Amman wholesale market   Amman wheat trade has deteriorated to a minimum level. Most interviewed wheat merchants indicated a tendency to shift their business interests to other grain and field crops after suffering a sharp decrease in the size of wheat transactions. Wheat millers are no longer buying from wheat merchants since the government took on the responsibility of providing all the wheat they require at a subsidized price. Secondly, after the 1967 war and the occupation of the West Bank of Jordan, Amman's wheat transactions with the West Bank have dropped to zero. A sizeable amount of wheat used to flow from the Amman market to several cities of the West Bank. Further, most Amman-Zarqa residents are no longer doing home bread baking, because bread is cheaper than wheat or flour. The government's subsidizing of the miller's wheat price reduces the price of bread. Jordanian urban households find buying bread from commercial bakeries a better deal and most advantageous than buying wheat, doing the milling, and baking. Price differentials are quite high. While the price of wheat is 60 fils per kg, the price of bread is only 50 fils. For one kilogram of wheat to be milled and baked will cost up to 70-75 fils, although the market controlled price is 50 fils, a saving of about 50 percent. The type of customers has changed over time for the Amman wholesalers, and currently, most of the grain sold at the market is used for feeding animals--poultry and livestock. It is an important change in the pattern of local wheat use, and its consequence on the government's responsibility to import more wheat for human consumption. Apparently, the relatively low price of wheat, compared to prices for other feed grains, attract animal feeders to demand more wheat. Other customers are retail wheat merchants, some households, and the Ministry of Supply.

It seems clear that the sales price of wheat among all merchants in the market is the same. There exists competition among sellers. Interspatial price differences between Jordan wheat city wholesale markets are small only enough to cover the transportation cost between them. However, since there is no free flow of wheat permitted between Jordan and the neighboring countries of Syria and Lebanon, prices differ between these countries. There is no international influence on the Jordanian wheat price since the government prohibits any private participant from external wheat trade. The Syrian government does not allow its private wheat merchants to export wheat to Jordan.

d. Economic analysis of the role and effect of Jordan government intervention on the internal wheat market

In recent years, Jordan's government has increased its intervention in the wheat subsector, until the middle of 1973 when it assumed complete control of wheat imports and, for all practical purposes, dominated the overall operation of the wheat subsector. The assumption of government intervention in the wheat subsector stems from two basic goals: one is to guarantee sufficient flow of wheat to meet the population's requirements of this important food item, and second, to accomplish the government's goal of keeping the price of bread for Jordanian households at a low level of 50 fils/kg.

As indicated in Chapter 1, government intervention in the wheat subsector has several measures and programs: a wheat price support program, wheat subsidized price program, wheat import and export policy, and flour and bread price control. This section deals with those measures which have bearing on the local wheat market, namely the wheat price subsidized program and wheat import and export policies. At the outset, it can be stated that despite the ultimate goal of government intervention in securing sufficient wheat flow to the milling industry to avoid a shortage crisis in bread supply (especially in densely populated urban areas), these measures have affected the structure of Jordan's wheat market, disturbing the market forces. Consequently, many wheat wholesalers have been driven from their traditional roles in the wheat subsector and have been forced to shift to other businesses, as shall be discussed below.

According to government-prepared wheat supply and distribution tables, a committee consisting of representatives from the Ministry of Supply, National Planning Council, and the Ministry of Industry and Commerce makes decisions regarding the sources and quantities of wheat to be imported. After wheat shipments arrive at the port of Aqaba, the government distributes the total shipment among the six major milling companies at a subsidized price of 33 J.D./ton for all kinds of wheat. As a consequence of this government-subsidized wheat distribution, a large portion of the local wheat transactions which used to be millers' purchases from the wholesale market has been terminated since the market price of wheat, 55-60 J.D./ton, is far above that of the subsidized price. Hence, milling companies no longer buy wheat from the local market. Prior to this government intervention, it was estimated that 40 percent of all the wheat required by the major commercial mills was obtained from the local wholesale wheat market. This 40 percent requirement amounts to a large proportion of the wheat sold in the internal market. In addition, some urban households are encouraged to buy milled flour for their home bread making instead of purchasing wheat from wholesalers and then milling it at a 10 J.D./ ton charge. This shift in purchasing attitudes is due to the government's subsidized wheat policy and control of flour prices. Jordanian householders can buy a ton of flour at 40.5 J.D., whereas they would pay 60 J.D. for the market price of a ton of wheat plus 10 J.D. cost of milling. A total of 29.5 J.D./ton can be saved by buying flour instead of wheat. Thus, the largest two customers, millers and householders, no longer deal with the local wheat wholesale market, indeed crippling the operation of the wholesale market. Currently, most wheat sold in the market is for animal feeding--primarily poultry. A newly emerging function for wheat wholesalers is expected as a result of the government price support program; the sale of wheat to the Ministry of Supply at the price support level and thus providing a link between wheat farmers and the government. This is because the government is interested in purchasing wheat in larger quantities, so wheat merchants may collect the wheat from farmers at just a little below the support price level and sell it to the government with a small profit margin.

2. Economic Analysis of Wheat Milling Operation in Jordan

a. Description of Jordan's milling industry

Functionally, Jordan's milling industry can be divided into two distinctive groups of enterprises: custom mills and commercial mills. Custom mills usually do not enter the wheat market, purchase the wheat, or sell the flour. In other words, they do not possess the wheat they mill, only providing the milling services on a custom basis, whereas the latter group of mills perform a more complete line of production activities in seeking to maximize their profits. Commercial mills purchase the wheat, processes it into flour, and sells the flour and other byproducts in the market. In addition to this basic functional distinction between the two businesses, other differences exist in terms of the size of their operations, their technical capacity, location, and relation to different governmental agencies, as discussed below.

i. Custom mills As indicated in Chapter I, there are a great many small custom milling houses operating throughout the country, especially in the rural villages. The custom miller charges for milling services on the basis of the amount of wheat (weight units in kgs). The going rate among most of the mills falls in the range of 5-7 fils/kg or 5-7 J.D./ton of wheat. In rural areas where most inhabitants consume their own wheat or through purchase of wheat, the existence and operation of these traditional small milling houses provide a valuable service for both farmers and public officials. Easy access to these mills enables farmers to retain their needed wheat and consume it without having to enter the wheat market. Since custom millers do not buy the wheat and sell flour but provide only the milling services at nominal fees, it allows wheat farmers to keep possession of the wheat until consumption. Hence, wheat producing villages seem to be satisfying their own needs for this important diet item without being affected by the conditions of the wheat market or by government intervention in wheat marketing, milling, or baking activities. Furthermore, it seems that the existence of such traditional milling operations on the village level has smoothed the internal flow of wheat in each village, thereby avoiding a bottleneck problem in furnishing wheat, flour, and bread in rural centers and reducing the responsibility of Jordan's decision makers to meet the problem of wheat only in the densely populated cities of Amman and Zarqa.

ii. Commercial millers This second class of millers plays a more subtle role in Jordan's wheat subsector. Commercial millers are characterized by far larger operations and more complicated wheat processing than those carried out by custom mills. Functionally, commercial mills participate in wheat marketing by purchasing the wheat from different sellers and selling the flour to different buyers. Furthermore, for the purpose of profit maximization, they operate on a relatively large scale in order to capture the benefits from the economies of scale of the milling operation. In Jordan, the milling industry operates under an imperfect competitive situation. The number of commercial mills is very small, with only six commercial companies operating to produce the flour requirement of all the commercial bakers and flour merchants in the country. These mills are located in the three largest cities of Jordan: three mills in Amman, two mills in Zarqa; and one mill in Irbid.

b. Commercial millers' purchases of wheat

In the middle of 1973, the Jordanian government took responsibility for providing all the wheat required by the major milling companies. Since then, most of the wheat purchased by the government is imported from the world wheat market and other foreign sources, as shall be discussed below. The government sells this imported wheat at the subsidized price of 33 J.D. per ton for all kinds of wheat--hard, soft, local, or imported. Hence, the government sponsors all the needed wheat for these six major milling companies and tries to meet their demands regularly. Usually, the government imports the wheat, and after the shipments arrive at the port of Aqaba, the Ministry of Supply distributes the total shipment to the six milling companies according to their relative sizes. Prior to mid-1973, the milling companies used to buy its wheat requirement from the local and world markets. Interviewed merchants revealed that the milling company usually buys 40 percent of its requirement from the local market and imports 20 percent from the world wheat market, with the government furnishing about 40 percent from foreign sources, mostly from donations and relief shipments.

i. Processing the wheat--milling--into flour There is no specific ratio of the different kinds of wheat blended by the commercial millers. Wheat usually is mixed according to the kinds available at the milling store at the time of processing. However, government regulations force wheat millers to process a ton of wheat into the following categories: 20-25 percent flour of zero--best--type; 60-65 percent flour of first type; and 15-20 percent into bran. This means that each ton of wheat makes 800-850 kg of flour. Currently, the most severe problems faced by the mill are the shortage of skilled labor, high turnover rates, and high wage increases demanded by labor, in addition to the increase in other costs of operation such as fuel and maintenance cost.

ii. Sales of flour Because of the wheat price subsidy given to the major commercial milling companies, the government controls the sale of flour, its prices, and distribution. It gives the bakery the right to choose one of these six commercial mills to buy flour from but determines the quantity which should be distributed every day. The government-imposed sales price of flour is 44 J.D. per ton of zero-type wheat, 38.5 J.D. per ton of type one wheat, and 20.5 J.D. for each ton of bran. The bran is sold by government permits for animal feed, mostly to poultry and sheep farms.

c. Economic analysis of the role and effect of Jordanian government intervention in the milling industry

Since the middle of 1973, the government has sold both the imported and local wheat at subsidized price of 33 J.D. per ton to major commercial millers. However, companies must sell their flour at government-regulated prices of 38.5 J.D. for grade one type and 44 J.D. for zero-type flour. These millers are not satisfied with the government intervention in their business and its control of their wheat purchases, flour sales, and determination of prices. Interviewed millers indicated that the major disadvantage of this government intervention is that it eliminates the competitive element between commercial millers in their operation since nearly all their activities are under the government control. All wheat requirements are sold by the government under a specific quota to each of these six commercial millers at a subsidized price, and all flour sales are controlled in both price and quantity. Hence, millers feel they no longer operate as entrepreneurs but rather as managers in an almost nationalized company. As a consequence, millers have no incentive for concern about the quality of their product since each has fixed sales predetermined by the government through the granting of flour purchase permits to a number of commercial bakers for each commercial miller. An interesting view expressed by one interviewed miller concerning his attitudes and perspective of the milling industry and the role of government in it predicted that the government will not be able to continue controlling the milling industry. He further expected that the milling industry will regain its competition and free enterprise operation. This particular miller intends to pay more attention to his flour quality and standard of services to his customers in order to keep competitive situations with other commercial millers in order to be able to capture more business once the government withdraws its intervention and bakers and flour merchants are given the freedom to buy in a competitive flour market. There is continued dispute between the commercial millers and the Ministry of Supply over the prices of wheat and flour. Interviewed millers expressed dissatisfaction with the government-imposed purchase price of wheat and sales price of flour. The Ministry of Supply made some economic calculations on the operation of the milling industry in order to determine the sales price of flour; however, these calculations have been under sharp criticism from commercial millers because they lack the economic understanding of the milling operation. It is argued that capital depreciation in the milling operation is ignored in the government calculation of the cost of milling. In terms of the cost of wheat milling, a ton of wheat costing 33 J.D. is processed into the following byproducts:

		Sales Price		J.D. Fils
60 percent flour type one	x	38.5	=	23.100
20 percent flour type zero	x	44.0	=	8.800
20 percent bran	x	20.5	=	4.100

The total value from a sale of a ton of wheat is 36 J.D.

Gross return: 36 - 32 = 4 J.D./ton

Millers estimate their operation cost	2.800
and capital depreciation	0.250
and cost of packing	0.350

The total processing and marketing cost is 3.400.

Thus, net profit is 4.0 - 3.4 = 0.6 J.D./ton of wheat. Interviewed millers indicated dissatisfaction with this low profit margin, and some commercial milling companies have decided to expand their production capacity in order to capture the benefits accruing from the economies of scale.

3. Economic Analysis of the Bread Industry in Jordan

a. Description of Jordanian bread making

As in the classification of the milling industry, there are two major kinds of business organizations involved in the bread making industry in Jordan: custom and commercial bakeries. The distinction between the two groups is quite clear, for in terms of their locations, custom bakers usually function in rural areas while commercial bakeries exist in urban and semiurban cities in Jordan. In terms of their economic activities, custom bakers usually do not enter the wheat or flour markets because they do not assume ownership of the flour they process or the bread they make but only provide the bakery services on a custom basis. Commercial bakeries, on the other hand, perform a rather complete line of production activities represented in purchasing their basic input (flour), processing it, and selling the product (bread) to the final consumers (households).

i. Local custom bakers This type of service is one of the oldest, most traditional types of agribusiness activities found in rural Jordanian areas and still performing a significant function for households on an easy payment term at a nominal charge. After the wheat is milled and made into dough by farm wives, it is taken to a neighboring custom baker, and within an hour or so, the freshly baked bread is ready. The system of charging customers for baking services is interesting indeed, for the custom baker charges his household customer on a monthly basis, according to the number of members in each household (excluding children under five years old). Instead of counting the number of loaves baked every day or weighing the baked bread, the baker has found a system based on the number in each household, dealing with him to be better. Interviewed custom bakers estimated the service charge to be approximately 5-10 fils per kg of bread. Local custom bakers, with their simple operation, provide valuable services to the rural areas since they meet the desires of the rural inhabitants who insist on baking their own bread from their own wheat. Their minimum costs are represented mostly by the fuel and labor services consumed. It is interesting to note that despite the fact that many rural households have their own baking facilities at home today, most prefer to use custom baking services which, apparently, cost much less than does the home baking. The custom baker seemed to function very efficiently by utilizing the baking room very wisely, operating it a few hours in the morning when every customer brings his dough ready for baking and thus is able to utilize his production capacity and minimize operation cost. This means he operates at the lower level of his long-run average cost curve. In addition, the custom baker usually works by himself, assisted by his sons, thus reducing labor costs and satisfying him with a very low margin over his operation cost.

ii. Commercial bakeries Commercial bakeries are mostly concentrated in urban areas. They sell a popular kind of bread, a rounded, flattened loaf called "Kemaj." Unlike commercial millers, commercial bakers have quite high competition, as many of them establish their business in one area. The size of their business operation is rather small, mostly run by the individual proprietor, along with his sons and several workers. In most commercial bakeries, the baking and selling of bread are carried out in the same place, with the owner usually supervising both the production and sales of bread.

iii. Purchases of flour From October 1974 until the present time, commercial bakeries have bought flour from one of the six milling companies under complete government supervision. The Ministry of Supply decides the daily flour requirement of each baker on the basis of his production capacity and daily sales, granting a written permit valid for two months. This allows the commercial baker to buy the predetermined amount of flour from any one of the six milling companies he choses (actually, commercial bakeries in the Amman area can chose to purchase their flour from only three milling companies since the other three operate in Zarqa and Irbid). Because of the subsidized wheat sold to the milling companies, their flour sale price is fixed and controlled by the government. Therefore, the commercial bakeries face a completely controlled purchase price of flour. The current flour prices are 38.5 J.D. per ton of grade one type flour and 44 J.D. per ton of grade zero type. In addition, the commercial baker pays for the transportation and loading cost of flour from the mill to his shop. The commercial bakers interviewed estimated their cost of transportation to be between 1-1.50 per ton. The commercial bakers get their daily requirement of flour on a daily basis; the amount of flour stored at the bakery is limited to cover the baker's needs for only two to four days. Prior to government takeover of the wheat subsector, commercial bakers were more free to buy their wheat from any miller or flour merchant, and competition between millers in quality and prices of flour gave bakers more market privilege to buy at the best offer. This was especially true in the 1960s when the supplies of wheat and flour were more plentiful because of large foreign donations in the form of wheat and flour which brought a decrease in flour prices in the market.

v. Sales of bread All commercial bakeries sell directly to the final consumers: households. The price of bread is controlled and fixed by the government at the rate of 50 fils per kilogram of bread, or 50 J.D. per ton of bread, the low price maintained for the past several years. A growing dispute between the government officials and commercial bakers is reflected in the bread market by occasional shortages of bread and poor services provided to the customers. A detailed discussion of the effect of government intervention in the wheat subsector is forthcoming.

b. Economic analysis of the role and effect of Jordan government intervention in the bakery industry

The ultimate goal of government intervention in the wheat subsector in Jordan is to guarantee sufficient flow of wheat into the market and to keep the price of bread at its low level for Jordanian households. In order to accomplish these two goals, the government sells imported and locally purchased wheat to the commercial milling companies at 33 J.D. per ton and has set the sales price of flour at 38.5 for type one and 44 J.D. per ton for zero type. By this government control over the wheat sale price to millers and flour purchase price to bakers, the right of fixing and controlling the bread sale price at 50 fils/kg is insured. This has been the going price of bread since 1966.

Interviewed commercial bakers expressed dissatisfaction with this government price freeze on bread while the prices of all other goods and services have been increasing in the past ten years. They further indicated that they are faced by the threat of closing out because of the very depressed margin of profit they receive, as well as from the severe difficulties caused by labor shortages and high rate of turnover. The great majority of commercial bakeries traditionally operate under very labor intensive conditions. This means the dependence on workers in the bakery industry is very high, compared to other types of food processing such as milling, which is very highly mechanized at the commercial milling level. The traditional baking business faced no problems in the past when labor was easily available at low wages, very long daily hours were acceptable, and flour supplies were abundant at low prices. However, in recent years, the picture has changed almost completely, and the baking industry currently faces a real crisis, in terms of its economic operation and existence. In the past few years, the urban centers have seen general shortages in the labor supply and a greater increase in wages. Prior to the 1970s, an unskilled laborer would accept 0.500-0.600 J.D. for his daily 12 hours work (about $1.5-$2), but in the most recent years, no worker will accept less than 1.500 J.D. a day. To study the reasons for such an increase is beyond the scope of this analysis. However, one factor which is believed to play an important role in demanding more labor is the high rate of growth in the construction industry, especially in the urban centers. This construction expansion is also a labor-intensive type of industry, demanding more labor and willing to pay higher wages than the food industries (bakery, dairy, etc.) pay. Hence, sharp competition from other industries presents unprecedented problems to the commercial baker. An unskilled worker can get about 1.300-1.600 J.D. in the construction industry for an eight-hour day, while the baker is unable to compete because of the price squeeze by government-controlled bread prices. In addition, working conditions in the bakery industry are not considered very attractive, with the high heat environment and very early working hours it involves. Higher pay is obviously needed to attract workers to this kind of work. In terms of economic cost and returns, the baker buys flour at 38.5 J.D./ton and pays around 1.5 J.D./ton for transportation and loading costs, a total cost of 40 J.D. per ton. Interviewed commercial bakers indicated that the cost of baking one ton of flour is estimated at 17 J.D. Thus, the total production cost if 57 J.D. (40 + 17) for 1.2 ton of bread made from each ton of flour. This represents total returns of 60 J.D. (50 J.D./ton x 1.2 ton), with a net return of 3 J.D. (60 - 57) for each ton of flour. Under current conditions, the commercial bakery is making 3 J.D. on each ton of flour; however, because of the increase in labor wages, most of this profit is likely to diminish to cover increasing labor cost. In order to capture this low profit, bakers are already cutting their expenditure on customer services, such as selling unsacked bread. The Ministry of Supply is in a continuing dispute over its price control of bread. Higher officials at the Ministry of Supply conducted an empirical study to estimate the cost of bread production (1). The finding of this study was that the net profit for each ton of flour is 5.230 J.D. Interviewed commercial bakers criticized this study as lacking the actual and real production environment and underestimating production cost and overestimating the flour-bread ratio. However, the writer believes that the difference between the two net profit estimates is not large. In both estimates, the profit margin is very low to sustain the bakery industry, especially in a phase of increasing production costs. The interviewed bakers suggested either permitting the price of bread to be free of government control and to be determined by forces of the market and competition between bakers, or raising the sale price of bread to 60 fils per kg in order to enable bakers to pay better compensation for labor and to offer better services to their household customers.

4. Jordan's International Wheat Trade and Donations

a. <u>Wheat import in Jordan</u>

Jordan is a net food deficit country. The total wheat requirement for the nation far exceeds its national production. Two major activities are being operationalized to cover this food deficiency: wheat donations and imports. The total annual wheat deficiency is estimated on the average at about 140,000 tons or approximately 50 percent of the total requirements. Wheat donations and relief from international organizations are estimated at around 73,000 tons or half of the food deficit. The remaining shortages are met by importing from the world market. Presently, the Jordanian government is assuming responsibility for all foreign wheat purchases. Since the middle of 1974, the private sector has not engaged in external wheat trade because of the government-subsidized wheat policy which inhibits any wheat wholesaler from importing wheat. The Jordanian government imports wheat at price levels ranging from 40-50 J.D. up to 80-90 J.D. per ton and sells it at 33 J.D. to the major milling companies. To determine the desired amount of wheat to be imported, the government usually prepares supply and distribution tables at the beginning of each year from which it estimates the local production and the expected flow of donated wheat. Table 7.1 reports the government-prepared supply and distribution tables for the three fiscal years, 1973/74, 1974/75, and 1975/76. On the basis of these estimates, the government determines the wheat required and studies the possible foreign sources of import. Jordan's external trade statistics show that there are several countries from which Jordan imports wheat (9). The top importing countries are the U.S.A., Canada, France, the United Kingdom, Argentina, Australia, West Germany, Iraq, Syria, and Lebanon. However, the greatest proportion of wheat, 75 percent, comes to Jordan from the United States. Of the U.S. wheat shipments, 70 percent is obtained under the P.L. 480 Title I program. Jordan is one recipient among many developing countries who obtain most of their wheat imports under the P.L. 480 program. (It is estimated more than 60 countries have received P.L. 480 shipments 1954 when the program was initiated. (6)). Table 7.2 reports Jordan's wheat imports from the U.S.A. under the P.L. 480 program. On the average, it is estimated about 30,000 tons of wheat are imported annually under P.L. 480. The payment arrangements are set up between the U.S. and Jordanian governments. Under these terms, Jordan pays 5 percent of the total value in U.S. currency and another 5 percent in Jordanian currency, with the U.S.

Table 7.1. Jordan's government supply and distribution table for the three years 1973/74 - 1975/76[a]

	1973/1974		1974/1975		1975/1976	
Supply						
Carryover	50,414		2,714		38,000	
Local production	39,000		180,000		60,000	
Total		89,414		182,714		98,000
Imports						
Donations						
UNRWA	49,000		50,000		51,900	
WFP	14,000		18,000		15,900	
SMC	28,000		10,000		12,000	
Charitable societies	4,000		2,000		1,000	
Total		95,000		80,000		80,800
Commercial						
Government imports	91,300		22,000		43,350	
Army	23,000		--		17,500	
SMC	--		--		14,350	
Commercial sector	3,000		17,000		--	
Total		117,300		39,000		75,200
Grand total, supply		301,714		301,714		254,000
Distribution						
Food consumption	270,000		277,000		91,000	
Seed, feed, waste	25,000		55,000		35,000	
Export to Saudi Arabia	4,000		15,000		8,000	
Grand total, distribution		299,000		347,000		334,000
Ending stock		+2,714		-45,286		-8,000

[a]Source: (30).

Table 7.2. Jordan wheat imports under P.L. 480[a]

Year	Quantities of wheat, tons	Total value of wheat, million $
1968	30,000	2.1
1969	20,000	1.5
1970	No purchase agreements were made	--
1971	22,000	1.2
1972	30,000	1.8
1973	20,000	3.6
1974	55,000	8.4
1975	40,000	6.8
Total	217,000	25.4

[a]Source: U.S.A.I.D. office in Amman, Jordan.

government financing 90 percent to be paid in 17 to 20 years at an interest rate of 2 percent for the first two years and 3 percent for the rest of the period. The Jordanian government submits a request to the U.S.A.I.D. office in Amman with the volume of wheat desired as indicated by the supply and distribution table. After approval of the request, the Jordanian government authorizes its embassy in Washington to find an American agent to procure the best wheat offer in the U.S. wheat market. The agent usually gets 1.5-2.5 percent of the total value of the shipment as his commission fee. P.L. 480 Title II is also operational in Jordan. This is free wheat shipment usually provided as donations by the U.S. government to some American voluntary agencies working in relief and rehabilitation in Jordan. It is estimated that approximately 3,000 tons of flour equivalent in wheat are sent to Jordan annually. The major charitable organizations are CARE and the Lutheran and Catholic societies. P.L. 480 Title II also permits the Jordanian government to apply for relief in drought years and under emergency conditions. In 1970, the U.S. government donated 11,000 tons of wheat to the Jordanian government for rehabilitation after the 1970 civil war.

Concerning Jordan's wheat export, there is a limited quantity of wheat permitted for export to the northern part of Saudi Arabia, adjacent to the southern region of Jordan. The annual exports are estimated at 8,000-15,000 tons. Because of its own acute shortages in wheat supply, Jordan's government restricts private grain wholesalers from exporting wheat or flour outside Jordan.

b. Foreign wheat donations

Jordan receives sizeable amounts of wheat and other forms of economic aid to help relief and rehabilitation of the Palestinian refugees of the 1948 war and West Bank displaced persons from 1967. UNRWA is the organization responsible for providing food, shelter, health, and education services to the Palestinian refugees of the 1948 war.[1] Fifty thousand tons of wheat are distributed free to about 300,000 registered refugees at UNRWA. Since the 1967 war the occupation of the West Bank of Jordan by Israeli forces, war refugee problems emerged again, with large numbers of Palestinians, estimated at 300,000 forced to leave their homes in the West Bank and Gaza Strip, taking refuge in Jordan. Consequently, a high governmental agency, the Supreme Ministerial Committee for Relief of Displaced Persons and Refugees, SMC, was formed for the relief and rehabilitation of these people. Another 35,000 tons of wheat are provided free of charge to about 270,000 displaced persons (39). Two major foreign contributors donate wheat to this relief program. The European Common Market, ECM, donates from 3,000-4,000 tons of wheat, and West Germany gives from 8,000-9,000 tons every year. The rest of the required relief, estimated at about 23,000 tons, are imported by SMC. Another foreign contributor to the wheat relief in Jordan is the World Food Program, WFP, which is one of the FAO programs and has been in operation in Jordan since 1963. The major objective of the program is to promote economic and social development through the supply of food (42). WFP usually operates through specific labor-intensive projects in rural areas, such as land

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[1]A Palestine refugee, by UNRWA's working definition, is a person whose normal residence was Palestine for a minimum of two years preceding the conflict in 1948 and who, as a result of this conflict, lost both his home and means of livelihood and took refuge, in 1948, in one of the countries where UNRWA provides relief (40).

clearing, tree planting, and road building. It is estimated that about 9,000 tons of wheat are provided to Jordan annually by this program. Finally, CARE, the Lutheran and the Catholic charitable societies, contribute 1,000-3,000 tons of wheat annually as part of their rural and community development projects in Jordan. Hence, the total wheat relief and donations which flow into Jordan's economy are approximately 73,000 tons annually, distributed as follows:

	Tons of wheat
UNRWA	50,000
ECM	3,000
WFP	9,000
West Germany	9,000
Charitable societies	2,000
Total	73,000

This wheat represents about one-fourth of the total wheat requirement of Jordan which flows free to about 600,000 of Jordan's inhabitants. These donations represent an interesting phenomenon in the wheat subsector of Jordan and add quite a unique element to the internal wheat market and to the pattern of wheat consumption in Jordan.

As indicated above, two major organizations, UNRWA and SMC, undertake the responsibility of providing basic food relief to the nearly 600,000 refugees of two years of 1948 and 1967. Both organizations provide the same monthly per capita food ration which consists of

10 kg of flour,

600 gm of sugar,

500 gm of rice, and

375 gm of soybean oil.

In addition to food, shelter, clothing, health and educational services are provided (39).

With respect to Jordan's wheat market and pattern of consumption, this group, Palestine refugees and West Bank displaced persons, receive an estimated amount of 85,000 tons of wheat free of charge; i.e., about one-third of the Jordanian population receives its wheat requirement at no cost. The remaining population lives either in the urban cities and/or the rural areas. Those who live in urban areas buy their daily bread from commercial bakeries at a subsidized price of 50 fils/kg or buy flour at a subsidized price of 40.5 J.D. per ton of flour. Therefore, this group receives government subsidy on their bread consumption, estimated at 30 percent of the total market value of bread.[1] The rural people who do not receive any flour ration and neither buy bread from commercial bakeries nor buy flour from flour merchants, instead consume from either their own produced wheat or wheat bought from the wheat wholesale market. This

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[1]Thirty percent subsidy is estimated by considering the bread price on the free market to be 70-75 fils/kg on the basis of the price of wheat plus the cost of milling and baking. This subsidized price is 50 fils. Thus, 20-25 fils/kg of bread subsidy or 20-25/70 x 100 = 30 percent.

group is not getting any benefit or subsidy from the government program in the wheat subsector. Thus, this group seems to be the most disadvantaged among Jordan's population with respect to the wheat subsidy policy; at the same time, it is recognized that this same group--rural people--is the lowest income group of the population, most of whom exist on a subsistence level of living.

VIII. ANALYSIS OF JORDAN'S WHEAT SUBSECTOR

1. Subsector Research System

The subsector approach as a conceptual framework for economic research appeared in the late 1960's as a response to ever-increasing interest in studying the U.S. food and fiber sector (21). In 1968, James Shaffer suggested that the food and fiber sector be partitioned into meaningful subsectors for analysis, in order to provide manageable units for observation and still permit consideration of the vertical relationships that were essential in evaluating coordination and performance of each subsector (12). A subsector is defined as "the vertical set of economic activities in the production and distribution of a closely-related set of commodities" (36). Another definition is "a meaningful grouping of economic activities related vertically and horizontally by market relationships" (37). For purposes of identification and analysis, the subsector is assumed to have specific economic activities within its boundaries.

The bounds of the subsector are narrower than those of a sector since they deal only with one commodity such as wheat. The boundary is also more inclusive because the wheat subsector includes wheat production (agriculture), wheat milling and baking (manufacturing), wheat policy (government), wheat input supply (wholesale-retail) and wheat agribusinesses such as custom tillage and spraying (services). The bounds of the subsector are much broader than those of a conventional industry. While industry includes a set of horizontal activities, the subsector consists of all vertical components such as factor markets, product markets, distributive trades and services, and households (21). In effect, this subsector research system resembles the Harvard Business School's commodity system approach. Ray Goldberg developed this approach called an agribusiness commodity system, which encompasses all the participants involved in the production, processing, and marketing of a single farm product. Such a system includes the farm suppliers, farmers, storage operators, processors, wholesalers, and retailers involved in a commodity, from initial inputs to the final consumers. It also includes all the institutions which affect and coordinate the successive stages of a commodity flow such as the government, future markets, and trade associations (15).

According to Shaffer, the uniqueness of subsector studies is not in methodology or approach but in the scope and comprehensiveness of the research. Thus, it is more of a departure in research organization than a departure from traditional approaches of agricultural economics research (38).

2. Jordan's Wheat Subsector

Why was the subsector research system adopted for Jordan wheat study? The primary objective of this thesis was to investigate the performance and coordination of a set of activities used to provide bread to Jordanians. The purpose of the description and analysis of the wheat-bread subsector of Jordan was to identify the most strategic points at which planners might try to invest, change inhibiting institutions, educate, or develop technology to improve the performance. The resources and time available required some delimiting and selecting within the wheat subsector. The most of the effort was focused on the problem of low wheat yield in Jordan rainfed areas. More specifically, the goals of this study were to provide an understanding of the problem of improved inputs adoption, to identify major obstacles which Jordanian dryland farmers face, and to suggest strategic solutions to remove these barriers and improve the performance of dryland wheat producers. To achieve these goals, it is believed that there are greater interdependencies and linkages between the wheat subsector activities. For example, wheat farmers' decisions to apply certain inputs--i.e., chemical spraying, fertilizers, etc.--depend on the availability of these materials from the agribusiness farm suppliers at the right time and at prices that farmers are able and willing to afford. Improved inputs adoption would require a study of farmers' knowledge and expectations of these improved inputs and incentives to use them. Such efforts call for an investigation of public policy in national wheat production to study how much the government is willing to invest in this wheat production by providing subsidized inputs, extension services, and conducting research to improve dryland productivity. The marketing structure of wheat is closely interconnected with wheat production. If farmers who improve their dryland wheat farming practices are faced with depressed market prices for wheat because of inefficiency in the marketing structure, a bottleneck in supply may appear, leading to a low-offering price to farmers for their wheat at the harvest time. These problems in the system may include storage facilities, transportation systems, and the small number of wholesale wheat merchants. Thus, wheat farmers may be discouraged from using modern practices, for example, new varieties, chemical spraying, etc., which usually costs more than their traditional practices. Hence, market demand for wheat, storage, and transportation facilities all affect the farmer's economic decision to improve his cultural practices. Finally, the wheat processing and bread making industries undoubtedly affect the wheat marketing structure since most of Jordan's wheat is intended for human bread consumption. The economic efficiency of the milling and bread making operation must be studied, due to their interconnectedness with wheat marketing activities. To sum up, a comprehensive study of the total wheat commodity system was needed in order to study the problem of low wheat yield and the adoption of improved inputs. This comprehensive information was best realized and approached through subsector system research.

a. Definition and identification of Jordan's wheat subsector

Jordan's wheat subsector is defined to include the vertical set of economic activities represented in the production of wheat, marketing, milling, bread making, and retail selling to Jordanian households. The wheat subsector of Jordan also includes external wheat activities, imports, foreign donations, and export of wheat. To analyze the problems of Jordan's wheat production, a brief view of the total agriculture sector of Jordan is provided.

Jordanian agriculture--food and fiber--sector is the basis of the country's economy and the main source of livelihood for about three-fourths of the population, excluding refugees. Jordan's agriculture contributes about 20 percent of the gross domestic product (20). The country's agricultural production is normally not sufficient to feed Jordan's growing population; thus, imports, mainly cereals and meats, are required most years. The principal domestic crops are wheat, barley, and lentils. The supply of fruits and vegetables is in far better agricultural condition than that of cereal production. Most vegetables and fruits are grown in the Jordan Valley under irrigation conditions and in higher rainfall areas, mostly in the northern hills of Jordan. Wheat occupies an important position in the agricultural sector, as over half of the arable area is planted in wheat and barley (5). In 1965, agricultural land was broken down into the following categories:

Field crops: wheat, barley, and lentils	52%
Vegetables: tomatoes, eggplants, etc.	5%
Fruits: grapes, olives, figs, etc.	10%
Fallow land	24%
Uncultivated area	9%
Total	100%

While vegetable and fruit production has shown remarkable progress over the past decade, wheat yield seems to be stagnant. Many writings have indicated that there is a strong possibility for increasing wheat yield through the adoption of better dryland farming practices (5, 23). To understand the possibility of improvement in Jordan's wheat production, a field survey of farmers was conducted to study and investigate their current cultural practices and to measure the adoption rate of improved inputs. The study[1] found that most wheat is produced by traditional methods, chiefly by hand broadcasting unimproved local seeds and minimum tillage operation. The adoption rates of improved input, as reported in Table 8.1, were low. It is evident from Table 8.1 that the majority of farmers are not yet adopters of improved inputs, especially in the areas of graindrilling, proper seedbed tillage preparation, summer fallowing, and the application of genetically improved wheat varieties. While spraying and fertilizing exist on a small scale in higher rainfall belts III and IV, while in Belts I and II purely traditional cultural practices dominate.

3. Obstacles to Improved Inputs Adoption

Subsector objectives are viewed to identify barriers to improved performance and problems of participants and to attempt to identify the means for removing these barriers or solving the

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[1]For more details, see Findings, Chapters IV and V.

Table 8.1. Adoption rate of improved inputs distributed by rain belts

Improved inputs	Belt I	Belt II	Belt III	Belt IV	All belts
Proper tillage practices	0	0	0	0	0
Improved seeds					
a. Genetically improved	0	0	0	0	0
b. Cleaned and treated local seeds	0	67.14%	75.71%	100.00%	65.0%
Use of graindrills	0	0	4.29%	0	1.5%
Chemical fertilizing	0	0	14.29%	43.33%	11.5%
Chemical spraying	0	0	25.71%	53.33%	17.0%
Clean summer fallowing	0	0	5.71%	3.33%	2.5%

perceived problem (38). Throughout the surveys conducted with Jordanian wheat subsector participants, the following obstacles which depress the wheat yield and the adoption of improved inputs were classified.

a. Availability of agricultural materials and services

There is a basic assumption that in order to have successful programs for encouraging traditional farmers to adopt improved inputs, "the new technology," these inputs must be made available in the village markets and rural cities at acceptable prices and easy terms of payment to wheat farmers. The case in Jordan's dryland areas is not as desired with respect to the availability of these inputs. Although the Jordanian government launched wheat demonstration programs eight years ago to show and demonstrate to wheat farmers the effectiveness of applying proper tillages, chemical spraying to control weeds, graindrilling, and fertilization, we find that farmers who have been given incentives and have learned about some of these practices are unable to use them for many reasons. One major reason is the inavailability of some of these inputs in the village, with the most obvious lacks in availability of chemical spraying and seed drilling agribusiness custom operators.

Chemical spraying custom services was observed to be one of the services most demanded by wheat farmers, especially in higher rainfall areas (Belt III and Belt IV). Farmers appreciate the value of chemical spraying after being shown a tangible expression of the new production function in readily comparable circumstances after weeds were controlled by chemical spraying (43). Farmers surveyed indicated willingness and desire to spray were these services to exist in the area. From the agribusiness field survey in the Irbid region, it was found that very few custom sprayers are operating. The lack of custom graindrilling services can be cited as another example of the inavailability of recommended improved practices, with field surveys showing only one graindrill belonging to an agricultural cooperative, for which member farmers have to wait several days to use.

Many farmers expressed the wish to use the graindrill, as they are facing increasing difficulty in hiring broadcast seeding men. Proper tillage equipment is also lacking, and the poor tillage work done results mostly from the inappropriate implements used.

b. Financial capacity of wheat farmers

It has been suggested that adoption by an individual farmer is dependent on the satisfaction of four conditions, covering the inherent profitability of the innovation, the awareness, the risk aversion, and the financial capacity of the farmer (43). Many farmers may be completely denied access to an innovation because of their financial situation. That is, in order to adopt any improved input available, farmers are expected to be financially capable of purchasing it. The economic conditions of Jordanian farmers were clearly observed through the field survey. Their type of living, clothing, housing, and diet--all these basic elements--indicated that most of Jordan's dryland farmers live on a very low subsistence level. Similar observations were cited in most rainfed agriculture areas in the Middle East and North Africa. Millions of farmers in these areas, whose main crops are usually wheat and barley, are today barely making a living at the subsistence level (2). These farmers are financially incapable of allocating some of their very limited resources to buy modern inputs. A study by the Dryland Farming Project by FAO conducted in Jordan revealed that the average dryland farm family income is estimated at 233.43 J.D., and the average per capita income is 34.83 J.D. or 100 dollars (25). With this drastically low level of income prevailing in rural Jordan, it seems that one of the barriers to adoption is in farmers' poverty. This may mean that in order to improve the productivity of Jordan dryland agriculture, public investment will have to become a required policy. Several forms of government aid to the agricultural sector are cited in agricultural development literature. Direct subsidy for the purchase of input can be used as selected strategy to promote the introduction of particular recommended inputs (19). According to experiences in Tunisia and other rainfed areas, the main requirements for reaching those subsistence farmers are through providing adequate supplies of fertilizers to farmers at low prices relative to cereal prices to encourage its use (18). An alternative strategy to enable farmers to purchase nontraditional inputs is through artificially raising farm product prices (44).

c. <u>Low economic return from wheat production</u>

This is due to: (i) Jordanian farmers seem to have low expectations of their farm productivity. This image indeed represents an added factor in keeping the traditional practices more persistent. It was observed that many farmers spend most of their day idly sitting in the sun with their neighbors, as their farms sit full of stones and weeds which could be removed if the farmers were to utilize their own time in labor. It was also observed that all the land was poorly tilled; land including that owned by farmers who have tractors and expected to do better jobs than the custom agribusiness operators.

(ii) A second reason for low economic return is the low price of wheat and relatively high cost of inputs. Wheat prices in Jordan are generally low and have been indirectly controlled by government programs in order to keep the price of bread at its old low level. At a price of 55-60 J.D./ton of wheat, farmers are not encouraged to purchase improved inputs. For example, it is estimated that adding 10 kg of compound fertilizer will cost farmers 1,250 J.D. With an expected increase in yield of 25 percent, this would mean--under the current price of wheat and fertilizer--that his marginal return is about 1 J.D./dunum (25/100 x 70 = 17.5 kg/du increase in yield and 17.5 x 55 = .963 J.D.) while the marginal cost is higher, estimated at 1.250 J.D./dunum. Hence, under current arrangements, farmers are discouraged from using chemical fertilizer.

Furthermore, with the low economic return from wheat, relative to other crops, farmers are encouraged to transfer the use of their land resources into higher return crops. Olive trees, vegetables, and summer cropping are among those which bring higher economic returns. For example, farmers in Belts III and IV stated that under no conditions would they practice summer fallow if they could grow summer crops instead. Summer cropping brings 6-8 J.D. net return to farmers, while summer fallow may increase yield by 30 percent, only amounting to an increase of 40 kg of wheat in Belts III and IV and bringing a total return of 2.20 J.D. (40 x 55 fils/kg).

d. Small landholdings, fragmentation, and oddly shaped land

The great majority of wheat farmers own small plots of land. Over 70 percent of the surveyed farmers in Belts III and IV own less than 300 dunums (or 30 hectares). In addition to these small landholdings, a fragmentation problem exists very widely for less than 10 percent of the Irbid farmers own their land in one consolidated location. Undoubtedly, inheritance laws have led to this considerable fragmentation problem, and there is a need to make land consolidation mandatory to stop fragmentation. Furthermore, it has been realized that the problem of oddly shaped landholdings is very prevalent in belts with more rainfall. This peculiar shape of long and narrow strips imposes a critical obstacle to the adoption of improved inputs such as machinery operation in tillage, spraying, and graindrilling.

4. Suggested Strategies to Improve Performance of Jordan Wheat Subsector

From the above analysis of the obstacles to improved input adoption, we may conclude that poverty may place farmers in a vicious circle, and it is believed without government planned assistance, they will not be able to break this circle. Hence, the government's role is needed to increase the wheat yield and improve farmers' economic condition. It is believed that the Jordanian government's national wheat policy must include the following specific strategies.

a. Wheat price incentive

Grain prices should be favorable relative to prices of competing crops and commodities (18). The survey of wheat farmers indicated that farmers respond positively to a wheat price increase. Farmers indicated desire and willingness to produce more through both vertical and horizontal expansion. There is strong evidence that people in underdeveloped countries respond in the expected way to price incentives (32). Since the supported price of wheat is set up by the government, the question which arises is what the price of wheat should be in order to increase wheat production. It is argued that marketing is strategically situated to serve as a "leading sector" in development, that the demand for marketing possesses potentially significant influence on the development of the primary agriculture sector (10). The most obvious connection between marketing and production is the purposeful use of price incentives to stimulate output.

However, the important point of incentive prices is not that intervention distorts prices from their equilibrium levels; rather it is how to distort the wheat price system wisely for the stimulation of production. This leads to the evaluation of another stage of the set of economic activities of the Jordan wheat subsector, namely the role of agribusiness in wheat marketing. It is realized that Jordan's private wheat marketing system has suffered great setbacks from direct government intervention and control of all the wheat sold to major commercial milling companies. Consequently, the size of wheat trade in the terminal and rural city markets has deteriorated, and many grain wholesalers have been forced to change to or add other lines of business. Furthermore, the wheat marketing survey showed that most of the wheat sold in the wheat market goes to feeding poultry. This in effect has had great impact on the marketing of wheat, the current operation of the wheat subsector and the responsibility of the Jordanian government in closing the gap between the annual local supply of wheat available for human consumption and the total requirement of wheat.

As a greater proportion of local wheat is sold to poultry farms, due to its relative cheapness with other feeds, more shortages of wheat occur and more financial trouble falls on the shoulders of government to increase its wheat imports. Undoubtedly, there is a need for reconsideration of Jordan's government price support program and direct intervention in the wheat market. The government of Jordan's main concern about its intervention in the wheat subsector is to guarantee a sufficient flow of wheat to Jordan's mills to avoid any shortages of bread for Jordanian households and to keep the price of bread at its low level of 50 fils/kg. Thus, in formulating wheat price incentive policies, a source of conflict must be solved: the balance between incentive prices to producers and low food costs for urban consumers. The government subsidy for each ton of wheat bought from the local market is estimated at 22 J.D. (55 purchase price from farmers--33 sale price to commercial millers). For wheat imported from foreign sources, the subsidy varies with each shipment, depending on the overseas price of wheat for each shipment. However, in many instances, the total subsidy far exceeds the cost of locally purchased wheat. Determining the price incentive level requires deeper studies of the supply response of wheat farmers to different levels of incentives and also of the Jordan's national goals toward self-sufficiency in wheat. If in order to attain this goal, Jordan must allocate more of its domestic resources than would be required to purchase all or part of its wheat requirement on the world market, then the goal of self-sufficiency is not economically efficient (16). Some economists suggest that a self-sufficiency policy should not be defined rigorously to mean no import at all. Because of the great fluctuations for rainfed wheat and the relative high cost of storage from good years to bad years, it may often be the most economic solution to aim at an average 90 percent self-sufficiency and to import significant quantities in serious drought years (2).

Whatever the level of price incentives and the target of self-sufficiency selected by Jordanian policy makers, the government price incentive must be implemented within the private market structure. This requires conducting planned strategy to encourage farmers to respond to increases in market prices of wheat, and the government--through proper mechanisms--to subsidize the wheat sold to millers to guarantee the low price of bread. Past experience of the Jordanian government indicated that direct purchase from farmers at price support was not successful, since most of the wheat collected was from the wheat merchants in Amman and Irbid and not from farmers. This emphasizes the fact that the link between production and marketing is strong and wheat merchants are efficient in maintaining a smooth flow of wheat from the farm to the market.

b. Provision of agribusiness
services and inputs at subsidized price

A policy of subsidizing inputs might be more effective as a stimulus for the adoption of modern farming techniques than a policy of subsidizing output. Here, the advantage of subsidizing purchaseable inputs such as fertilizers and pesticides is that the cost of the subsidy program is related to the utilization of practices that increase productivity. Higher wheat prices add to the income of both innovators and noninnovators, while lower input prices reward only the cultivators who adopt new techniques. However, the way the government should execute its input subsidy program is of significant value to the whole wheat subsector of Jordan. As discussed in Chapter VI, the Role of Agribusiness in Wheat Production, direct government subsidy may drive private agribusinesses out of business and does not increase the efficiency of the adoption program. It is desirable for the private sector to provide agribusiness services, as it would reduce the financial and manpower burden on a government already facing the problem of scarce resources, particularly those of managerial talents. Reliance on the private sector provides the benefits of competition and avoids excessive dependence upon a single source of supplies. It will thus attain flexibility and quick decision making in importing and selling needed agricultural materials. As indicated in Chapter VI, private agribusiness is willing to cooperate with the government, provided the government forms a balanced strategy by inviting private business to participate. A simple procedure can be arranged between government and agribusiness, the government subsidizing the input sold by the agribusiness.

c. Agricultural research of problem solving nature

One of the most important roles the government can play is to provide those services and inputs which the private agribusiness is unable to provide. Most important of these is agricultural research and development. For the past eight years, research underway to improve wheat production has been underway mainly through conducting agricultural demonstrations. However, more specific research is needed to aid Jordanian farmers to overcome the problems they face.

For example, a number of farmers have adopted good technical practices, but research is needed to determine the most profitable level of adoption for each different physical situation and product-price and input-cost relationship (4). For example, one of the institutional obstacles mentioned above is the peculiarity of the shape of landholdings which inhibit adoption of any kinds of improved inputs. Certainly, the government can solve this problem, as well as the problem of land fragmentation by making land consolidation mandatory.

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XI. APPENDIX A: LIST OF NAMES OF VILLAGES UNDER INVESTIGATION

No. of village	Name of village	Total land area in dunums	Average annual rainfall level in mm per year
1	Um El-Jimal	37,906	Less than 250 mm
2	Hausha	38,449	Less than 250 mm
3	Sorrah	42,729	Less than 250 mm
4-7	Ramtha	160,074	250-300 (Ramtha is taken to represent 4 villages)
8	Hamama	9,063	250-300
9	Rihab	22,019	250-300
10	Khanasry	15,273	250-300
11	Burma	34,289	300-400 mm
12	Kafkafa	26,493	300-400 mm
13	Et Turra	27,906	300-400 mm
14	Howarah	17,423	300-400 mm
15	El Mughaiyir	15,027	300-400 mm
16	Neumeh	5,919	300-400 mm
17	Jarash	14,282	300-400 mm
18	Aidun	14,528	Above 400 mm
19	As Sareih	27,454	Above 400 mm
20	Al'al	8,077	Above 400 mm

XII. APPENDIX B: INTERVIEW SCHEDULE FOR WHEAT FARMERS IN IRBID DISTRICT

FIRST: INTRODUCTORY INFORMATION

1. Name of farmer:

2. Name of village:

3. Level of average annual rainfall:

4. Age of farmer:

5. How long have you been a wheat farmer?

6. Educational level of farmer?

7. What is your farm size?

8. What is the status of the location of your land?

9. What is your normal wheat yield per dunum:

   a) in 1974? (which is considered a good year)
   b) in 1973? (which is considered a bad year)
   c) in an average year?

10. Do you belong to a cooperative organization?

    a) If yes, which one and why you obtained its membership?
    b) If no, what are the reasons behind not seeking its membership?

11. What are the services provided to you by your cooperative?

12. What cooperative should do in addition to its existing services, in your opinion, to improve its operation and to help wheat farmers like yourself?

FIRST: FALLOWING PRACTICES AND CROPPING SEQUENCE

1. How many times have you fallowed your wheat ground in the last six years?

2. What is your typical crop sequence?

3. What do you believe the difference in wheat yield per dunum planted after fallow and after crop as wheat, lentils, or watermelon?

4. What do you estimate it costs to fallow?

5. If you practice continuous cropping, under what conditions would you fallow?

SECOND: BETTER TILLAGE PRACTICES

1. How do you get your land tilled?

2. How many times and when do you till your land to plant wheat (for wheat seedbed preparation)?

3. How many times and when do you till your land when you fallow it before wheat planting season?

4a. What kind of tillage tool is used:

   a) Disc plow
   b) Malboard plow
   c) Disc harrow
   d) Others: Specify ______________________

4b. And how deep do you plow?

5. What is your total cost of tillage for:

   a) wheat planting?
   b) fallowing?

6. Do you believe more or different tillage practices could change your wheat yield?

7. What are the three changes in your tillage which you believe would increase wheat yield most?

8. If you change all these how much more would it cost?

9. If you changed all these, how much do you believe would increase wheat yield?

10. Have you heard of a system of shallow rapid tilling done more frequently that keeps the straw on top of the ground? Yes or no?

11. If your tractor man suggested to use such different system of tillage on your land for the same total cost, would you try it?

12. If someone organized a tillage district and offered to cultivate and plant all the wheat fields together for 25% less cost and charge you your proportionate share. Would you agree?

THIRD: NEW IMPROVED SEEDS

1. Where do you get the wheat seeds you plant and what are the varieties you use:

   a) Horani nawawi
   b) F8
   c) Others: ______________________________

2. How much higher yield do you get if you use cleaned treated and pure seeds?

3. Have you heard of new higher yielding short wheat types which require fertilizer and water but give high yields?

4. If yes, how much do you believe these wheat types may yield more?

5. How much would you pay above the market price for wheat seeds that would yield 20 percent more?

FOURTH: GRAINDRILL

1. How do you sow your wheat seeds?

   a) By handbroadcasting.
   b) By graindrills.

2. Have you heard of graindrills?

3. If yes, do you understand why they are recommended?

4. Do you think a graindrill would be used on your land? If no, why?

5. How much do you think the graindrill:

   a) would cust to use?
   b) would save in seeds?
   c) would increase the yield?

6. If you don't use a graindrill, under what conditions would you be willing to use one?

FIFTH: FERTILIZATION

1. How many times in the last six years have you put fertilizer on your wheat crop?

2. How much of a yield increase do you believe chemical fertilizer could make in your wheat on the average over six years?

3. How much do you think it costs per dunum to buy and apply chemical fertilizer?

4. If you do not use fertilizer, under what conditions would you apply chemical fertilizer?

SIXTH: SPRAYING

1. When do you sow your wheat seeds:

   a) Before rain.
   b) After first rain.
   c) After enough rain to start weeds and can cultivate them.

2. Have you heard of chemicals to spray on standing green wheat to kill the weeds among the wheat plants?

3. Do you think such spraying would increase your wheat yield? If yes, how much?

4. How much do you think it would cost you to spray?

5. If you don't practice spraying, under what conditions would you spray for weeds?

THIRD: EVALUATION OF WHEAT PRODUCTION IMPROVED TECHNIQUES

1. Are you satisfied with your wheat yield?

2. Other than moisture factor, what do you think the most important factor is to increase wheat yield:

   a) Practice better cropping pattern.
   b) Fertilization.
   c) Better tillage practices.
   d) Spraying.
   e) Clean fallowing.
   f) Adopting improved genetically and/or cleaned and treated varieties.

XIII. APPENDIX C: THE WHEAT FARMERS INTERVIEW QUESTIONNAIRE (IN ARABIC)

استمارة اسئلة موجهة
الى
مزارعي القمح في محافظة اربد

اولا : معلومات مبدئية

١ — اسم المزارع : —

٢ — اسم القرية : —

٣ — معدل سقوط الامطار السنوية :

٤ — عمر المزارع :

٥ — كم سنة مضى لك وانت تمارس زراعة القمح :

٦ — هل اتيحت لك فرصة الذهاب الى المدرسة ؟ المستوى التعليمي :

٧ — ما هي مساحة أرضك الزراعية ؟

وهل هي مركزة في مكان واحد أم مبعثرة في أكثر من موقع ؟

٨ — ما هي معدل انتاجية ارضك قمح في سنة جيدة مثل سنة ١٩٧٤ ؟

ما هي معدل انتاجية أرضك قمح في سنة رديئة مثل سنة ١٩٧٣ ؟

ما هي معدل انتاجية ارضك قمح في سنة وسط ؟

٩ — هل انتسبت الى جمعية تعاونية زراعية ؟

اذا نعم — ما هي الخدمات التي تقدمها اليك .

اذا لا — ماهي الاسباب

١٠ — ما هي في رأيك الخدمات الواجب على الجمعية تقديمها بالاضافة الى خدماتها الحالية ؟

ثانيـا : دراسة وسائل مختارة لتنمية انتاجيـة القمـح

الوسيلة الاولى : ممارسة الكراب والدورة الزراعيـة

ملحوظة احصائية : يجب الحصول على معلومات رقمية عن :

١) اثر الكراب على انتاجيـة القمـح
٢) تكاليف ممارسة الكراب من حيث الحراثة
٣) اسعار القمح المتوقع أن يلعب دورا في تغيير الدورة الزراعيـة أو في ممارسـة الكراب ٠

١ ــ كم مرة مارست الكراب خلال الاعوام الستة الماضيـة ؟
مثلا : ولا مره ، مره واحده ، مرتيـن ، ٣ مرات ٠

٢ ــ ما هي الدورة الزراعية العادية التي تتبعها في أرضـك ؟
مثلا: قمح ــ قمح زراعة دائمة ــ أو قمح ــ عدس ــ صيفي أو قمح ــ عدس ــ كراب ٠

٣ ــ ما هي برأيك الفرق في انتاجية القمح الدونم الواحد بين ارض ارتاحت سنة ــ تكريت ــ قبل زراعتها قمح وبين ارض تم زراعتها عدس ــ أو بطيخ أو أى محصول آخر قبل زراعتها قمحا ٠

٤ ــ ما هي تقديراتك لتكاليف ممارسـة الكراب
مثلا : تكاليف الحراثة خلال عام الكراب ٠

٥ ــ اذا كنت تمارس زراعة ارضك سنويا دون ان تريحها ــ تكربها ــ ما هي الشروط التى ممكن ان تدفعك لممارسة الكراب ؟
مثلا ارتفاع سعر القمح ــ اواى عامل آخر.

او اذا كنت تمارس الكراب في ارضك، ما هي الحوافز التى ممكن ان تدفعك لان تزرع ارضك باستمرار ؟

الوسيلة الثانية : ممارسة الحراثه الجيدة
ملحوظة احصائيه : يجب الحصول على معلومات احصائية رقمية عن
(١) تكاليف كل حرثه
(٢) اثر تطوير الحراثة على انتاجية دونم الارض قمحا
(٣) اسعار القمح

١ ــ من يقوم بحراثة ارضك
مثلا : هل تؤجر احد لحراثتها او تحرثها بنفسك ؟

٢ ــ كيف تحضر ارضك لموسم زراعة .... القمح .
مثلا : كم عدد المرات التى تحرث ارضك ومتى تحرثها لتحضيرها لزراعة القمح
مثلا من شهر عشره لغاية شهر ٢ او وقت البذار.

٣ ــ ما هي نوع الالات التى تستعملها في الحراثة

٤ ـ ما هي تكاليف الحراثه الكلية الكلية لزراعة القمح

٥ ـ هل تعتقد تغيير طريقة الحراثه او عدد الحرثات ممكن ان يفيد انتاجية الارض قمحا .

٦ ـ اذا نعم ، ما هي برايك ٣ تغييرات في طريقة الحراثة تعتقد قادرة على زيادة انتاجية القمح باكبر كمية ممكنة .

٧ ـ ما هي التكاليف الاضافية المترتبة على ممارسة هذه التغييرات الثلاث .

٨ ـ ما هي الزيادة المتوقعة في انتاجية القمح نتيجة قيامك بهذه التغييرات الثلاث ؟

٩ ـ هل سمعت بطريقة الحراثة السريعة على عمق بسيط ومتكرر ويحفظ القش (العقير) على سطح الارض ؟

١٠ ـ اذا اقترح الحراث (الذى يحرث لك الارض بالاجرة) ان يقوم بحراثة أرضك بهذه الطريقة هل تقبل أن تجربها بنفس الاجرة ؟

١١ ـ اذا قام أحد الاشخاص بتنظيم حراثة ارض القرية ـ أو منطقة كاملة وعرض عليك أن يقوم بحراثة المنطقة وزراعتها بشكل جماعي وأن يخفض أجرة الحراثة والزراعة بـ ٢٥ ٪ هل توافق على هذا الاقتراح ؟

الوسيلة الثالثة : البذار المحسنة

١ ــ ما هي انواع البذار التي تستعملها في أرضك ومن أين تحصل عليها ؟

٢ ــ ما هي الزيادة في انتاجية الدونم قمحا اذا استعملت البذار النظيفة المعقمة بالمحسنة .

٣ ــ هل سمعت في أنواع من البذار قصيرة القصبة ذات انتاجية عالية ولكن تتطلب كمية من السماد والرطوبة .

٤ ــ اذا الجواب نعم ،كم تعتقد كمية الزيادة في الانتاجية متوقع استعمالها (هذه البذار) .

٥ ــ كم ترغب في دفع زيادة اثمان بذار تدر لك عائد في الانتاج يزيد ٢٠ ٪ عن البذار التي تستعملها ؟

الوسيلة الرابعة : استعمال البذارة :

ملحوظة احصائية : حاول الحصول على معلومات رقمية

١) تكاليف استعمال البذارة لدونم واحد .

٢) وفورات البذار للدونم ناتج عن استعمال البذار

٣) الزيادة المتوقعة في انتاجية الدونم نتيجة لاستعمال البذارة

٤) اسعار القمح المطلوبة لاستعمال البذارة .

١ ــ كيف تقوم برش بذار القمح في حقلك .

مثلا : أ) هل باليد أم بالبذارة ؟

٢ ـ اذا ترش باليد ، هل سمعت بالبذارة ؟

٣ ـ اذا سمعت بالبذارة ، هل تعرف لماذا يوصون باستعمالها ؟

٤ ـ هل تعتقد أن البذارة يمكن استعمالها في أرضـك ؟
اذا الجواب لا : لماذا ؟

٥ ـ كم تعتقد البذارة تكلف لاستعمالها للدونم الواحد ؟

كم تعتقد البذارة توفر لاستعمالها للدونم الواحد ؟

كم تعتقد البذارة ترفع انتاجية الارض من القمـح ؟

٦ ـ اذا لا تستعمل البذارة ، ما هي الشروط التي تدفعك لاستعمالها ؟
مثلا : ما هي التكاليف او الوفورات التي ترغب أن تحققها لك البذارة لترغبك في استعمالها •
مثلا : اذا كانت تكاليفها اقل من تكاليف الرش باليد أو
وكانت تكاليفها عائدة اعلى .... أو
أو اذا ارتفعت اسعار القمح الى حد معيـــن ؟

الوسيلة الخامسة : ممارسة تسميد الارض
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ملحوظة احصائية : احصل على معلومات رقميه حول :

(١) اثر السماد على انتاجية الارض
(٢) تكاليف السماد للدونم الواحد
(٣) سعر القمح المراد تحقيقه لاستعمال السماد

١ــ ما هي عدد المرات التي سمدت ارضك بها خلال الـ ٦ اعوام الماضية سواء سماد عضوى (زبل) او سماد كيماوى .

٢ــ ما هي معدل الزيادة المتوقعة تحقيقها نتيجة استعمال السماد الكيماوى في المتوسط من ٦ اعوام .

٣ ــ ما هي التكاليف المتوقعة لشراء واستعمال السماد الكيماوى للدونم الواحد ؟

٤ ــ اذا كنت لا تستعمل السماد الكيماوى
ما هي الشروط او الحوافز التي تشجعك استعمال السماد الكيماوى
مثلا : انخفاض اثمانها
ارتفاع اثرها على الانتاج
ارتفاع اسعار القمح

الوسيلة السادسة : ممارسة رش الاعشاب الضارة
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ملحوظة احصائية : احصل على معلومات رقمية عن

١) تكاليف رش الدونم بمبيدات الاعشاب
٢) اثر الرش على انتاجية الارض بالقمح
٣) سعر القمح المتوقع أن يلعب دورا في ممارسة الرش

١ ــ متى تقوم برش ارضك في بذار القمح

مثلا : ١) قبل أول مطـــره

٢) بعد أول مطـــره

٣) بعد سقوط امطار كافية تسمح لنمو الاعشاب وبعدئذ يقوم بحراثتهـــــــا لقطع الاعشاب وبعد ذلك رشها بالبذار .

٢ ــ هل سمعت في مبيد الاعشاب الكيماوية التي ترش على نبتة القمح وتستطيـــع قتل هذه الاعشـــاب الضـــارة .

٣ ــ هل تعتقد أن رش مبيدات الاعشاب سيزيد من انتاجية الارض للقمح ؟

اذا الجواب نعم : ما هي الزيادة المتوقعة بالنسبة المئوية .

٤ ــ ما هي برأيك تكاليف رش مبيد الاعشاب للدونم الواحـــد .

• ــ اذا لا تمارس الرش حاليا ، تحت اى دوافع وظروف تجعلك ترغب برش الاعشاب بمبيدات الاعشاب.

مثلا ، اذا ارتفع سعر القمح .....

او اذا ادى الرش الى زيادة انتاجية الدونم كذا ....

ثالثـــا : تقييم شامل لوسائل الانتاج المختارة الحديثة .

١ــ هل انت مقتنع بانتاجية ارضك من القمح حاليا ؟

٢ــ الى جانب عامل الرطوبة ، ما هو برايك اهم عامل ــ عوامل ــ لرفع انتاجية القمح

(١) ممارسة الحراثة الجيدة

(٢) ممارسة التسميد

(٣) ممارسة دورة زراعية جيدة

(٤) ممارسة الرش للاعشاب الضاره