The Dryland Subsector of Jordanian Agriculture: A Review

Agriculture Division
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THE DRYLAND SUBSECTOR: OUTLINE

THE DRYLAND SUBSECTOR OF JORDANIAN AGRICULTURE: A REVIEW

A. Forward

The purpose of this paper is to lay the foundation for the assistance activities comtemplated by AID for Jordan's dryland agricultural subsector. Its specific objective is to present a description and analysis of that portion of Jordanian agriculture which is rainfed and for which rainfall is the major determinant of productivity.

A gross overview of the entire agriculture sector was presented as Annex B, "Agricultural Sector Statement,"[1] in the FY 75 "Development Assistance Program - Jordan." As an overview, the Statement remains valid despite the two-year interval since its drafting; that is, the values of the variables have changed, but the underlying structure has not. What is required for the present purpose is more detail, both descriptive and analytical, which provides rationale for an assistance strategy and for specific assistance activities.

This detail is presented in the five sections which follow:

B. The Dryland Subsector: Structure and Performance in Brief

C. Physical/Climatological Setting

D. Biological Setting

E. Economic Setting

F. Development Activities in the Dryland Subsector

G. USAID Strategy

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[1] Copies available in USAID/Jordan and AID/W

The context for these sections is the development policy and programs which the Jordanians have been pursuing, with donor assistance, since the late 1960's.

In this effort the commodity of major interest was, and continues to be, wheat. Area, production, and income considerations are such that wheat demands the bulk of attention, and the paucity of information, published or otherwise, on the other annual crops produced in the dryland areas forces an unfortunate bias toward wheat in this paper.

The bias is unfortunate because it draws attention away from the "systems" aspect of dryland farming--of which wheat is only one element or implies only one set of elements. An assistance strategy for the dryland subsector requires that attention be given to all commodities and all resources, the relationships (competitive and otherwise) among them, and the environment within which farmers' decisions and actions are taken.

Moreover, it requires that the subsector analysis be a continuing process. This paper is, at best, a first step in an ongoing analytical program which, if accepted, will form an integral part of U.S. assistance to Jordanian agriculture.

Some limitations must be set on the scope of the paper. Rainfed vegetables, perennial crops, and livestock are essentially ignored. Perennial crops--fruits other than citrus, olives, and nuts--are produced in hilly areas in which annual crops offer only minor competition. A Ministry of Agriculture

project, supported by the World Food Program, is providing incentives for terracing and the planting of approximately 3,000 ha. per year to olives and grapes.

Except for a productive and expanding poultry industry, livestock production in Jordan remains very much a traditional sheep and goat grazing activity. There is some feeding of dairy cattle, but most cows are carried, as are most sheep and goats, as scavengers along roadsides and among crop residues for indifferent quality forages.

Attempts are underway to institute intensive dairy and sheep fattening schemes using domestic forages and imported and domestic feed grains. Current international prices for feed grain, domestic prices for livestock, and typical feed conversion rates suggest that these schemes are unprofitable. To the extent that feed grains can effectively compete with other crops for resources, it would probably be more economical to export them than to use them as feed in Jordan.

Current programs in range-livestock development and in veterinary medicine are being assisted by FAO and the Federal Republic of Germany.

Obviously, the integration of livestock with annual crop production on a significant commercial scale is both desirable and predictable. The priority need now, however, is to concentrate

on increasing productivity in crops as part of the economic base for such integration.

3. Introduction

1. Production

Jordan's agriculture sector has been estimated to provide about 12 percent of the country's total gross domestic product which averaged JD 244 million[2,3] over the period 1973-75 (East Bank only). Although value added in agriculture is projected to grow at the rate of 7 percent annually during the 1976-80 plan period, faster growth rates in other sectors are expected to reduce agriculture's share of GDP during that period to about 9 percent.[4]

Within agriculture the percentage contribution by water regime and produce group is estimated as shown in Table 1. Dryland wheat and other field crops (largely barley, pulses, and industrial crops), the commodity groups of interest here, are thus estimated to provide 23 percent of agriculture's share and 40 percent of that from the dryland areas.

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2 JD 1.000 = U.S. $3.03

3 From HKJ, National Planning Council, Five Year Plan for Economic and Social Development, 1976-1980.

4 Five Year Plan

Table 1 - Estimated Percent Contribution to Total Agriculture GNP in East Jordan

Product Group	Irrigated Agriculture Including Jordan Valley[a]	Rainfed Farming and Range	Total
Wheat	2	18	20
Other Field Crops	5	5	10
Vegetables and Fruits	32	8	40
Livestock Including Poultry	3	27	30
Total	42	58	100

[a] There are about 115 thousand dunums irrigated in the Jordan Valley. The "Jordan Valley Development Plan" projects this to increase to about 206 thousand in 1977 and 360 thousand in 1982. In addition there are 45-50 thousand dunums irrigated in the uplands. The dunum is 0.1 hectare.

Source: FAO. Report of FAO/UNDP Programming Mission to Jordan. FAO Sector Programming Mission Series No. 6. June 1975.

Area, yield, and production of principal dryland field crops in recentyears are shown in Table 2, below. The principal

Table 2 - Area, Yield and Production of Wheat, Barley, Chick Peas and Lentils in Jordan, excluding Jordan Valley. 1970-1975.

Item	Harvest Year 1970	1971	1972	1973	1974	1975
Wheat						
Area, 1000 dunums	2228.4	2393.0	2155.6	2343.1	2354.6	1111.2
Yield, kg/du	24.3	68.0	92.9	17.2	96.4	45.0
Production, 1000 tons	54.1	162.8	200.2	42.0	226.9	42.3
Barley						
Area, 1000 dunums	408.5	524.5	602.5	520.0	622.6	511.6
Yield, kg/du	13.6	49.5	55.8	8.9	59.5	20.2
Production, 1000 tons	5.5	25.9	33.6	4.6	37.1	10.4
Lentils						
Area, 1000 dunums	205.8	205.3	284.0	241.3	215.6	139.8
Yield, kg/du	31.8	101.2	78.7	20.0	145.8	37.2
Production, 1000 tons	6.5	20.8	22.4	4.8	31.4	5.2
Chick Peas						
Area, 1000 dunums	12.3		30.9	72.4	124.9	35.4
Yield, kg/du	22.1	N.R.	63.9	24.7	72.9	26.3
Production, 1000 tons	0.3		2.0	1.8	9.1	0.9

N.R. - Not Reported

Source: HKJ. Department of Statistics. Agriculture Statistical Yearbook and Agriculture Sample Survey. Annual 1970-1974. Data for 1975 from unpublished data of the Department of Statistics.

features of dryland crop production in Jordan--low and highly variable yields--are clearly brought out in these data. Yield risk, associated with great year-to-year variations in rainfall, is argued to result in minimum input farming whose outcome is low yields.

2. Trade

Jordan's negative trade balance in agricultural commodities is a reflection, in percentage terms, of the country's overall trade (Table 3). That is, over the 1970-74 period, the value of imports in both categories, total and agricultural, averaged about 4.5 times the value of exports.

Jordan is deficit in all major agricultural commodities except poultry meat. In wheat the deficit runs to about 150 thousand tons, approximately one-half total consumption requirements including relief donations. Growing imports of feed grain, primarily maize, are required to support a productive and expanding poultry industry.

Table 3 - Commodity Trade, 1970-74: Total, Agricultural, and Selected Agricultural Commodities

Item	Calendar Year 1970	1971	1972	1973	1974	1970-74 Avg.
Total imports, JD 1000	65,882.0	76,627.0	95,310.1	108,247.9	156,507.1	100,514.2
Total exports, JD 1000[a]	12,169.8	11,440.8	17,005.2	18,284.5	49,752.4	21,870.7
Balance	-53,712.2	-65,186.2	-78,304.2	-89.263.4	-106,754.7	-78,644.1
Agricultural Commodities[b]						
Value of imports, JD 1000	23,020.0	25,737.9	33,171.7	37,079.9	49,721.0	33,746.1
Value of exports, JD 1000[a]	5,867.7	5,014.1	6,139.2	6,965.6	13,198.6	7,437.1
Balance	-17,152.3	-20,723.8	-27,032.5	-30,114.1	-36,522.4	-26,309.0
Wheat and Flour in Wheat Equivalent[c]						
Imports, 1000 tons	151.4	130.5	208.9	173.9	132.1	159.4
Exports, 1000 tons[a]	4.2	5.6	9.4	9.4	4.6	6.6
Balance	-147.2	-124.9	-199.5	-164.5	-127.5	-152.8
Barley and Other Feed Grains						
Imports, 1000 tons	34.2	31.2	42.8	50.0	15.6	34.8
Exports, 1000 tons[a]	0.1	0.6	2.5	0	0.2	0.7
Balance	-34.1	-30.6	-40.3	-50.0	-15.4	-34.1

[a] Includes re-exports if any

[b] Includes processed agricultural commodities and products of fisheries

[c] Assumes 72 percent flour extraction rate

Source: Calculated from data in HKJ. Department of Statistics. External Trade Statistics. Annual 1970-1974.

Rough projections (Table 4) indicate that population growth and rising incomes would increase wheat imports by 50 to 75 thousand tons in 1980 if there is no increase in domestic production.

Table 4 - Projected Wheat Imports in 1980 Assuming No Increase in Domestic Production

Year	Population[a]	Disposable Income[b]	Wheat Consumption		Wheat Net Imports	
			e_y=0	e_y=0.16[c]	e_y=0	e_y=0.16
	(1,000,000)	(JD 000,000)	(1000 t)		(1000 t)	
1975	1.90	295	304[d]	304[d]	153[e]	153[e]
1980	2.25	462	360	378	209	227

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[a] East Bank only. Population estimates from Five Year Plan. Implied annual growth rate is 3.5%, 1975-1980.

[b] From projections in Five Year Plan. Computed as current income to private sector less direct taxes and net transfers to government.

[c] Income elasticity estimate from Akram Stetieh and Mohammed A. Smadi, "Wheat in Jordan: Demand and Supply, Estimations and Projections." HKJ. Royal Scientific Society, July 1974.

[d] Estimated for 1975 at 160 kg per person

[e] Average for 1970-74 from Table 3

Concessional imports of wheat (PL 480, UNRWA donations, World Food Program, etc.) averaged about 135 thousand tons annually over the three years 1973-75. C.I.F. prices for imported wheat averaged about JD 65 per ton from 1973 through the second quarter of 1975. Assuming that both concessional imports and import prices remain roughly constant to 1980, the annual foreign exchange cost of commercial wheat imports will rise from JD 1.2 million at present to a projected JD 4.8 or JD 6.0 million in 1980.

Feed grain imports in 1980 were projected through a budgeting exercise which related total feedgrain import requirements to:

1) Red meat, dairy, and poultry production projections of the National Planning Council
2) Livestock and feedgrain prices
3) Feed conversion ratios

The exercise concluded that, with current price ratios between livestock and feed and with reasonably attainable feed conversion ratios, poultry meat and egg production are the only enterprises capable of profitably using feed grains. The implications of the exercise for future imports are summarized in Table 5, below.

Table 5 - Projected Feedgrain Imports in 1980 Assuming No Increase In Domestic Feedgrain Production[a]

	Imports to Meet Projected Feed Requirements			
	Assumption I. NPC[d] livestock production projections realized		Assumption II. Sufficient domestic livestock production to meet NPC demand projection	
Year	All Livestock	Poultry Only[c]	All Livestock	Poultry Only[c]
	(1000 tons)		(1000 tons)	
1975	34.1[b]	34.1[b]	34.1[b]	34.1[b]
1980	433.5	45.7	777.7	86.5
Increase	399.4	11.6	743.6	52.4

[a] 1973-75 average production of barley and maize, including that from Jordan Valley, was 20.7 thousand tons.

[b] 1970-74 net feedgrain imports were 34.1 thousand tons (Table 3)

[c] Does not imply that all of current production and imports are used exclusively for poultry. Does imply that only the production of poultry will expand significantly, and, therefore, all increased imports will be so used.

[d] National Planning Council. Unpublished projections made by Council staff.

Considering the profitability of using feedgrains in future livestock production expansion and assuming no increase in domestic production, annual feedgrain imports are projected to grow to somewhere in the range of 45 to 90 thousand tons by 1980.

Concessional feedgrain imports are small--10 thousand and 25 thousand tons in 1973 and 1974, respectively, being the only such imports between 1969 and 1975. Assuming zero concessional imports and a continuation of the C.I.F. prices averaging JD 51 per metric ton over 1973 through second quarter 1975, the annual foreign exchange costs of feedgrain imports would grow from approximately JD 1.7 million currently to between JD 2.3 and JD 4.6 million in 1980.

3. Employment

Significant changes in Jordan's industrial structure in recent years are reflected in the estimates of the distribution of the labor force[5] among sectors (Table 6). The data indicate a relative decline in direct production activities from 1961 to 1975, with the greatest impact falling on agriculture.

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[5] Where the labor force is defined as those persons in the age category 12 years and older available for employment.

Table 6 - Percent Distribution of Jordan's Labor Force Among Sectors

	Year	
Industry	1961	1975
Agriculture	35	18
Industry	21	19
Services	44	63
Total	100	100

Source: 1976-80 Five Year Plan

Estimates of employment[6], by sector, for 1975 and for 1980 are shown below in Table 7. Although employment and labor force are different concepts, and the estimates for each were derived from different sources[7], the orders of magnitude are essentially the same, and the percentage distributions are roughly consistent.

The data in Tables 6 and 7 project a decline in the rate of relative transfer of employment from agriculture. Table 7, in fact, projects an increase in the absolute numbers

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[6] Employment is defined as the number of persons actually working. Productivity, in this, is ignored so that under-employment is not captured by the data.

[7] See Kelley and Taylt, Appendix I.

Table 7 - Distribution of Employment in Jordan by Sector, 1975 and Projections to 1980

Sector	1975 Numbers (1000 persons)	1975 Percent	1980 Numbers (1000 persons)	1980 Percent
Agriculture	79.8	20.1	97.6	17.1
Industry	70.8	18.0	127.8	22.4
Services	245.4	61.9	345.5	60.6
Total	393.3	100.0	570.9	100.0

Source: William Kelley and Alan Salt, "Manpower Development in the Hashemite Kingdom of Jordan with Special Reference to the Jordan Valley" (Preliminary Draft). Hashemite Kingdom of Jordan, Jordan Valley Commission and U.S. Agency for International Development. March, 1976.

employed in agriculture--from 79 thousand in 1975 to 98 thousand in 1980.

Direct estimates of the fraction of the 79 thousand employed in agriculture which are working in dryland production are not yet available.[3] A rough indication of this, however, may be obtained from employment data for the East Jordan Valley

[3] Data from the 1975 Agricultural Census are not yet published. The Mission has been told, informally, it may have access to the data when tabulated.

for 1973.[9] Survey results showed 15.7 thousand agricultural workers resident in the Valley. The difference, 63.3 thousand, probably overstates the employment in upland agriculture because resident labor is augmented to an unknown extent by seasonal and other short-term labor resident in the uplands. In fact, migration or commuting is two-way, depending on the season, but the net movement appears to be strongly toward the Valley.

The number, 63.3 thousand, is 80 percent of the total employed in agriculture. Admitting this to be an overstatement of the case, the overwhelming proportion, perhaps two-thirds to three-quarters, of those employed in agriculture are in dryland farming.

Open unemployment throughout Jordan is very low due to the country's own rapid growth in recent years and that of other countries in the region. The unemployment rate for 1975 was estimated, nationally, at 2.1 percent.[10] These rates measure only open unemployment. A farm operator is fully employed by definition,

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[9] HKJ, Department of Statistics, "Social and Economic Survey of the East Jordan Valley, 1973," Amman, June 1973.

[10] Kelley and Salt, p. 17

and seasonality, particilarly in dryland farming, results in significant underemployment in this subsector. For example, survey results in the dryland farming area near Kerak showed that the average number of days worked per year per man was 126.[11]

C. Physical/Climatological Setting

Dryland field crop production in Jordan (East Bank only) is generally limited to that area receiving 200 milimeters and more of rain each year and whose topography and soil resources permit reasonably effective tillage. This area is estimated to be about 6.18 million dunums (10 dunums= 1 hectare) of a total East Bank area classified as agricultural land of 8.71 million dunums.[12] Its distribution by average rainfall and topographic categories is shown in Table 8, below.

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[11] Hashemite Kingdom of Jordan, Ministry of Agriculture, "Report on Agricultural Zoning," March 1974

[12] The total area of the East Bank is about 88.80 million dunums. (Total area and that classified as agricultural land are given by the Department of Lands and Surveys.)

Table 4 - Distribution of East Bank Lands Receiving Average Annual Rainfall of 200 Millimeters and Over by Rainfall and Topographic Categories

Rainfall (mm)	Slope Categories 0 - 8%	9 - 25%	Total
		(1000 dunums)	
200-350	2361.7	2283.4	4645.1
350-500	262.9	648.7	911.6
500-600	6.1	619.0	625.1
Total	2630.7	3551.1	6181.8

Source: Report on Agricultural Zoning

Much of the land in the highest rainfall category is in small plots lying in valley bottoms and hillside benches scattered throughout the hilly areas to the east of the Jordan Valley. The two lower rainfall categories occur primarily on extensive level or rolling lands farther east of the hills and to the east of the Dead Sea and Wadi Araba (between the Dead Sea and the Gulf of Aqaba).

Soils throughout the area tend to be heavy clay with good moisture holding capabilities. Many fields are stony, and rocks are sometimes of a size to inhibit the use of light equipment, such as field sprayers.

Another perspective on the extent of the dryland cropping area can be seen from the Ministry of Agriculture's land use capability map (Figure 1) on which the approximate locus of the 200 millimeter isohyet has been drawn. The area given as the total in Table 8 is approximately that on the map indicated as Dry Farming and enclosed within the 200 mm isohyet.

From the table and map the area in Jordan with potential for dryland cropping development is thus seen to be severely limited. Rainfall, the most limiting natural constraint, is highly variable, both spatially and from year to year. On the eastern side of the dryland farming area, toward the desert, the annual average can decline from 500 mm to 300 mm within the space of 10 kilometers.

Annual variation is reflected in the year-to-year changes in average wheat yields shown in Table 2. The extremes for the years shown, occurring in 1973 and 1974, were 18 and 96 kg per dunum, respectively. A gross correlation between rainfall and wheat yields from the check plots (traditional technology) in the demonstrations carried out by the Wheat Project is shown in Figure 2. Although the correlation is by no means perfect, the definite positive relationship between yield and rainfall is clear.

The severe limitation on agricultural land suitable for dryland cropping places a premium on yield increasing

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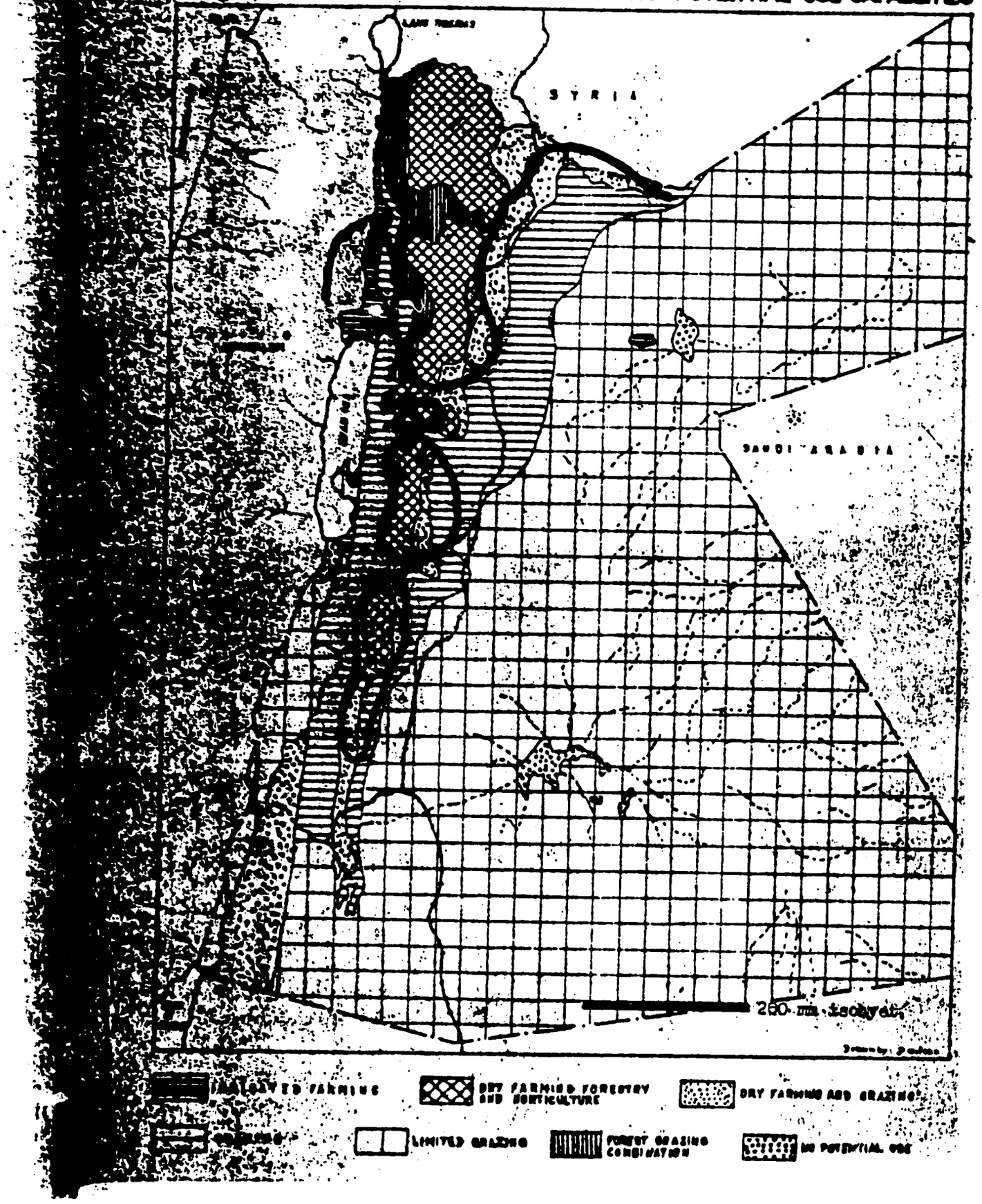
GENERAL MAP OF EASTERN JORDAN SHOWING POTENTIAL USE CAPABILITIES



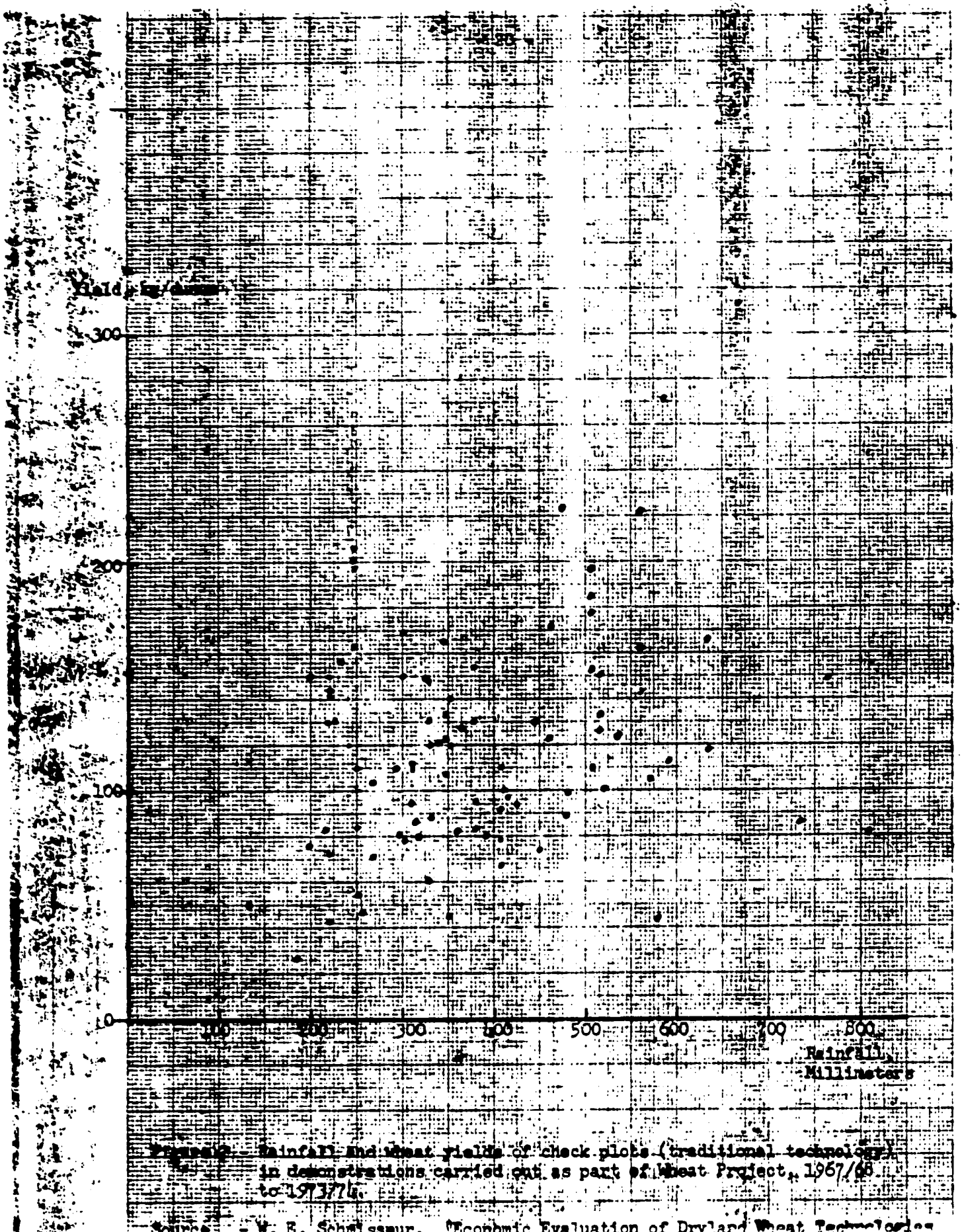


Figure 2. - Rainfall and wheat yields of check plots (traditional technology) in demonstrations carried out as part of Wheat Project, 1967/68 to 1973/74.

Source - W. E. Schmisseur. "Economic Evaluation of Dryland Wheat Technologies

technologies for raising dryland production. Any such efforts must cope directly with the constraint posed by limited and variable winter rainfall.

B. Agronomic Setting[13]

1. Traditional Technology

Dryland farmers in Jordan traditionally attempt to obtain a crop each year. A description of typical cropping patterns and production methods from west to east, i.e., from higher to lower average rainfall, is taken primarily from Nabulsi, et. al.[14]

a. The Upland Area - in excess of 400 mm annual rainfall average. In this high rainfall area there is snow most years. Fields are in general small, stony and irregular in shape making it difficult to use wheat farming machinery. Tillage is minimal, often performed with a small, animal-drawn, steel-tipped wooden plow. There are few surfaced roads to use when moving farm machinery or hauling farm products to market.

Wheat yields are good in those years when only

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[13] Description, here, of production practices is specific to wheat. It applies almost in toto to barley and, in spirit, to all dryland field crops.

[14] A. Nabulsi, A. Abu-Sha'er, Z. Ghosheh, M. Aweida, D. Winters. "A Working Paper for Developing and Increasing Wheat Production in Jordan." HKJ, Ministry of Agriculture, March 1974.

a fair amount of rainfall is recorded. In normal or wet years the soil becomes saturated resulting in a poor crop because of root-rots.

The usual practice in this area is to broadcast about 15 kg of seed wheat per dunum after a good rain (50 mm or more). After broadcasting, the seed is covered with the small plow.

No chemical fertilizers are used. Wheat varieties used are Horani Nawawi and F-8.[15]

Weeding is done mostly by hand, but in a limited way, backpack sprayers are used for chemical control.

The crop rotation usually is wheat followed the next year by legumes or summer vegetables.

b. <u>The Western Plains Area</u>: 300-400 mm annual average rainfall zone.

This area is considered the best for the production of wheat in Jordan. With good soil and relatively reliable rainfall, the western plains area is a more consistent part of the country for good production. Annual average wheat production is estimated to be about 50 thousand metric tons.

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[15] Horani and F-8 are durum varieties used in East Jordan since the 1930's.

Farming is somewhat mechanized, with 70 to 80 percent of the area (600 thousand to 650 thousand dunums) being plowed and harvested with machinery. Tillage is done by tractor-drawn disk plows or mold board plows. Fields are seeded by hand broadcasting. The seed then is covered by a disk harrow to depths varying from zero to 10 cm. Only about 2 percent of the area is seeded by grain drills because these are not readily available to farmers. For the vast majority of farms, machine services are provided by custom operators.

Seed wheat is planted annually at rates between 3 and 15 kg/du. Most of the seed wheat is from the farmers' commercial fields. Wheats used are mostly of the varieties Horani Nawawi and F-8.

Little chemical fertilizer is used. Chemical weed control is just beginning to be used.

c. <u>The Eastern Area</u>: 250-300 mm of average annual rainfall.

The area receiving this amount of rainfall is estimated to total 700 thousand dunums. The land

is suitable for the use of all farm machinery on about 95 percent of the area. The remaining 5 percent is preferred for planting of forest or fruit trees.

The land is prepared for planting by tractor-drawn disk plows. The seed is broadcast by hand on 95 percent of the plantings with grain drills being used on the remaining 5 percent.

The normal seed rate varies between 5 and 7 kg/du of Horani Nawawi or F-8. Most of the seed wheat used is from commercial production. Though wheat dominates throughout the area, barley production becomes significant at lower rainfall.

About 2 percent of the area is fertilized with ammonium sulphate at an average rate of 10 kg/du.

Farmers generally plan on a crop each year, usually waiting for soil moisture to become adequate for seeding. The uncertainty of rainfall creates a decision problem. The point of no return is mid-February. At this time the farmer must decide to plant and hope that later rains will be adequate for a wheat crop, not plant at all and thereby, in effect, fallow for a season, or if

adequate rains follow, plant a summer crop of grain legumes such as lentils, vetches or chick peas.

Chemical control of weeds is limited to about 1 percent[16] of the wheat area because of few available sprayers. Hand weeding is done on a small scale, not exceeding 10 percent of the area. Harvesting is typically by combine.

d. The Desert Area: 200-250 mm of average annual rainfall.

Wheat is still the major crop in this area, but barley is also prominent. The area, because of irregularity of rainfall, produces a wheat crop once every 5 or 10 years.

Most of wheat seed is broadcast by hand on the surface or in the dust. The seed will be planted or covered by tractor carrying disk plows or disk harrows.

The seeding rate is between 4 and 5 kg/du of local varieties, or mixtures of unknown source when bought from farmers on the local markets.

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16 This was described in 1974. Chemical weed control is spreading and the percentage is probably larger today.

Chemical fertilizer and weed control are not used. Hand weeding is not done because of the high cost and scarcity of labor.

Farmers do not follow a rotation program but plant every year. Seeding is done in November. Harvesting is done in June in good years by combine harvesters, by hand with sickles in fair years and grazed by livestock in the poor years.

In summary, the traditional dryland cropping system throughout the East Bank area can be described as one of minimum input: inadequate seedbed preparation; traditional varieties sown without regard for seed placement; little or no chemical fertilizers; chemical weed control at an early stage of adoption; no planned fallow program in the drier regions (less than 300 mm average annual rainfall).

2. "Modern" Technology

In the eight years of the Wheat Project, Ministry of Agriculture technicians and Oregon State University specialists designed and demonstrated a technological package for wheat production which proved itself capable of increasing wheat yields by averages of 40 to 70 percent over traditional methods. The elements of the package were:

a. Tillage. Tillage practices under the Wheat Project were aimed at soil and water conservation and the preparation of a suitable seedbed. In annual

cropping areas fall plowing was followed by harrowing prior to seeding. In the lower rainfall, summer fallowed areas, deep plowing was followed by harrowing to maintain a dust mulch and proper seedbed and rod weeding to keep the fallow ground weed free. Typically, these were one pass with the sweep plow and two or three with the rod weeder. In all cases tillage was done on the contour for soil and water conservation.

b. Seeding. Seeding was done with a grain drill, also on the contour and late in the fall, in order to properly meter, and thereby save, seed and to achieve proper seed placement.

c. Fertilizer. Fertilizer was applied to all demonstration plots in amounts ranging from 1.2 to 6.6 kg/dunum of nitrogen and 1.4 to 4.2 kg/du of P_2O_5, depending on rainfall.

d. Chemical Weed Control. All demonstration plots received 100 grams per dunum of 2-4-D applied in solution with either boom-type or knapsack sprayer.

e. Harvesting was by combine.

3. Comparative Results

Average yields and measures of yield variability

for the demonstration program in three governorates of Jordan over the period 1967/68 - 1973/74[17] are shown in Table 9, below, for both demonstration and check (control) plots.

Average governorate yield differences between demonstration and check plots ranged from 41 to 52 percent in the annual demonstrations and 43 to 68 percent in the fallow demonstrations. Ignoring possible biases due to unreported data, all yield increases had less than a 5 percent probability of being due to chance alone.

Schmisseur points out in his final report[18] that in the annual demonstrations the comparison is not between modern technology and traditional methods since project staff managed both the demonstration and check plots. The difference in treatment between the two was that the demonstration plots received both chemical fertilizer and herbicide, while the check plot received neither. Tillage and the use of the grain drill were the same on each.

In the fallow demonstration program the check plots can be called traditional technology because they were managed by the farmers themselves.

The yield increase in the annual demonstrations can, therefore, be said to be due to the fertilizer/herbicide combination, but in grain-drilled wheat. It says nothing about the impact due to

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17 Data not reported in all years in all governorates

18 W. E. Schmisseur, "An Economic Evaluation of Dryland Wheat Technologies Introduced in Jordan." Oregon State University Contract. AID/sa-C-1024. January 1, 1976.

Table 9 - Average Yields[a] and Yield Variabilities on Demonstration and Check (Control) Plots in the Wheat Project Demonstration Program. 1967/68 - 1973/74.[b]

Governorate	Number of Demonstrations	Mean Yields, $\bar{X}$ (kg/dunum)	Variance, S^2	Relative Variance, $(S/\bar{X})^2$
A. Annual Cropping				
1. Irbid				
Demonstration	29	168	3558	0.126
Check	29	119	1003	0.0708
Percent Increase		41		
2. Amman				
Demonstration	24	218	4550	0.0957
Check	24	143	2774	0.136
Percent Increase		52		
3. Kerak				
Demonstration	17	165	4367	0.160
Check	17	110	2393	0.1978
Percent Increase		50		
B. Summer Fallow				
1. Irbid				
Demonstration	10	137	922	0.0491
Check	10	96	1873	0.203
Percent Increase		43		
2. Amman				
Demonstration	7	196	3316	0.0863
Check	7	129	2199	0.132
Percent Increase		52		
3. Kerak				
Demonstration	6	163	1060	0.0399
Check	6	97	9409	0.1796
Percent Increase		68		

[a] Statistics computed over all plots and years for each governorate from reported data

[b] Data not reported for all years in all governorates.

Source: W.E. Schmisseur, op. cit. (Draft)

tillage or to the grain drill itself. The program gave no information on the effect of fertilizers and herbicides on hand-sown wheat.

A single experiment on the effect of fertilizer on hand-sown wheat was carried out at the University of Jordan's Faculty of Agriculture in 1974/75.[19] Two plots receiving no fertilizer had an average yield of 55 kg per dunum, while four plots receiving 12.5 kg per dunum of each of ammonium sulfate and superphosphate at planting in December had an average yield of 112 kg per dunum. The plots received 347 mm rainfall during the November 1974 to March 1975 season. This is clearly within the annual cropping rainfall zone.

Schmisseur also points out that the difference in yields in the fallow demonstrations is due to more than the physical elements of the new technology. Also important is the difference in management capability between wheat project staff and traditionally oriented farmers.

These differences also show up in yield variability. As measured by the variance, S^2, yield variability is greater in the annual demonstration plots than in the annual check plots. In the fallow demonstration plots, yield variability tends to be less than in the fallow check plots.

When variability is measured relative to average

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19 M. Dwairi, A. Steitieh, A. Beqaa'en. "The Economics of Fertilizer Application on Wheat Under Dry Farming Conditions, a Preliminary Report, 1974/75." University of Jordan, Faculty of Agriculture, Department of Agricultural Economics and Extension, January 1976.

yield, $(S/\bar{X})^2$, that for the demonstration plots was less than that for the check plots on annual cropping demonstrations in two of the three governorates and, to be sure, on all the fallow demonstrations. This suggests that the additional technological inputs may reduce physical yield risks in addition to increasing average yields.

4. Knowledge Gaps

Despite the significant increases in yield associated with additional technological inputs, their adoption rate has been disappointing. Only chemical weed control has achieved any significant adoption by farmers, where Ministry of Agriculture personnel estimate that, for the 1974/75 season 25 percent of the wheat land requiring weed control actually received it.[20] Some increase in the use of cleaned seed, treated for fungus diseases, is reported to have occurred in the Irbid region. The cooperative movement, being promoted in this region within the framework of the UNDP/FAO Project, Integrated Agricultural Development of the Rainfed Areas, is credited with this increase. This suggests that one factor in the slow and fragmented adoption of the package was its complexity. It was presented by the Wheat Project as an integrated whole, and as such it was a great and complex departure from the familiar. Specific diagnoses, relative to its agronomics, are given below.

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20 Norman Goetze and David Moore, "Constraints of Adoption of Improved Wheat Production Practices in Jordan." USAID/OSU Contract AID/sa-C-1024. January 1976. p. 1.

a. Research

Goetze and Moore, in their report reviewing the Wheat Project,[21] point out a number of research gaps in the agronomics of new dryland technologies. These imply a research program aimed at examining the productivity of the components of the technology package and, along with knowledge gaps in the social and economic environment of dryland production,[22] suggest that too little is known to intelligently program large volumes of material resources to this subsector.

They recommend a continued agronomic research commitment in:

(1) Stand Establishment

The need is for a method of seeding which approaches the physical effectiveness of the grain drill without its great investment cost. Specific agronomic questions relate to

(a) effect of soil type on machinery design

(b) seeding rate

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21 Goetze and Moore, op. cit.

22 See section E, The Economic Setting, below.

(c) seeding depth

(d) row spacing

(2) New Varieties. They argue that existing varieties may be a constraint to increased production as other elements of improved technology come into use. They argue that new varieties must be geared to the "technology expected to be in use 5 to 10 years in the future because of the long lead time involved in plant breeding."

As a comment on this, it should be pointed out that forecasting technology in use that far ahead is, itself, a subject for careful analysis. In any case an explicit assumption about predicted technology must be part of the plant breeder's work. Further, it seems unlikely that Jordan has the resources to mount a program of basic variety development. An armchair benefit-cost analysis suggests that testing selection from new varieties developed elsewhere would be more economical.

(3) Cropping Sequence. They argue that too little is known about the spatial distribution of cropping rotations which take maximum advantage of average available rainfall.

Along with research designed to delineate, agronomically, the rainfall zones, a great deal of research is required to design low-cost tillage programs which are soil and, particularly, water conserving.

(4) Fertilization. Ministry of Agriculture scientists have indicated that knowledge of nitrogen fertilizer response is so limited as to inhibit them from making any but the most conservative recommendations. Knowledge of phosphorus response is even more limited.

Goetze and Moore argue that a fertilizer response probably exists, at least in the wetter areas. This is corroborated somewhat by Schmisseur's data for the annual demonstration plots,

discussed above, although there was a confounding of the effect due to fertilizer and that due to chemical weed control. The effect, also, was measured on grain drilled and properly tilled plots. Further confirmation was obtained from the Dumeiri, et. al., experiment on hand-sown plots.

These results are much too limited to justify a fertilizer action program. Goetze and Moore recommend a large number of simple experiments to map, spatially and temporally, the zones of response for nitrogen and phosphorus. Once response zones are known, later experiments can refine the data in terms of response curves.

Knowledge of fertilizer response, particularly on hand-sown cereals, seems extremely important as fertilizer is an input well-suited for small farmer adaptation. It is almost infinitely divisible and requires no more than

seasonal credit for its financing.

(5) Weed Control. Chemical weed control, as pointed out above, is the one element of the technology package gaining farmers' acceptance. Possible reasons are:

(a) its effect is almost immediately apparent;

(b) it is relatively low cost on a custom application basis;

(c) technical expertise is required of the custom operator, rather than the farmer;

(d) like that of the combine harvester, but unlike that of stand establishment, its perceived effect is independent of other agronomic practices.

Goetze and Moore point out that as technology improves, second generation weed problems, involving heavier infestations and new problem species, will emerge. They urge the need to anticipate these problems with research

so that solutions can be "taken off the shelf" when required.

b. Extension

A gap in extension work is also pointed out in the Goetze-Moore report. There was almost no involvement of the regular extension service in the operations of the Wheat Project. As a consequence, extension personnel are not well-acquainted with the technological package; they could not be used to reinforce the initial impact of each demonstration; and they could not play extension's vital role of feeding back farmers' reactions to Project staff.

Thus, extension weaknesses also inhibit the programming of large-scale material assistance to the subsector, and strengthening extension and agronomic research must be early priorities in the subsector's development.

E. Economic Setting

1. Micro-Economic Elements of New Wheat Technologies

Partial budgets, prepared by Schmisseur[23], provide partial answers to the question of the basic profitability of the Wheat Project's package. Tables 10-12 indicate that the adoption of fertilizer and weed control is profitable for farmers in annual cropping zones who are already using tillage and grain drills.

Tables 13-15 are the partial budgets for the adoption of clean fallow, chemical weed control, fertilizers, and grain drills in fallow rotation zones. It is seen from the tables that the technology package is of questionable profitability. In the Irbid Governorate adoption results in a loss on the basis of weighted average yields, and from the yield data for the years reported, the adopting farmer would achieve break-even or better approximately half the time. In the other two governorates, Amman and Kerak, results are somewhat better, but losses would result in one out of every four years.

Although Schmisseur did not have the data, and time does not now permit its collection, budgeting analyses of tillage, grain drill, fertilizer and chemical weed control versus traditional practices in annual cropping zones would probably have yielded

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23 These are from both his draft and final reports, op. cit.

Table 10 - Additional Costs and Returns on Average to Larger Than Average Farms Adopting Fertiliser and Chemical Weed Control. Irbid Governorate. 1975 Prices.

Item	Quantity (per dunum)	Unit Cost or Price JD/Unit	Change in Cost or Return (JD/du)
1. Revenue Increases			
Increased yield	49 kg	0.065	3.185
2. Cost Increases			
Ammonium sulphate	17.5 kg	0.061	1.068
Super phosphate	13.5 kg	0.021	0.284
Herbicide spray	100 gr 2-4-D	-	0.350[a]
Subtotal			1.702
Opportunity Cost, 10%			0.170
Total Cost Increase			1.872
3. Increase in Net Revenue			1.313
4. Break-Even Yield Increase			29 kg/du
5. Percent of Years Break-Even Achieved[b]			100

[a] Custom application and material cost

[b] Based on average yield increase in demonstration plots in all years 1967/68 - 1973/74

Source: Schmisseur draft report, op. cit.

Table 11 - Additional Costs and Returns on Average to Larger than Average Farms Adopting Fertilizer and Chemical Weed Control. Amman Governorate. 1975 prices.

Item	Quantity (per dunum)	Unit Cost or Price JD/Unit	Change in Cost or Return (JD/du)
1. Revenue Increases			
Increased yield	75 kg	0.065	4.875
2. Cost Increases			
Ammonium sulphate	16.0 kg	0.061	0.976
Super phosphate	15.0 kg	0.020	0.300
Herbicide spray	100 gr 2-4-D	-	0.350[a]
Subtotal			1.626
Opportunity Cost 10%			0.163
Total Cost Increase			1.789
3. Increase in Net Revenue			3.086
4. Break-Even Yield Increase			28 kg/du
5. Percent of Years Break-Even Achieved[b]			100

[a] Custom application and material cost

[b] Based on average yield increase in demonstration plots in 5 years 1967/68 - 1970/71, 1973/74

Source: Schmisseur draft report, op. cit.

Table 12 - Additional Costs and Returns on Average to Larger Than Average Farms Adopting Fertiliser and Chemical Weed Control. Kerak Governorate. 1975 prices.

Item	Quantity	Unit Cost or Price	Change in Cost or Return
1. Revenue Increase			
Increased yield	56 kg	0.065	3.640
2. Cost Increases			
Ammonium sulphate	16.5 kg	0.062	1.023
Super phosphate	13.5 kg	0.022	0.297
Herbicide spray	100 gr 2-4-D	-	0.350
Subtotal			1.670
Opportunity cost, 10%			0.167
Total cost increase			1.837
3. Increase in Net Revenue			1.803
4. Break-Even Yield Increase			28 kg/du
5. Percent of Years Break-Even Achieved			100

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[a] Custom application and material cost

[b] Based on average yield increase in demonstration plots in 5 years, 1967/68 - 1970/71, 1973/74

Source: Schmisseur draft report, op. cit.

Table 13 - Additional Costs and Returns on Average to Larger Than Average Wheat Farms in Irbid Governorate in Adopting Clean Fallow, Fertilization, Chemical Weed Control, and Grain Drilling Technology Package. 1975 prices.

Item	Quantity	Unit Cost or Price	Change in Cost or Return
1. Revenue Increase			
Increased yield	41 kg	0.065	2.665
2. Cost Increases			
Sweep	2X	0.436	0.872
Rodweed	2X	0.436	0.872
Grain drill		0.791	0.791
Ammonium sulphate	14.5 kg	0.061	0.885
Single super phosphate	12.5 kg	0.021	0.263
Custom herbicide spray[a]	100 gm 2-4-D	-	0.350
Opportunity costs[b]	10%	-	0.300
3. Cost Reductions			
Eliminate			
Deep plowing	2X	0.250	0.500
Hand Seeding		0.250	0.250
Light disc		0.150	0.150
Seed savings	2.0 kg	0.065	0.130
Total Cost Increase			3.303
4. Increase in Net Revenue			-0.638
5. Break-Even Yield Increase			51 kg/du
6. Percent of Years Break-Even Achieved[c]			50

[a] Custom application and material costs

[b] Ten percent of increase in direct costs

[c] Based on average yield increase on demonstration plots in four years, 1968/69, 1970/71, 1972/73, 1973/74.

Source: Schmisseur final draft, op. cit.

Table 14 - Additional Costs and Returns on Average to Larger Than Average Wheat Farms in Amman Governorate in Adopting Clean Fallow, Fertilization, Chemical Weed Control, and Grain Drilling Technology Package. 1975 prices.

Item	Quantity (per dunum)	Unit Cost or Price JD/Unit	Change in Cost or Return (JD/du)
1. Revenue Increases			
Increased yield	67	0.065	4.355
2. Cost Increases			
Sweep	2X	0.436	0.872
Rodweed	2X	0.436	0.872
Grain drill		0.791	.791
Ammonium sulphate	15.5 kg	0.061	.946
Single super phosphate	11.0 kg	0.020	.220
Custom herbicide spray[a]	100 gm 2-4-D	-	.350
Opportunity costs[b]	10%	-	.302
3. Cost Reductions			
Eliminate			
Deep plowing	2X	0.250	0.500
Hand seeding		0.250	0.250
Light disc		0.150	0.150
Seed savings	2.0 kg	0.065	0.130
Total Cost Increase			3.323
4. Increase in Net Revenue			1.032
5. Break-Even Yield Increase			51 kg/du
6. Percent of Years Break-Even Achieved[c]			75

[a] Custom application and material cost

[b] Ten percent of increase in direct cost

[c] Based on average yield increase on demonstration plots in 4 years, 1968/69-1970/71, 1973/74

Source: Schmisseur final report, op. cit.

Table 15 - Additional Costs and Returns on Average to Larger Than Average Wheat Farms in Kerak Governorate in Adopting Clean Fallow, Fertilization, Chemical Weed Control, and Grain Drilling Technology Package. 1975 prices.

Item	Quantity (per dunum)	Unit Cost or Price (JD/unit)	Change in Cost or Return (JD/du)
1. Revenue increase			
Increased yield	66	0.065	4.290
2. Cost Increases			
Sweep	2X	0.436	0.872
Rodweed	2X	0.436	0.872
Grain drill		0.791	0.791
Ammonium sulphate	13.5 kg	0.062	0.837
Single super phosphate	9.0 kg	0.022	0.198
Custom herbicide spray[a]	100 gm 2-4-D	-	0.350
Opportunity costs[b]	10%	-	0.289
3. Cost Reductions			
Eliminate			
Deep plowing	2X	0.250	0.500
Hand seeding		0.250	0.250
Light disc		0.150	0.150
Seed savings	2.0 kg	0.065	0.130
Total Cost Increase			3.179
4. Increase in Net Revenue			1.111
5. Break-Even Yield Increase			49 kg/du
6. Percent of Years Break-Even Achieved[c]			75

[a] Custom application and material cost

[b] Ten percent of increase in direct costs

[c] Based on average yield increase on demonstration plots in four years, 1968/69, 1971/72-1973/74

Source: Schmisseur final report, op. cit.

similar results. The adoption of the package would also be of questionable profitability under annual cropping and would be subject to similar risk.

The conclusion of the previous section, that the technology package may reduce physical yield risk, must be modified: though physical risk may be reduced, financial risk of adoption is increased.

The cost of the technology package is a basic issue in its profitability and adoption. Haldorson[24] argues that custom rates for machine services are not excessive in Jordan, being only about 60 percent of the charge for similar services in Oregon. He further argues that higher custom rates could be justified in Jordan in that small fields and distances operators must travel reduce operating efficiency. He could have added that basic machinery investment and many direct operating expenses (e.g. fuel and spare parts) are more costly in Jordan than in the U.S.

At the custom rates shown on Tables 13-15 for plowing, the operator makes a quick pass over the field the long way, usually up and down the slope. The field is left rough with many heavy clods. The field is seeded by hand, after rains have

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24 Leonard Haldorson, "Availability of Goods and Services for Improved Wheat Production in Jordan," USAID/OSU Contract AID/sa-C-1024. October 12 to December 23, 1975. pp 14 and 15.

smoothed the earth to some extent, and then covered with a light disc, also the long way.

Farmers complain of the quality of land preparation, but apparently the value of plowing and seeding on the contour is not perceived as being of sufficient value to warrant their willingness to pay the additional costs involved.

Grain drilling, if done on the contour, could overcome much of the disadvantages of earlier land preparation. The grain drill is an extremely expensive machine. Imported from the U.S. the cost is around $3,600, and Schmisseur estimated the per dunum charge at JD 0.791, the highest cost of all operations considered. Drills imported from Spain were purchased by the Ministry of Agriculture for about $2,100, still very expensive. At this price the per dunum charge for drilling would be about JD 0.500, not enough reduction to alter the partial budget's outcome significantly.

An obvious need is to find ways of reducing the cost of the package. Research is required on (1) the effect of reducing tillage under both annual cropping and fallow regimes; (2) lower cost, perhaps smaller machines suitable for individual farmers' ownership; and (3) alternative methods of seeding.

A partial package, involving only chemical weed control and fertilizers and, as they become available, more

productive cereal varieties, seems a more viable starting point than a complete package, even though positive interaction effects of good stand establishment are foregone.

The elements of the partial package are suitable for adoption on small farms in that they are infinitely divisible, their impact is perceived in a relatively short period of time, and their financing requires no more than seasonal credit.

The yield results of the single experiment with fertilizer on otherwise traditionally managed wheat, by Dueiri, et. al., was discussed above. The application of 12.5 kg per dunum of each of ammonium sulfate and super phosphate increased the yield of dunum from 55 kg to 112 kg.[25] The experiment was subjected to financial analysis, and the resulting partial budget is shown in Table 16.

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25 Incidentally, the experiment also indicated the importance of technical assistance to farmers in the use of new inputs. The experiment involved eight plots, for which the results of only six were discussed above. All eight plots were sown in mid-December, and on four, those averaging 112 kg yield, fertilizer was added at seeding time. Two plots received no fertilizer, and two received 12.5 kg of ammonium sulfate per dunum in late March. A priori knowledge suggests that March is too late for nitrogen to have a positive impact on December-sown wheat, and the results, 51 kg average yield, showed it.

Table 16 - Additional Costs and Returns From Fertilization of Hand-Sown Wheat. Amman. 1975.

Item	Quantity (per dunum)	Unit Cost or Price (JD/unit)	Change in Cost or Return (JD/du)
1. Revenue increase			
Increased yield	57 kg	0.055 (0.065)[b]	2.850 (3.705)[b]
2. Cost increases			
Ammonium sulfate	12.5 kg[a]	0.080 (0.061)[b]	1.000 (0.762)[b]
Super phosphate	12.5 kg[a]	0.020	0.250
Total Cost Increase			1.250 (1.012)[b]
3. Increase in net revenue			1.600 (2.693)
4. Benefit-cost ratio			1.78 (3.66)
5. Break-even yield increase			23 (16) kg/du

[a] Includes material, delivery, and application costs

[b] Numbers in parentheses reflect prices used in the Schmisseur budgets

Source: Dueiri, et. al., op. cit.

The Dueiri, et. al. outcome shows a benefit-cost ratio of 1.78, not all that great when compared to the BCR's of 5.00 and greater for fertiliser-variety technologies in the humid tropics. The Dueiri, et. al., yields combined with the prices used in Schmisseur's budgeting give a BCR of 3.66, still low for gaining rapid acceptance by traditional farmers.

The latter prices may be more realistic for the near term. Current (spring 1976) market prices for top quality domestic durum are reported at about JD 70 per ton, and fertilizer prices have fallen sharply from their 1974-1975 level.

These BCR's are not all that bad for an essentially fertilizer-only technology, but they are probably too low for rapid adoption by traditional farmers. Typical farmer BCR's would be well below those of experimental (or even demonstration) results.

Further research on the geographic and temporal distribution of fertilizer response under both traditional and (more or less) modern management systems is an obviously urgent requirement. Additionally, the search for higher yielding varieties, again under both traditional and modern management regimes, must be accelerated.

Partial budgeting results appear only on paper and beg a number of questions concerning the environment within which

adoption occurs. Important among these are:

a. Farmers' knowledge of and attitudes toward new technologies

b. Farm size and tenure

c. Personal characteristics of dryland farmers

d. Input availability

e. Marketing and price policy

The following subsections discuss each of these in turn.

2. Adoption Rates, Knowledge, and Attitudes Toward New Technologies

From interviews conducted with a sample of 200 farmers in the Irbid Governorate, Hurani[26] estimates adoption rates for the elements of the Wheat Project technology package generally in line with those reported by Ministry of Agriculture technicians (see Agronomic Setting, above). These are summarized below in Table 17.

The high rate of acceptance (65 percent) of cleaned and treated seed appears to be based on the apparent low cost and simplicity of the technology, the fact that seed is the one tangible, material input farmers have always used, and the simplicity of the

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26 M. Haitham El-Hurani, Economic Analysis of the Development of the Wheat Subsector

Table 17 - Adoption Rate of Improved Inputs Distributed by Rainfall Zone

Improved Inputs	Rainfall Zone 250 mm	250-300	300-400	400	All Zones
	(Percent of Farmers Adopting)				
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 grain drills	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

Source: Hurani, op. cit.

argument that better seed produces better crops.

Adoption rates for the other practices are consistent with earlier observations and with the arguments about the adaptability of fertiliser-chemical technologies to small farm use.

Further results of the survey can be summarized as follows:

a. Most farmers have heard of the newer practices or inputs covered in the survey and would adopt them if convinced of their profitability.

b. In general, however, farmers' knowledge of the productivity and cost of the newer practice or input is very limited. This is revealed by the wide range of responses when farmers were asked to estimate costs and yield effects, including a significant number who refused to make quantified estimates of yield increase from adoption of each.

Similar results are appearing from a less formalized series of interviews being carried out by staff members of the Ford Foundation currently headquartered in Amman. Farmers are aware of the existence of new methods; they are ignorant of costs, effects,

and specific techniques; and they have little knowledge of convenient input sources. A draft report of this work is expected this summer.

3. Farm Size and Tenure

The size distribution of agricultural land ownership in the Irbid, Amman, and Kerak Districts, excluding the Jordan Valley, is shown in Table 18. The average size of ownership ranges from 34 to 61 dunums and the fraction of ownership units less than 50 dunums in size ranges from 0.72 to 0.85.

These data cannot be directly interpreted as farm size indicators in annual cropping areas since they

a. measure only the ownership of registered lands and give no indication of tenancy,
b. include lands in the more hilly areas which tend to be in forests and fruit trees and whose units tend to be smaller in size than units in the flatter annual cropping areas.

On balance, these data would probably underestimate, somewhat, farm sizes in the relevant annual cropping regions.

Table 18 - Distribution of Numbers of Plots and Areas by Size Group, Irbid, Amman, and Kerak Districts Excluding the East Jordan Valley, 1971. (Numbers of Plots in Thousands, Areas in Thousands of Dunums)

Size Group (dunums)	Irbid		Amman		Kerak	
	Number of Plots	Area	Number of Plots	Area	Number of Plots	Area
< 30	39.0	437.6	14.7	191.8	24.8	287.0
30-49	7.5	324.8	3.8	145.7	5.0	191.8
50-199	10.7	1088.5	5.8	542.8	4.6	495.9
≥ 200	2.2	964.7	1.4	697.8	0.6	224.4
Totals	59.4	2815.6	25.8	1578.0	35.1	1199.1
Average Size, Dunums	.78	47.4		61.2		34.2
Fraction of Total Plots Less than 50 Dunums			.72		.85	

a Rounding discrepancy in some of the totals

Source: Hashemite Kingdom of Jordan, Department of Statistics, Agriculture Statistical Yearbook and Agricultur Sample Survey, 1974

Data gathered in preparation for the UNDP/FAO project, Integrated Agricultural Development of the Rainfed Areas, currently under execution in the Irbid Governorate, show that farm sizes in the field cropping region are very close to those shown in the aggregate data of Table 18. The average size of holding[27] in the project area is 41.2 dunums, and 78 percent of all holdings are less than 50 dunums in size. Farms in the field crop areas of Amman and Kerak are somewhat larger.

Information on the incidence of some form of tenancy, as opposed to farming by a full owner, is fragmentary for the dryland farming regions. A survey of tenure arrangements in two villages in the Baq'a, a productive area of larger-than-typical farms north of Amman, showed a distribution of tenure arrangements as given below in Table 19.

Table 19 - Distribution of Holdings by Type of Tenure in the Baq'a Valley, 1968

Type of Tenure	Number of Holdings	Land Area (dunums)	Dunums per Holding
Full owner-operated	18	1935	107.5
Full sharecropping	20	4828	241.4
Mixed	40	10011	250.3
Total	78	16774	215.1

Source: UNDP/FAO, "Dryland Farming, Jordan: A Socio-Economic Study with Special Reference to Land Tenure Problems in Abu-Nassir and Mubis Villages, Baq'a Valley." AGS:SF/JOR18. Technical Report No. 1. 1970

[27] Where a holding is, in effect, a farm unit without regard to tenure

The 78 holdings had 185 owners of whom 112 were absentee.

Note that the larger holdings are in sharecropping and mixed owned-sharecropped farms. This is not surprising as farmers often attempt to expand their operations with limited capital by renting. Note that none of the holdings are rented for cash, usually regarded as an economically more efficient form of rental, and one preferred by tenants but not by landlords.

Sharecropping can be theoretically as efficient in the short-run as cash renting if the variable costs of production are distributed in the same proportion as is the produce. No information on this is reported for the Baq'a survey.

A similar survey in an FAO pilot project area near Kerak[28] yielded the following information on tenure by number of holdings but not by size:

	Holdings	Percent
Full Owner-operated	63	56
Fully sharecropped	12	11
Mixed	36	32
Freely occupied (squatters?)	1	1
Total	112	100

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28 See A. M. El-Zoobi, "FAO/Dryland Farming Project (JOR 18), Socio-Economic Survey of the Operator Farmers in the Three Pilot Areas of the Project." Socio-Economic Studies Series No. 8. UNDP/FAO and Ministry of Agriculture. 1973.

Sharecrop leases are typically oral and typically for the crop season, though they are usually renewed. Again, none of the leases is for cash.

The high incidence of tenancy shown in both surveys suggests, if the results can be generalised, that for much of the land there is little incentive for investment whose costs are not fully recovered in the same season. Thus, there is little effort expended in terracing, land leveling, stone removal, or other soil conserving measures.

Division of crops and of costs for the sharecroppers in the Kerak survey are given below in Table 20.

Table 20 - Divisions of Costs and Returns for Sharecropping Leases. Kerak Survey.

	Division of Costs		Division of Returns		
	Landlords	Tenants	Landlords	Tenants	Percent of Tenants
1.	Plowed lands, seeds, mechanized harvesting	Labor	½	½	47
2.	Land	Labor, seed, harvesting	1/3	2/3	49
3.	Poor land	Labor, seed, harvesting	1/4	3/4	2
4.	Unknown	Unknown	0	1	2[a]

[a] The "freely occupied" holding

Source: El-Zoobi, op. cit.

There was no apparent attempt made to quantify the division of costs between landlord and tenant, and it seems unlikely that the division is close to the division of returns.

Lease improvements would help create incentive for greater productivity, especially productivity increases requiring long-term investments. Included in such a list would be

a. cash rent
b. longer term, written leases
c. provision for compensation for the remaining life of investments made by the tenant

These tend to be rather sophisticated and demand a strong business orientation on the part of the tenant.

Land fragmentation increases operating costs, thereby inhibiting increases in productivity. The Baq'a survey showed that the 78 holdings were divided into 294 fragments, or almost four fragments per holding.

The Kerak survey showed fragmentation on the basis of ownership, not so useful as on the basis of the holding, but still indicative (Table 21). Tenancy creates the opportunity, at least, for land consolidation. Fragmentation, by holding, may therefore be less, but probably not much less.

Table 21 - Fragmentation of Lands by Ownership, Kerak Project Area

Degree of Fragmentation	Number of Owners
Consolidated	5
Two or three fragments	27
Four to six	50
Seven to nine	12
More than nine fragments	5
Total	99

Source: El-Zoobi, op. cit.

The inheritance laws are credited as the major cause of land fragmentation. All male heirs get one full share, and all female heirs receive a half share. Land titles were first registered in the 1930's under the British Mandate, so that by the 1970's some lands have had nearly two generations in which to be divided and sub-divided. In the Baq'a survey area it was pointed out that 16,048 dunums were transferred from 52 deceased owners to 175 heirs. Size of ownership fell from an average of 309 du to 91 du in a generation.

The inheritance law has its foundation in Islam. Although a number of seemingly straightforward arrangements for

land consolidation or for the avoidance of further fragmentation could be offered, religious and other deeply held social factors inhibit their institution. In the Baq'a survey, just over 12 percent of the farmers indicated agreement with the idea of land passing to a single heir only. Fifty-six percent of those who opposed the idea did so on religious grounds; thirteen percent, in order to avoid disputes among heirs; twelve of the opponents liked the present system; and 19 percent gave no reason.

This notion of equity extends not only to the size distribution among heirs, but also to the physical orientation of the land divided. Long narrow strips are laid out up and down slopes in order that heirs share equally in both the poorer land at the top and the richer land at the bottom.

4. Personal Characteristics of Dryland Farmers

The Kerak survey[29] also yielded information on the farm labor force in the project area: family size and composition; age distribution of farm operators, of the head of household and eldest son; and non-farm sources of family income.

These data are summarized as follows:

a. Sixty percent of all heads of household are more than forty years old. Fifteen percent are over sixty.

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29 See El-Zoobi, op. cit.

b. About 60 percent of all heads of household are illiterate.

c. But, of their eldest sons, 88 percent are literate. Forty-six percent of eldest sons have received at least the Intermediate Certificate (junior high school).

d. Minimum farming experience of heads of household is five years. About 47 percent have 25 years experience.

e. Farming provided an average of 126 days employment per adult male equivalent worker annually.

f. Forty-four percent of all heads of household had other occupations, providing additional family income. No estimate of this supplementary income is given.

g. Families in the project area had an average of 0.86 adult part-time family workers. To the extent these persons are otherwise gainfully employed, their earnings form an additional source of family income.

The picture presented here of the dryland farming decision-maker is that of a middle-aged, illiterate whose farming

operation occupies only a portion of his time and is likely to provide only a portion of his income. To the extent that this picture can be generalized to all of Jordan's dryland farming area, complex new technologies of only moderate productivity are not going to be very attractive.

5. Input Availability

The cost elements of the enterprise budgets presented earlier are meaningful only as inputs are available to the farmer when needed. A wheat farmer in a small village near Kerak recently asserted that a bag of fertilizer, 50 kg, would cost him three dinars over the price of fertilizer or JD 0.060/kg more than the JD 0.061-JD 0.080 per kg for ammonium sulfate used in the budgets. His argument, paraphrased through an interpreter, ran as follows:

> "There is no fertilizer here in the village, and none in Kerak. I must go to Amman to buy it. This means a taxi to Kerak, a bus to Amman, and another taxi to the store. With luck, I can get back to the village the same day. If not, I must stay in a hotel and return the next day. In any case, I would have to buy a meal in a restaurant. I could only carry one bag of fertilizer on the bus. Besides,

I couldn't go to Amman and return with nothing for my children. Anyway, I don't know how to use fertilizer."

The village lies within the zone of 350-400 mm average rainfall, so there is some likelihood of a positive wheat yield response to nitrogen. But at that price it is not attractive.

Farmers in the village asserted that they had little or no contact with extension workers and consequently had little knowledge of the use of such inputs. Further, they had had virtually no contact with Ministry and FAO staff from the Dryland Farming Project which had been providing technical assistance in the immediate neighborhood between 1971 and 1975.

The story undoubtedly exaggerates the magnitude of the problem. Nevertheless, it may be generalized that input marketing, particularly at retail, is an element in the development of Jordan's dryland agriculture which requires strengthening.

There have not been any quantitative analyses of input markets, marketing operations, and market structures in Jordan. A less formal analysis was carried out under the AID-sponsored Wheat Project by Leonard Haldorson,[30] a fertilizer and herbicide dealer in eastern Oregon, in November-December 1975.

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[30] Leonard Haldorson, op. cit.

Haldorson was asked to look at and evaluate marketing of fertilizer, tractors, other farm implements, and seeds. He concentrated on private firms, but he briefly examined the role of the cooperative movement.

a. Fertilizers

Although Jordan is a producer of phosphate, it is largely exported as raw material. Phosphatic fertilizer, triple super phosphate, is imported as are all supplies of nitrogen in the form of ammonium sulfate. Approximately 15,000 tons are imported and used annually; half of this is ammonium sulfate.

Five private dealers import fertilizers. The largest and second largest importers have approximately 50 and 20 percent of the market, respectively. The remaining three have about 10 percent each.

Most fertilizer sales are in the Jordan Valley and other vegetable growing areas. Wheat farmers have been using less than 1000 tons of ammonium sulfate annually. There are privately owned retail outlets in Amman, Irbid, Zerqa and about 20 small shops in the Jordan Valley. Other retail sales are made by about 20 agricultural engineers employed by the five firms as traveling salesman.

Cooperative societies are becoming important as retail outlets, particularly in the north in the Irbid region. The Jordan Cooperative Organization (JCO) obtains most of its supplies from the private importers and distributes them at cost to the societies, absorbing the internal transport costs.

The Ministry of Agriculture has imported fertilizer on its own account for distribution through the cooperatives. Four thousand tons were imported in 1974 when fertilizer prices were very high. Not all of this was sold before world prices declined in 1975. It is reported that when world prices fell, the Government induced private traders to maintain prices at a high level until its own stocks were sold.

It seems likely that larger fractions of fertilizer sales will be made through cooperatives, with more being imported on Government account. Domestic manufacture of diammonium phosphate is included among the Five Year Plan projects, but production will not be available before the end of the 1970's, if then.

It seems likely that a variant of Say's Law inhibits the spread of retail sales of fertilizer in the dryland areas. Private firms will not expand without some assurance of profit. The requisite demand, in turn, depends upon knowledge of fertilizer's productivity, first at the research and then at the farmer's level. Farm management and marketing research are necessary complements to agronomic research and extensions.

b. Seeds

The Ministry of Agriculture and the JCO are cooperating in a program to expand the use of cleaned and treated

seeds by Jordan's wheat farmers. In 1975, 855 tons of seed of the varieties F8 and Horani Nawawi were supplied to JCO by the Ministry for distribution to cooperative societies at JD 72 per ton. Wheat produced from the seed is to be cleaned to seed quality, the amount distributed is returned to the Ministry via the JCO, and the remainder purchased by the Ministry, for future distribution as seed, at JD 72 per ton.

Wheat production in excess of the amount of seed borrowed need not be returned to the Ministry, but may be sold as milling wheat. Present prices, one month before the 1976 harvest, are about JD 70 per ton. These will no doubt fall at harvest time, but the Ministry of Supply is offering a support price of JD 65 per ton for top quality milling wheat from the 1976 harvest.

In order that seed production be attractive to farmers at this price relationship, the clean-out percentage would have to be less than 10 percent. Jordanian farmers tend to believe in a strong positive correlation between seed size and resultant yield. Farmers using seed cleaned by the Ministry in the past have insisted on such large kernel sizes that seed yield from threshed or combined wheat has averaged closer to 60 percent. Relaxation of these standards for the seed distributed in 1975 resulted in a 50 percent increase in the quantity of seed available over that in earlier years.

Strict varietal purity was not maintained in the 1975 program in order to distribute as much seed as possible. A certified seed program is to begin with the 1976 planting. Registered seed is to be produced on 1800 dunums of Ministry-owned land. Registered seed is to be distributed through the JCO and cooperative societies to member farmers for increase to certified seed.

A certified seed program can be a productive venture on the part of the Ministry. It requires, however, significant inputs of quality manpower to which the Ministry may not be sufficiently sensitive. Its impact would be greatly enhanced if it were built upon varieties more productive than F8 and Horani. None are currently available.

An alternative to the Ministry's undertaking the direct production of registered seed would be to contract for that production with qualified farmers or cooperatives under Ministry supervision.

c. Herbicides

In his report on a visit to Jordan in early 1974,[31] Haldorson noted a large increase in the use of chemical weed control in wheat from his first visit in 1969. He observed that dealers had more adequate inventories of both herbicides and equipment than

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31 Leonard Haldorson, "Commercial Herbicide Application in Jordan." AID/OSU Contract No. AID/su-C-1024. April 1974.

earlier. Cooperative societies in the Irbid region were making herbicide application part of their services to members, and a number of custom operators in the Irbid, Amman, and Kerak regions had started offering weed spraying services.

Fairly rapid adoption of chemical weed control is not surprising:

(1) It is low cost relative to hand weeding;

(2) Its impact on weeds is quickly perceived;

(3) The required expertise in application to cereals is relatively minor and can be concentrated in the hands of relatively few custom operators or cooperative society employees.

(4) Its perceived effect is independent of other agronomic practices.

d. Farm Tractors, Sales and Service

Between 400-500 tractors were sold in Jordan last year, the bulk of these in the 70 horsepower category. The headquarters for all the six dealers are in Amman. Some have branch offices in Irbid and Zarqa. The Zetor (Czechoslovakia) and Massey-Ferguson dealers both had branch offices in Kerak, but closed them in 1973 when tractors were difficult to obtain. These may be reopened now that new tractors are more readily available. No company has a branch in the Jordan Valley.

Small farm sizes inhibit the purchase of a tractor by the individual farmer for his exclusive use. Most sales are to farmers and others who will perform custom services. Sales to cooperative societies, as a means of group ownership, are increasing. Tractor purchases are often motivated by the need for basic transportation, in addition to farm tillage work.

Tractor repair facilities are concentrated in Amman, though most of the larger towns have automotive repair shops in which minor tractor repairs can be accomplished.

Haldorson observed, but did not note in his report, that while dealers have considerable expertise in tractor sales and service, they appear to have almost no familiarity with the use of the machine on the farm. He did point out that most tractor dealers have an associated automobile sales line and do not handle other farm implements. The "climate" for developing a comprehensive understanding of farm mechanization is absent. Thus the technical assistance function performed by dealers in the U.S. is missing in Jordan.

e. Farm Implements

Combine harvesters, moldboard and disc plows, disc harrows for covering seed, and field sprayers are virtually the full range of implements sold for and used in Jordan's dryland farming

areas.

Since almost all of Jordan's cereal growing area is plowed by tractor-drawn plows, it can be described as being well tractorized but not well mechanized. Ministry of Agriculture personnel estimate that 70 to 90 percent of the wheat and barley is combine harvested. Seeding is practically all done by hand broadcasting, followed by covering with the disc harrow. Fertilizer, to the extent it is used, is hand broadcast. Most weeding, if done, is with hand labor, although spraying with 2-4-D is increasing.

Haldorson observed that while many implements currently being sold are imported, a number of blacksmith shops in and around Amman were manufacturing moldboard plows, disc harrows, and field sprayers. In the last case firms used an imported kit of pump, control valves, and nozzles, while tanks, booms, and frames were manufactured locally. Locally produced items, though crude, were quite usable in his opinion. They were lower priced than imported equipment.

A number of shops are manufacturing spare parts for implements sold by dealers, and some were considering the manufacture of spike tooth harrows and tool bars for sweep and chisel plows.

Blacksmith shops in other areas of Jordan were performing major repairs to plows manufactured in Amman. It appeared

to Haldorson that even in the villages these shops had the necessary tools and expertise to do major blacksmith repairs.

The grain drill, as pointed out earlier, is almost unknown in Jordan. Dealers reported that they were unaware of the type of drill most useful here. Indeed, over 25 different possible types are available--and expensive. Haldorson believes that a simple, serviceable drill could be manufactured by blacksmiths in Jordan. Research on such implements, and others which may fit the present level of tractorization, should be encouraged.

f. Cooperatives in the Dryland Farming Regions

Most of the cooperative societies in the dryland farming regions are in the Irbid area. That area has the longest tradition of cooperation, and there are now ten near Irbid with about 2,000 members in some 50 villages. One cooperative is operating in Madaba, south of Amman, and four were recently formed near Kerak. Cooperatives exist in other areas, but they are of less importance for dryland cereals farmers.

The services they offer are input marketing (seeds, chemicals, and group ownership and operation of machinery); credit, in which a land-owning member has a borrowing limit of about JD 250 while a tenant's limit is JD 150-JD 180; produce marketing; and some technical assistance to members.

Subsidies to the societies consist of the salaries of each society's manager and agronomist, low cost loans, and low prices for inputs.

It is estimated that currently less than 10 percent of Jordan's wheat farmers are members of cooperatives. But membership is increasing rapidly, and if the current trend continues, as many as 50 percent would be members by 1980.

The achievement of this goal would require tremendous inputs of trained manpower and capital. It is questionable whether or not the goal could be reached and the societies maintain the same high level of management and performance which is reported to exist with the societies in Irbid. It is particularly questionable in the southern dryland farming areas, where the tradition of cooperative business farms is weak.

g. Custom Operators

Cooperatives are one way of spreading the cost of expensive equipment among several units. The custom operator is another and has a longer history in Jordan. The quality of custom field work, and commentary on it by farmers, has been discussed above. Barriers to quality improvement include:

(1) Small size and inconvenient layout of fields;

(2) Lack of a perceived increase in yields from contour tillage;

(3) Lack of knowledge, at both research and farm levels, of low cost tillage operations.

FAO staff working near Irbid have reported some initial successes in inducing farmers to informally combine their plots to permit contour tillage. Cooperative societies may be a means for encouraging this, with or without cooperatively owned equipment.

Farm size trends appear to be downward due to inheritance practices. This ignores trends in tenancy, for which no data is available, but which may be a device for increasing farm size to make machinery use more effective. In some cases, low cost, small tillage equipment may be most effective. Mechanization research, using the IRRI concept would be extremely useful.

h. Conclusions

This brief review of input marketing in Jordan suggests the following conclusions:

(1) Private agribusiness firms have a reasonable level of competence and capacity to supply inputs to dryland farmers.

(2) Retail outlets are concentrated in Amman

and Irbid, and the expansion of these outlets to other areas, and particularly to the smaller villages, is inhibited primarily by lack of demand.

(3) From earlier discussion this lack of demand can be attributed to ignorance of new technologies, an understandable conservatism in the face of risk and uncertainty, and reasonable doubt as to the profitability of new technologies.

(4) Cooperative societies, supported by subsidies, are expanding to offer retail services. Their major impact is in areas which have a fairly long cooperative tradition.

(5) Effective expansion of cooperatives to other areas may be inhibited by lack of quality manpower and adequate budgets.

(6) Demand generation through research, extension to both farmers and agribusiness, and policy incentives (see below) can contribute to the spread of retail services by both private firms and cooperative societies.

6. Price Policy Setting

Accelerating price inflation during the 1970's has been led by increasing retail prices of foodstuffs (Figure 3).[32] The resulting political pressures are being met largely by an attack on symptoms. The Ministry of Supply, created in 1973, has price control authority over a number of foodstuffs at retail and, along with the Ministry of Agriculture, sets the floor prices paid for wheat. Export embargoes are set by the two Ministries on fruits and vegetables, particularly during Ramadan.

The Government has shown remarkable ability to maintain the price of bread, the basic food item of low income groups. The price of the standard Arab loaf was maintained at 48 fils (JD 0.048) per kilo until 1970 when it was raised to 40 fils, where it remained through 1975 (Figure 4). It has recently been increased to 55 fils (not shown). Retail prices have been maintained in the face of gradually increasing prices for domestic wheat and sharp increases in prices for imported wheat, which makes up one-half or more of Jordan's consumption.[33]

[32] Commodity groups, rather than the overall index, are shown in Figure 3. The overall index is weighted by urban (Amman) expenditure patterns of the middle 1960's. Disaggregation reduces bias caused by growth-related shifts in expenditure patterns.

[33] Jordan imports Hard Red Winter wheat from the U.S. under PL480 and other bread wheats from other sources. In late 1974 durum, which forms the bulk of Jordan's production, was priced at $73 (approximately JD 24) per ton over Hard Red Winter in Rotterdam. Premiums for durum have since fallen to about $22 (approximately JD 7) per ton. Durums have historically traded at a premium over bread wheats, and the exchange of durum for bread wheat represents a potential trading opportunity for Jordan if production increases to provide commercially exportable quantities and if Jordan is willing to cease importing under PL480.

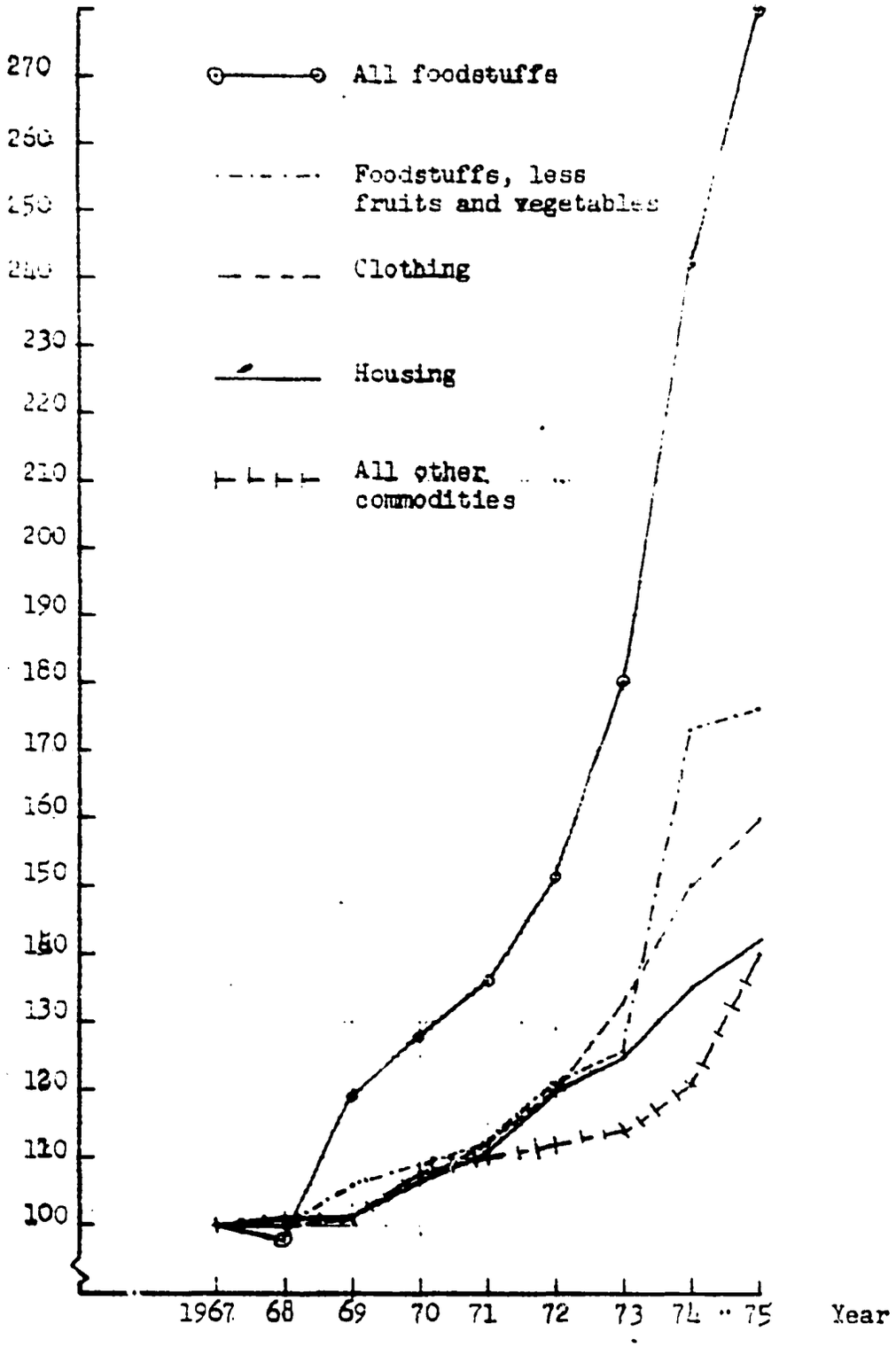

Figure 3 - Amman Retail Price Index by Commodity Groups, 1967-76. (1967 = 100)

Source: Hashemite Kingdom of Jordan, Department of Statistics, Consumer Price Index

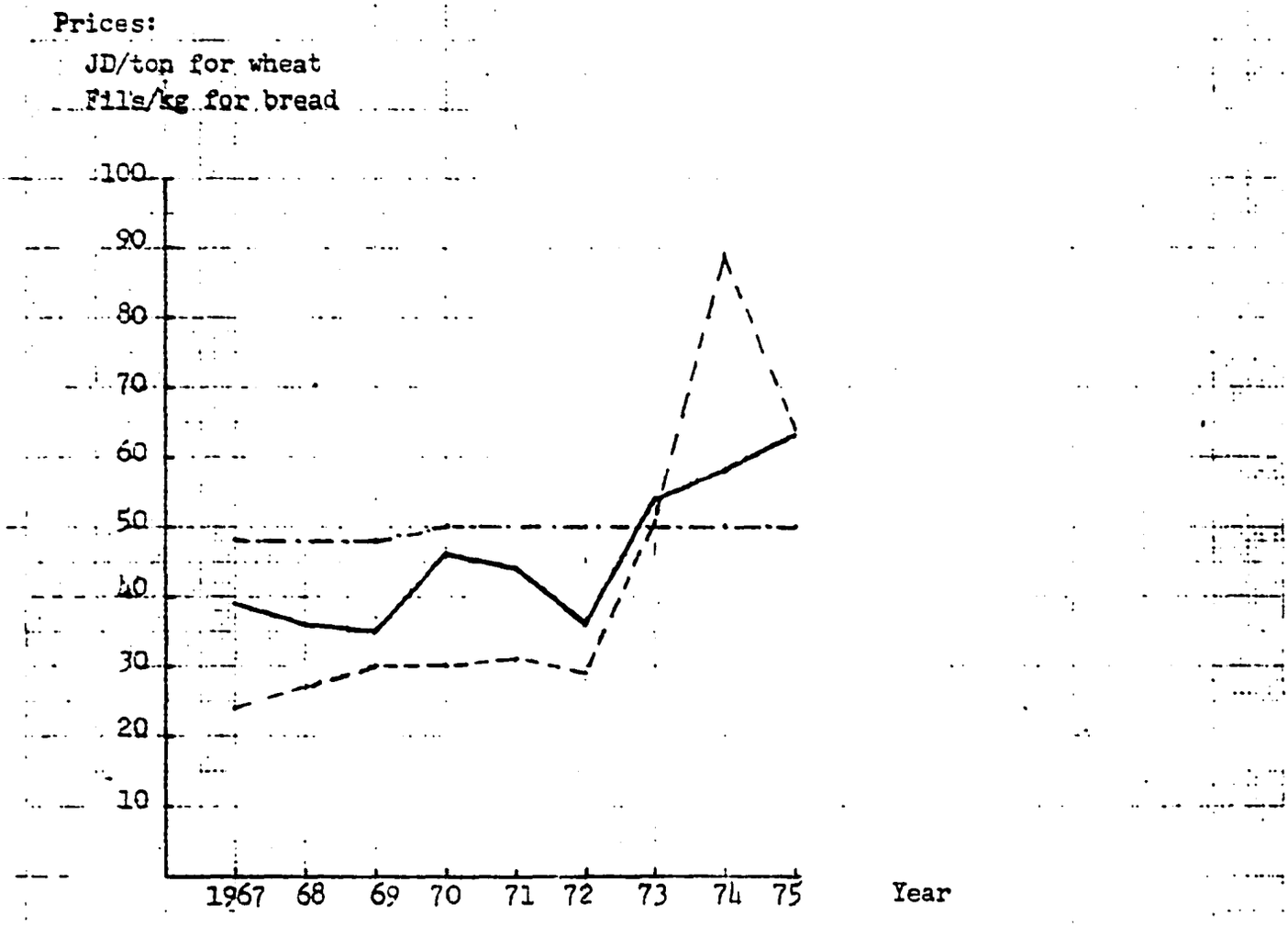

Figure 4 - Wheat and Bread Prices in Jordan, 1967-1975

Sources:

a) Hashemite Kingdom of Jordan, Department of Statistics, External Trade Statistics

b) Department of Statistics, Statistical Yearbook and Consumer Price Index

Hurani[34] estimated that, in order to maintain bread prices at 50 fils per kilo, the Government was paying a subsidy to flour mills of approximately JD 22/ton of wheat in 1975. This was based on the Government's support price to farmers of JD 55/ton for medium grade wheat and a sales price of JD 33/ton to millers. The subsidy is, in fact, considerably larger than JD 22 per ton, since all of the more than 40,000 tons imported during 1975 was sold to mills at JD 33 but imported at an average price of JD 64.

In a recent (April 19) seminar held at Jordan University's Faculty of Agriculture, Carl Gotsch of the Ford Foundation pointed out that there is no "tension" in the system creating pressure for productivity increases in dryland farming.

At the national, political level both the balance of payments and food supply questions, which elsewhere would be of major concern, are hidden by PL480 imports and massive budget support subsidies[35] by friendly countries. At the same time, however, budget support is not limitless, and the need for subsidies on imported wheat, whose import price cannot be controlled, creates pressure for maintaining low prices on domestic wheat.

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34 Haitham El-Hurani, PhD dissertation, op. cit.

35 These subsidies have been running to approximately one-third of the national budget and in 1975 totaled JD 71,000,000 of which the U.S. supplied approximately one-third.

Policy makers, to the extent they think in these terms, evidently believe the supply elasticity for wheat is zero. Indeed, there is no evidence to believe otherwise, at least in the short-run. Stetich and Smadi,[36] in estimating supply functions for wheat production in Jordan, found that rainfall was the major determinent of area, yield, and production, and that estimated parameters for lagged wheat prices were exceeded by their standard errors. The study suffered from data of questionable accuracy and short time series. Further, over the period of the study wheat prices were remarkably stable, limiting possibilities for a price impact on output to reveal itself.

The degree of concern with price policy as an instrument for inducing greater productivity is revealed in the price ratios between domestic wheat and fertilizer shown in Figure 5. When world fertilizer prices started their dramatic rise in late 1971, increases in domestic prices for wheat kept pace with neither fertiliser prices nor world wheat prices. Haldorson[37] estimated that, at the time the Ministry of Agriculture was holding unsold supplies of ammonium sulfate, the JD 63 per ton charged by the cooperative societies could

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36 Akram Stetich and Mohammad Smadi, "Wheat in Jordan: Demand and Supply, Estimations and Projections." HKJ, Royal Scientific Society, July 1974.

37 Leonard Haldorson, "Availability of Goods and Services for Improved Wheat Production in Jordan," op. cit.

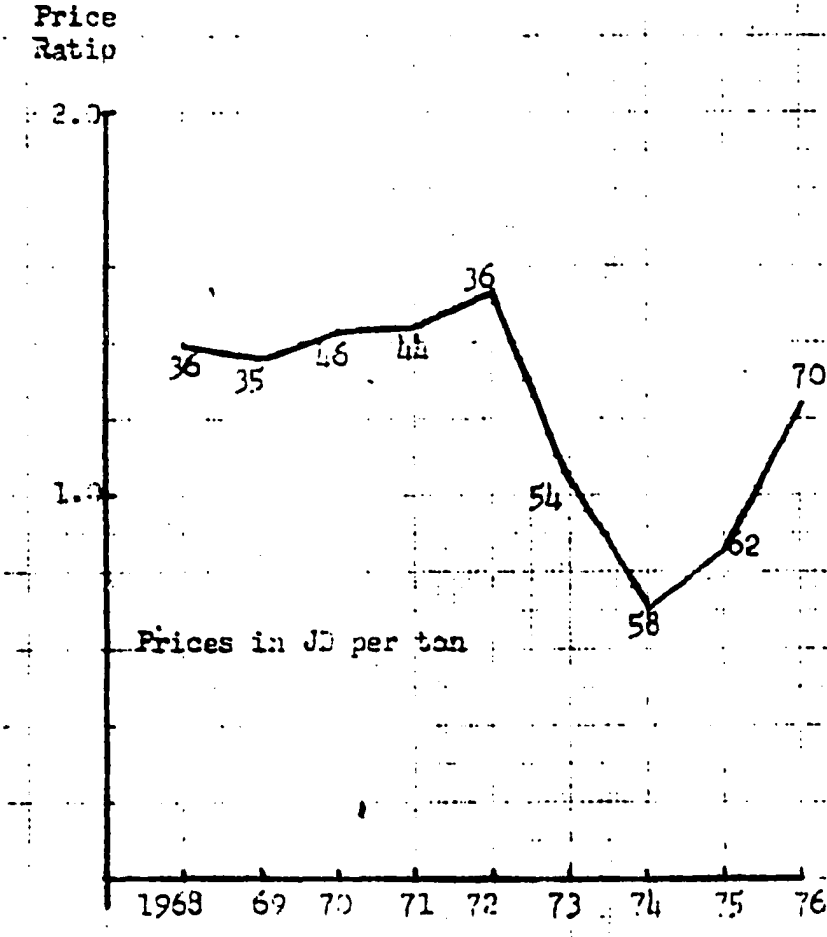

Figure 5 - Wheat Prices and Wheat-Fertilizer Price Ratios in Jordan, 1968-1973

Sources: Ratios taken from seminar paper, "Public Policy and Demand for Technology in Jordanian Agriculture" given by Carl Gotsch at the Faculty of Agriculture, University of Jordan, April 19, 1976.
Prices taken from Department of Statistics, Statistical Yearbook, 1974; and Consumer Price Index, December 1975; and from Ministry of Agriculture reports

have been JD 10 - 15 lower and still provided a reasonable margin over import costs.

The wheat-fertilizer price ratio illustration does not, by itself, constitute an argument for fertilizer subsidies. As pointed out earlier, knowledge of fertilizer response is very limited, and fertilizer subsidies may have only minimum impact. That illustration, along with the others presented above, does present a picture of concern with food price symptoms and budgetary limitations. The policy environment, in terms of incentives for greater productivity in dryland farming needs improvement.

F. Development Activities in the Dryland Subsector

In recent years the Government has been engaged in a number of activities aimed at the development of dryland farming in Jordan. The commodity emphasis of these activities has tended to be in wheat, with some attention paid to fruit trees (including olives) and field crops other than wheat. Donor assistance has been provided by the United Nations and by AID through the Wheat Project.

1. Earlier United Nations Assistance[38]

a. UNDP/FAO Dryland Farming Project (JOR/69/518)

This project, which started in 1969 in the Baq'a area and subsequently transferred to Kerak in 1971, operates in three pilot areas, amounting to a total of 7,000 ha. The UNDP allocation

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38 Extracted from "Draft Report of the Rainfed Areas Agricultural Development Project Preparation Mission in Jordan," Report No. 14/74 IDC JOR. 2. FAO Investment Centre. November 1974.

of the project is US $1.2 million. Its strategy rests on a concerted effort of interrelated disciplines to check soil erosion and achieve increased agricultural production in low rainfall areas of heavily fragmented lands.

The project operates on the principle of convincing farmers to pool together their fragmented plots into viable Management Units for block cultivation. The average size of each Management Unit ranges from 30 ha to 45 ha. The Management Units in each village are subsequently grouped into voluntary service cooperatives which could enable the village community to carry on the tasks of land development and farm production on its own initiative. Out of a total of 7,000 ha, only 800 ha have so far been covered by the Management Units. The UNDP/FAO project provides machinery at free cost but the farmer pays for 75% of the fertilizer cost.

The physical improvements initiated through the project such as contour ploughing, terracing, other soil improvement practices and improved cultural methods are beginning to produce good results and increases of up to 300% in crop productivity have been achieved in several Management Units. However, the methods adopted appear to require a heavy dose of inputs and the extension of the pilot experience on a large scale would run at prohibitive costs.

b. Other UNDP Activities

A number of other large and small scale UNDP/FAO projects are concerned fully or partly with the development of dryland farming. The projects entirely concerned with dryland farming are Tobacco Development (JOR/7 /520), Range Management (JOR/71/006) and Forest Management (JOR/72/001). Those which are partially concerned with dryland farming include such large scale projects as the newly established Meat and Milk Production Project (JOR/73/008), Agricultural Research and Extension Project (JOR/71/527), Agricultural Marketing Project (JOR/69/522) and a number of other small scale projects. In addition, two new large scale projects, National Water Plan (JOR/ 3/019) and the Soil Resource Appraisal Project are under active consideration. The latter is of particular importance as land capability studies are essential for the priority areas to be selected under the proposed dryland farming development programme.

Recently a feasibility study by a sub-contractor has been carried out with a view to establishing the sugar industry in Jordan based on the cultivation of sugar beets in the Jordan Valley as well as in rainfed areas. The conclusions of the study will have implications for the proposed dryland farming programme.

c. WFP Assistance

Three major WFP projects are concerned in one way

or another with the development of dryland farming in East Jordan. These include:

(1) Soil Conservation and Fruit Tree Planting in Selected Areas. This project, which involves WFP food assistance of US $8.1 million, is a follow-up to two earlier projects of a similar nature. The current project started in June 1969 and ended in July 1974. It involved the terracing of nearly 15,000 ha, the planting of 700,000 olive trees, 139,000 grape trees and many other varieties of fruit trees. Most of the targets appear to have been achieved. A new three-year agreement (Development of Highland Agricultural Regions) is being negotiated with emphasis on the development of the catchment areas, including Wadi Zerqa. The new project will cover such activities as the construction of dry-stone terraces, ripping, rock raking, deep cultivation, land clearing, construction of 740 km of farm access roads, construction of cisterns, fencing by stone walls, tree

planting on 7,400 ha, construction of farm utility buildings and the training of farmers. The total cost to the WFP is estimated at US $7.8 million. It is hoped that the Inter-Governmental Committee will approve this project through correspondence and that the plan of operations will be signed this year.

(2) Development in Dryfarming Areas. This project, involving WFP assistance of US $1.2 million, was initiated in conjunction with the UNDP/FAO Dryland Farming Project. It started its activities in the Baq'a area and was subsequently shifted to Kerak to coincide with the change in the location of the UNDP/FAO project. The food incentives provided under the WFP project are closely knitted with the development activities of the UNDP/FAO project (terracing, soil conservation measures, tree planting, etc.) and good results are beginning to emerge. The project is to last until July 1977 and will be tied to the follow-up phase of the UNDP/FAO Dryland Farming Project.

(3) Construction of Roads in Rural Areas. The purpose of this project is to construct a network of farm roads in the rainfed areas of East Jordan and cover all the five districts of Irbid, Amman, Balqa, Kerak and Ma'an. The duration of the project is three years and its cost to WFP is US $3.2 million. It envisages the construction of 1,450 km of farm and village roads to provide easy access to the marketing centres. The execution of the project started early in 1974.

2. A New UNDP/FAO Project

In September 1975, the Ministry of Agriculture and the Jordan Cooperative Organisation in cooperation with UNDP/FAO, began implementation of the Integrated Agricultural Development of Rainfed Areas of Jordan Project in the Irbid Governorate.

The purpose of the project over its five year life is to implement a program of technical assistance to increase agricultural production and incomes on approximately 40 thousand farms covering 2.8 million dunums in the Irbid region.

Project elements include technical assistance in:

a. Land capability classification

b. Cooperative organisation for marketing, input supply, and credit

c. Improved dryland farming practices, including

soil and water conservation

d. Integration of range livestock production with cultivated forages

The Project will work with some 25 cooperative societies in the region as the main vehicle for supplying improved inputs to farmers. Material assistance to these societies is provided by the JCO in the form of salaries for each society's manager and agronomist, low cost loans for facilities and working capital, and inputs sold to them at cost.

Total Project costs are estimated at JD 7 million. First year costs are estimated at about JD 955 thousand, of which the Government's contribution is JD 640 thousand. Emerging financial problems caused by inflation and a decline in subscriptions for the UNDP budget may force a cutback in the scope of the Project.

FAO Project staff are reasonably well satisfied with progress during the first eight months of the Project's life. They report good cooperation with the Ministry and with the JCO and considerable enthusiasm for participation on the part of farmers.

Two factors appear to be important in this. The first is the subsidization of the cooperative societies, and the second is the magnitude of FAO's technical assistance input. Three experienced dryland farming technicians are assigned to the Project

for its duration. A fourth technician is leading the work in soil mapping and will depart when that is completed. As a matter of comparison, the USAID-sponsored Wheat Project had two resident technicians during 1968-1970 and one during 1973-75.

3. Dryland Agricultural Development in the Five Year Plan.[39]

The Government is planning an expenditure on agricultural development projects of approximately JD 26 million over the 1976-80 life of the Plan. Of this amount JD 5.6 million is to be spent in contribution to the UNDP/FAO Integrated Development Project; the Project's replication in the Amman Governorate; continuation of the Wheat Project's demonstration activities; establishment of two stations for the production of registered seed and for experimental and extension work; and the establishment of seed and soils laboratories at the stations.

G. USAID Strategy

The foregoing review of Jordan's dryland farming subsector and of the planned development efforts by the Government and supporting activities of UNDP/FAO forms the basis for the strategy selected by USAID in assisting the development of the subsector. The focus of the strategy is technical assistance aimed at building up

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[39] Taken from the Five Year Plan, 1976-80 (Summary in English), op. cit. and Ministry of Agriculture, "Wheat Project Development Project in Jordan Through the Five Year Plan," mimeo, 1975 (?)

the infrastructures required to support and complement the direct production activities of the Ministry and UNDP/FAO.

The Project activities described immediately above leave gaps in three critical areas required for a sustained increase in dryland agricultural productivity. These areas are:

1. The agronomic research base necessary for an adequate generation of adapted technologies;
2. The extension base in the form of an active extension service sensitive to farmers' needs and capable of forming an effective link between the farm and the research establishment;
3. Social science (primarily economics), policy-oriented research on which to base the effective manipulation of the social environment for increased dryland agricultural productivity.

A five-year project, designed to fill these gaps, is currently under preparation for implementing in 1977. An additional technical assistance element of the project provides assistance to the Ministry in internal planning in order that the Ministry can better focus its resources on critical development problems in agriculture. The project makes tentative provision for capital assistance as the technical assistance activities reveal profitable opportunities for investment by farmers and by agribusiness serving the subsector.