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Cost and Returns of Crop Production for Dryland Farms in the Mafraq Region of Northeastern Jordan

by

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INTRODUCTION

The enterprise budgets presented in this publication are based on crop production in the Mafraq dryland farming region of northeastern Jordan. Barley, and to a lesser extent wheat, are the major crops in the region. Most farms are mixed livestock and crop operations with many farmers owing flocks of sheep and goats. Olives are also grown extensively in the area.

OBJECTIVES

The overall objective of this study is to construct enterprise budgets for barley and wheat crop operations. Specifically, the aim is to:

1. Construct estimates of production costs faced by typical farmers in the region to facilitate economic analysis of current and innovative farming practices with mathematical programming models or other types of economic models.

2. To construct estimates of farm returns and profitability under current farm operations.

3. Provide information for use by government officials, researchers, and current and prospective farmers in evaluating the prospect for current and innovative farm practices.

SOURCES OF INFORMATION AND INFORMATION ANALYSIS

Two surveys of farm operations for the 1988 and 1989 crop year in the Mafraq region are the primary sources of information for this study. The surveys were conducted by Dr. Abdulla Jaradat (Professor in the Department of Agronomy and Soils at the Jordan University of Science and Technology in Irbid, Jordan) and Mahmoud Oglah (researcher at the International Center for Agricultural Research in the Dry Areas (ICARDA) at Aleppo, Syria). Additional information is derived from expert opinion provided by Dr. Jaradat,

while other data are taken from a variety of publications. Summary statistics and statistical tests used in determining values in this study are presented in Appendix Tables 1A through 9B.

Farm operations are divided into various groupings to check for statistically significant differences in enterprise operations. Possible differences between farms in costs, practices, and returns in their barley and wheat enterprises are examined in terms of farmer strategies, farm size categories, and rainfall zones. In this regard, farmers are divided into four strategy categories as follows: a) farmers who only grow crops, b) farmers who grow crops and have olive groves, c) farmers who grow crops and maintain flocks of sheep and goats, d) farmers with livestock flocks, crops, and olive groves. Farm operations are also divided into two separate sets of quartiles, one set of quartiles being based on the size of farm barley operations, while the other set is based on the size of wheat enterprises.

The Mafraq area is divided into three precipitation zones (Figure 1). In the western zone, annual precipitation ranges from just over 400 mm to 300 mm. While barley is the major crop, wheat is relatively important in the western area. The eastern zone receives less than 200 mm of annual precipitation. In the eastern zone, barley is the predominate crop and wheat is relatively unimportant. The central (transitional) zone receives from 200 to 300 mm of annual precipitation and has a mixture of the cropping patterns found in the eastern and western regions. Farmers are also divided into three groups based on the rainfall zone where their farm is located.

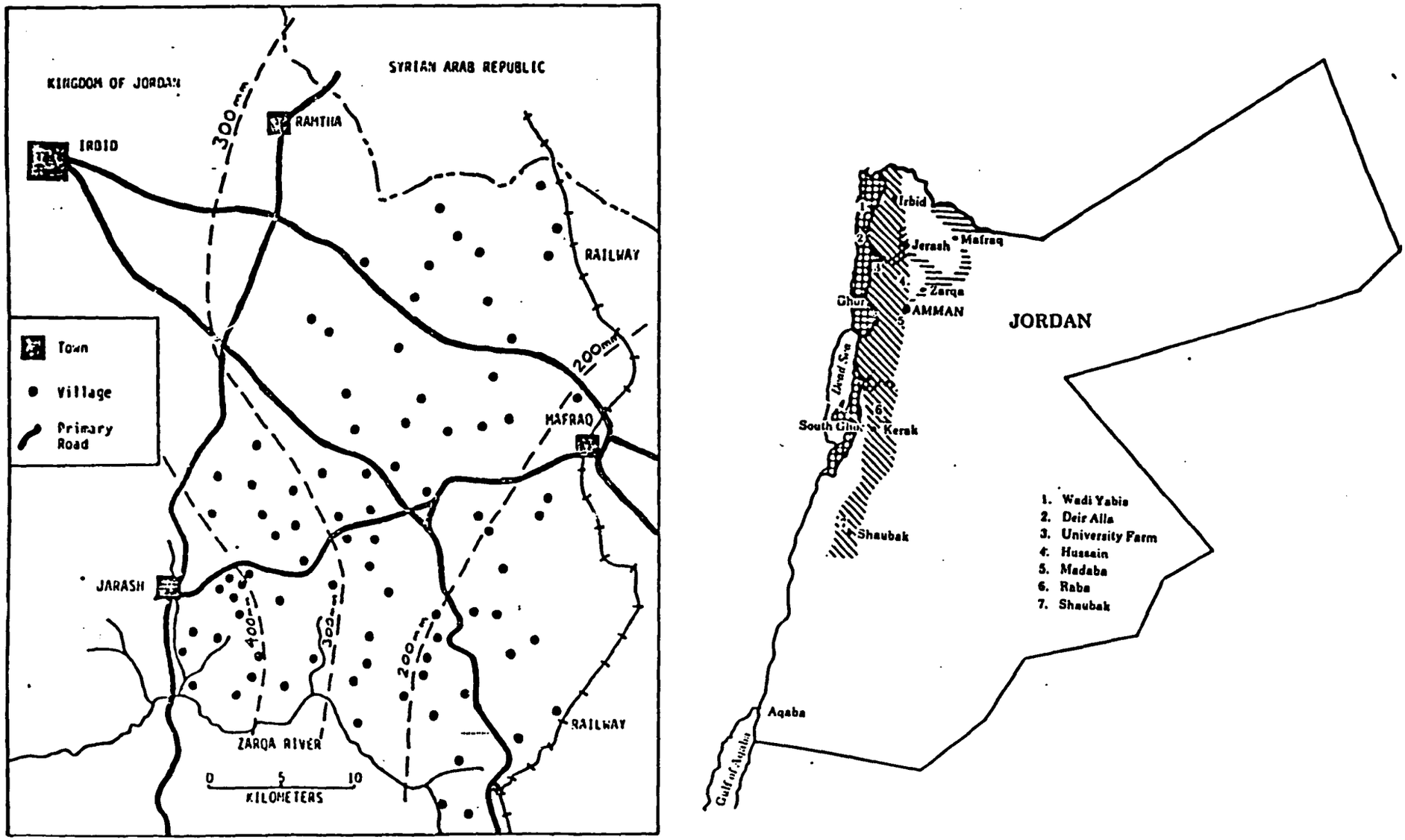

Figure 1. Location of the Three Rainfall Zones in the Mafraq Farming Region of Jordan

ANOVA and covariance analysis shown in Appendix Table 1A through Appendix Table 9B indicated little evidence of statistically significant differences between farm operations based on their strategy, size of operation, or precipitation zone. The statistical evidence implies that barley and wheat enterprises tend to be fairly homogeneous in terms of input use, costs, and productivity. Accordingly, the barley and wheat enterprise budgets presented here are assumed to be representative of all types of farm operations found throughout the region.

BUDGET AND GROSS MARGIN ASSUMPTIONS

GENERAL ASSUMPTIONS

1. Average prices paid for farm inputs as estimated from 1989 survey are:

Custom Hire Moldboard Plow	1.0	JD/Donum
Custom Hire Disk Harrow	0.50	JD/Donum
Barley Seed	0.09	JD/Kilogram
Wheat Seed	0.11	JD/Kilogram
Custom Hire Mechanical Seed Drill	1.0	JD/Donum
Fertilizer	0.078	JD/Kilogram
Chemical Weed Control	0.4	JD/Donum
Hired Labor	1.5	JD/Man-Day

2. Average prices received by farmers as estimated from the 1989 survey are:

Barley Grain	0.068	JD/Kilogram
Barley Straw	0.029	JD/Kilogram
Grazed Barley in lieu of Harvest	1.67	JD/Donum
Grazed Barley Crop Aftermath	0.40	JD/Donum

Wheat Grain	0.11	JD/Donum
Wheat Straw	0.029	JD/Kilogram
Grazed Wheat in lieu of Harvest	1.78	JD/Donum
Grazed Wheat Crop Aftermath	0.42	JD/Donum

3. Machinery is provided by local cooperatives or by neighboring farmers on a custom hire basis.

4. The farm is an owner-operator enterprise

ASSUMPTIONS SPECIFIC TO CROP OPERATIONS

1. Pre-Plant Tillage and Seed Covering Tillage: The reported tillage cost per donum is used to determine the type of tillage operation used by the farmer. A typical custom-hire, disk harrow operation costs JD (Jordan Dinar) 0.5 per donum and a custom-hire, disk or moldboard plow operation costs JD 1.0 per donum. For the 1989 survey data, farms with tillage cost in the closed range JD 0.0 to 0.75 per donum are assumed to use only a disk harrow operation. Farms with tillage cost in the closed range of JD 0.8 to 1.25 per donum are assumed to use only a plow operation. Farms with tillage costs per donum in the range from JD 1.3 to 2.0 are assumed to hire both a disking or moldboard plow as preplant tillage and a disk harrow for covering see. The 1988 survey contains specific information concerning tillage implements used in pre-plant and seeding covering operations. This specific information took precedent over the farmer tillage use estimates that were based on cost-data.

2. Labor Costs: Labor costs are incurred for the hand broadcast of seed, for manual weed control, and for crop harvest. Labor charges for seed broadcast and weed control are implicit opportunity costs credited to farm family labor unless noted as otherwise. Likewise, hired labor costs incurred by surveyed farmers are assumed to occur in the harvest period. Total harvest labor costs per farm are assumed to equal JD 2 per donum for all farms. Therefore, the JD 2 per donum may be a charge to family labor used in harvest, an actual expenditure for hired labor, or a combination of the two.

ASSUMPTIONS SPECIFIC TO CROP GROSS MARGIN ANALYSIS

1. Harvested Output: Grain and straw harvest is reported for the typical farmer in the region. Straw harvest in the survey data is underreported. Accordingly, the level of straw harvest for these budgets is estimated based on a harvest index (grain

harvested/biomass) of 0.30 and the assumption that 90 percent of plant biomass is harvested by hand.

2. Sold Output and Fed Output: All harvested barley grain and straw, as well as grazed crop aftermath, are valued at mean market prices derived from the 1989 survey. In reality, farmers may sell all of their crop output, feed all crop production to their own livestock, or sell some output while feeding the remainder to their own livestock.

DISCUSSION OF CROP BUDGET AND GROSS MARGIN INFORMATION

In this section, crop budget and gross margin information for the typical barley and wheat enterprise is discussed. The information is presented in four tables with all values being reported on a per donum (1/10 of a hectare) basis.

Table 1A and 1B: Barley and Wheat Production Cost Per Donum

Pre-plant Tillage: There is a considerable variation among farms regarding use of preplant tillage in barley operations, as shown in Appendix Table 2A. However, the most prevalent tillage operation cited by farmers in the 1988 survey was one preplant tillage using a moldboard plow.

Quantity of Seed and Seed Price: The mean value for barley seed use per donum across all farmers was 4.9 kilograms per donum. Wheat was assumed to be seeded at a rate of 5.9 kilograms per donum. Barley seed prices and wheat seed prices were provided by Dr. Jaradat (oral communication).

Drill Seed and Fertilizers: No surveyed farmer used either fertilizer or a seed drill. 85 kilograms per donum of diammonium phosphate fertilizer is recommended for farms in the Mafraq region. The per kilogram price of fertilizer is provided by Dr. Jaradat.

Manual Seed and Harrow Cover: Per donum labor requirements for manual seeding are taken from Duwayri. A disk harrow operation is used to cover the seed.

Weed Control: No farmers in the survey reported used herbicides in their barley operations. Labor requirements for manual weeding are taken from Duwayri.

Manual Harvest Costs: Average hired labor cost for surveyed farmers is 0.5 JD per donum. All hiring of labor is assumed to occur in the harvest period. Charge to

family labor is calculated as the difference between assumed total harvest labor costs per donum and manual labor.

Grain Bagging and Transport costs: Grain bagging and transport costs are based on a cost of 0.60 JD per 100 kilograms of harvested grain (Duwayri). Quantity applies to average grain production given in Table 2A for barley and Table 2B for wheat.

Harvested Output: Harvested output varies from lows of no harvested grain to a high of 200 kilograms per donum for barley. Average barley yield over the 1988 and 1989 crop years was 50 kilograms of grain per donum. Average wheat harvest is 44 kilograms of grain per donum. Harvested barley and wheat straw were calculated by assuming a harvest index (harvested grain production relative to total plant biomass) of .30 and by assuming that 10 percent of plant above ground biomass remains on the field. This remaining biomass is either grazed by livestock (grazed aftermath) or is incorporated into the soil. Livestock grazing of aftermath occurs on grain fields after the harvest period either by the own-farm flock, neighboring farm, or by herdsmen migrating through the region. Aftermath grazing is valued at the average price farmers received in the 1989 crop year for renting their land out for that purpose.

Gross Margins: Gross margin is the net returns to land, invested capital, and operator's management. Gross margin is calculated as total value of production minus harvest cost and operating cost, including an allowance for interest on operating costs. Gross margins in this report reflect only the experience of farmers in this area during the two-year period, 1988-89. An evaluation of crop production over a number of years with different rainfall levels and market conditions may show a different level of gross margin and different relative margins for wheat and barley. Also, differences in inherent productivity in wheat and barley fields are not controlled for in the survey results. Finally, many farmers produce barley because it is an important source of feed for their livestock.

REFERENCES

Duwayri, M. "Farm Systems in Rain-Fed Areas" p. 89-125 in The Agricultural Sector of Jordan, Policy and Systems Studies A.B. Zahlan and S. Qasem (eds) Ithaca Press, London, 1985.

Jaradat, A. "Oral Cummunication". Pullman Wa., Aug. 1989.

Table 1A. Per Donum Barley Production Partial Budget for a Typical Farm in the Mafraq Farming Region of Jordan

Cost Calculations Input	Timing	Unit	Price or Cost/Unit (JD)	Quantity	Enterprise Cost per Donum (JD/Donum)
Pre-Plant Tillage:	October				
Disk Plow		Donum	1	0	0.00
Moldboard Plow		Donum	1	1	1.00
Chisel Plow		Donum	1	0	0.00
Disk Harrow		Donum	1	0	0.00
Crop Seeding:	November				
Seed Used		Kg.	0.09	5.9	0.53
Cover Seed and		Donum	1	0	0.00
Apply Fertilizer		Kg.	0.078	0	0.00
Labor, Hand		Man-Day	1.5	0.05	0.08
Broadcast Harrow		Donum	0.5	1	0.50
Weed Control:	March				
Herbicide Application Manual		Donum	0.4	0	0.00
Weeding		Man-Day	1.5	0.4	0.60
Total Preharvest Cost/Donum					2.71
Harvest:	June				
Family Labor		Donum	2	0.75	1.50
Hired Labor		Man-Day	1.5	0.33	0.50
Combine		Donum	1.7	0	0.00
Grain Bag & Transport		Donum	0.60	0.50	0.30
Total Harvest Cost/Donum					2.30
Total Expenditures/Donum (JD)					2.90
Capital Charge on Expenditures (JD)					0.13
Total Cost/Donum (2.71 + 2.30 + .13) (JD)					5.13

NOTES: A donum equals 1/10th of a hectare. JD is a Jordan Dinar with a 1988 exchange rate of 2.38 Jordan Dinar to 1 U.S. Dollar. The recommended per donum fertilizer rate is 85 kilograms of diammonion phosphate (17 percent nitrogen and 47 percent phosphorous). Grain bag and transport costs are based on a per bag costs of 0.60 JD for bags holding 100 kilograms of grain. All hired labor is assumed to be employed at harvest time. Capital charge is on all out-of-pocket expenditures at a 9 percent rate of interest. Out-of-pocket expenditures include all costs except (family) labor costs.

Table 2A. Per Donum and Total Barley Revenue and Gross Margin for a Typical Farm in the Mafraq Farming Region of Jordan

Revenue Item	Unit	Selling Price (JD)	Quantity	Revenue (JD)
Harvested Output:				
Grain	Kg./Donum	-----	50	-----
Straw	Kg./Donum	-----	100	-----
Revenue:				
Cash Sales:				
Grain	Kg./Donum	0.066	50	3.28
Straw	Kg./Donum	0.027	100	2.65
Grazed	Donum	1.67	0	0.00
Grazed Aftermath	Donum	0.40	1	0.40
Total Cash Sales/Donum				6.33
Gross Margin (Net Returns to Land, Capital & Management):				
Per Donum				1.19

NOTES: All grain, straw, and aftermath grazing are valued at average 1989 market prices. Straw production is assumed to be twice as large as grain production on a typical farm.

Table 1B. Per Donum Wheat Production Partial Budget for a Typical Farm in the Mafraq Farming Region of Jordan

Cost Calculations Input	Timing	Unit	Price or Cost/Unit (JD)	Quantity	Enterprise Cost per Donum (JD/Donum)
Pre-Plant Tillage:	October				
Disk Plow		Donum	1	0	0.00
Moldboard Plow		Donum	1	1	1.00
Chisel Plow		Donum	1	0	0.00
Disk Harrow		Donum	1	0	0.00
Crop Seeding:	November				
Seed Used		Kg.	0.12	6.9	0.83
Cover Seed and		Donum	1	0	0.00
Apply Fertilizer		Kg.	0.078	0	0.00
Labor, Hand		Man-Day	1.5	0.05	0.08
Broadcast Harrow		Donum	0.5	1	0.50
Weed Control:	March				
Herbicide Application Manual		Donum	0.4	0	0.00
Weeding		Man-Day	1.5	0.4	0.60
Total Preharvest Cost/Donum					3.00
Harvest:	June				
Family Labor		Donum	2	0.75	1.50
Hired Labor		Man-Day	1.5	0.33	0.50
Combine		Donum	1.7	0	0.00
Grain Bag & Transport		Donum	0.60	0.44	0.26
Total Harvest Cost/Donum					2.26
Total Expenditures/Donum (JD)					3.16
Capital Charge on Expenditures (JD)					0.14
Total Cost/Donum (3.00 + 2.26 + .14) (JD)					5.40

NOTES: A donum equals 1/10 of a hectare. JD is a Jordan Dinar with a 1988 exchange rate of 2.38 Jordan Dinar to 1 U.S. Dollar. The recommended per donum fertilizer rate is 85 kilograms of diammonion phosphate (17 percent nitrogen and 47 percent phosphorous). Grain bag and transport costs are based on a per bag costs of 0.60 JD for bags holding 100 kilograms of grain. All hired labor is assumed to be employed at harvest time. Capital charge is on all out-of-pocket expenditures at a 9 percent rate of interest. Out-of-pocket expenditures include all costs except (family) labor costs.

Table 2B. Per Donum and Total Wheat Revenue and Gross Margin for a Typical Farm in the Mafraq Farming Region of Jordan

Revenue Item	Unit	Selling Price (JD)	Quantity	Revenue (JD)
Harvested Output:				
Grain	Kg./Donum	-----	44	-----
Straw	Kg./Donum	-----	88	-----
Revenue:				
Cash Sales:				
Grain	Kg./Donum	0.108	44	4.75
Straw	Kg./Donum	0.027	88	2.33
Grazed	Donum	1.78	0	0.00
Grazed Aftermath	Donum	0.42	1	0.42
Total Cash Sales/Donum				7.50
Gross Margin (Net Returns to Land, Capital & Management):				
Per Donum				2.10

NOTES: All grain, straw, and aftermath grazing are valued at average 1989 market prices. Straw production is assumed to be twice as large as grain production on a typical farm.

Appendix Table 1A. Analysis of Variance (ANOVA) of Seeding Rates, Per Donum Seed Cost, Per Donum Total Costs, and Per Donum Grain Production for Barley Enterprises Between Farmer Strategies in the Mafraq Region

Strategy & Variable			Test Results	
	Mean	Variance	Test	Probability
Seeding Rates:				
Crop Only	5.80	5.04		
Crop, Livestock	5.96	5.22		
Crop, Livestock, Olives	6.17	5.11		
Crop, Olives	5.35	7.31		
F-test			0.361	0.781
Chi-Square			0.697	0.874
Seeding Costs:				
Crop Only	0.412	0.033		
Crop, Livestock	0.432	0.034		
Crop, Livestock, Olives	0.435	0.038		
Crop, Olives	0.442	0.023		
F-test			0.083	0.969
Chi-Square			0.795	0.851
Total Costs:				
Crop Only	0.412	0.033		
Crop, Livestock	0.432	0.034		
Crop, Livestock, Olives	0.435	0.038		
Crop, Olives	0.442	0.023		
F-test			0.083	0.969
Chi-Square			0.795	0.851
Grain Per Donum:				
Crop Only	41.32	1284.63		
Crop, Livestock	50.75	1155.89		
Crop, Livestock, Olives	50.90	2449.60		
Crop, Olives	58.65	995.43		
F-test			0.610	0.610
Chi-Square			[illegible]06	0.157

For the F-test, the probability indicates the likelihood of no significant difference for the variable in question between farmer strategies. The probability for the Chi-Square value (Bartlett test for homogeneity of group variance) shows the likelihood of no significant difference in variance for the variable in question between farmer strategies.

Appendix Table 2A. Distribution of Estimated Tillage Implement Use in Barley Enterprises by Farmer Strategy in the Mafraq Region of Jordan.

Strategy	Tillage Implement			Total
	Harrow	Plow	Both	
Crop Only	2	6	4	12
Crop, Livestock	22	10	2	34
Crop, Livestock, Olives	3	10	1	14
Crop, Olives	1	7	0	8
Total	28	33	7	68

Appendix Table 3A. Distribution of Estimated Tillage Implement Use in Barley Enterprises by Farmer Strategy in the Mafraq Region of Jordan, Predicted Values and Standardized Residuals

Strategy	Tillage Implement		
	Harrow	Plow	Both
Crop Only:			
Predicted Value	8.94	9.97	4.61
Standardized Residual	(-1.04)	(-.04)	(1.50)
Crop, Livestock:			
Predicted Value	17.30	19.30	8.92
Standardized Residual	(2.05)	(-1.24)	(-1.03)
Crop, Livestock, Olives:			
Predicted Value	9.70	10.82	5.00
Standardized Residual	(-.92)	(0.92)	(-.07)
Crop, Olives:			
Predicted Value	7.42	8.27	3.83
Standardized Residual	(-.95)	(0.89)	(0.01)

Test of Model Fit:		Independence Probability
Degrees of Freedom	= 6	
Pearson Chi-Square	= 13.55	0.035
Likelihood Ratio Chi-Square	= 13.14	0.045

Note: Standardized Residuals equal the observed value minus the predicted value divided by the square of the predicted value. A change value of 3.84 was added to each predicted value to eliminate sparse predicted values. Probabilities for Pearson and Likelihood Ratio Chi-Square indicate the likelihood of independence between rainfall zone and flock type.

Appendix Table 4A. Analysis of Variance (ANOVA) of Seeding Rates, Per Donum Seed Cost, Per Donum Total Costs, and Per Donum Grain Production for Barley Enterprises Between Farmers in the Three Rainfall of the Mafraq Region

Strategy and Variable			Test Results	
	Mean	Variance	Test	Probability
Seeding Rates:				
Eastern Zone	5.20	4.18		
Central Zone	6.03	5.08		
Western Zone	6.34	6.84		
F-test			1.72	0.184
Chi-Square			1.46	0.483
Seeding Costs:				
Eastern Zone	0.391	0.030		
Central Zone	0.443	0.033		
Western Zone	0.443	0.034		
F-test			1.172	0.184
Chi-Square			1.457	0.483
Total Costs:				
Eastern Zone	3.834	7.180		
Central Zone	2.755	4.175		
Western Zone	3.713	6.591		
F-test			2.530	0.085
Chi-Square			3.206	0.201
Grain Per Donum:				
Eastern Zone	58.60	1613.39		
Central Zone	47.42	1390.93		
Western Zone	45.84	1208.30		
F-test			0.955	0.388
Chi-Square			0.484	0.785

NOTES: For the F-test, the probability indicates the likelihood of no significant difference for the variable in question between farmer strategies. The probability for the Chi-Square value (Bartlett test for homogeneity of group variance) shows the likelihood of no significant difference in variance for the variable in question between farmer strategies.

Appendix Table 5A. Distribution of Estimated Tillage Implement Use in Barley Enterprises by Rainfall Zone in the Mafraq Region of Jordan

Strategy	Tillage Implement			Total
	Harrow	Plow	Both	
Eastern Zone	7	7	1	15
Central Zone	23	11	5	39
Western Zone	2	11	1	14
Total	32	29	7	68

Appendix Table 6A. Distribution of Estimated Tillage Implement Use in Barley Enterprises by Rainfall Zone in the Mafraq Region of Jordan; Predicted Values and Standardized Residuals

Strategy	Tillage Implement		
	Harrow	Plow	Both
Eastern Zone:			
Predicted Value	11.51	10.73	5.00
Standardized Residual	(-.13)	(0.11)	(0.03)
Central Zone:			
Predicted Value	21.65	20.18	9.41
Standardized Residual	(1.17)	(-1.14)	(-0.11)
Western Zone:			
Predicted Value	11.09	10.33	4.82
Standardized Residual	(-1.50)	(1.48)	(-0.12)

Test of Model Fit:	Independence Probability
Degrees of Freedom = 4	
Pearson Chi-Square = 7.15	0.128
Likelihood Ratio Chi-Square = 7.34	0.119

Note: Standardized Residuals equal the observed value minus the predicted value divided by the square of the predicted value. A change value of 4.08 was added to each predicted value to eliminate sparse predicted values. Probabilities for Pearson and Likelihood Ratio Chi-Square indicate the likelihood of independence between rainfall zone and flock type.

Appendix Table 7A. Analysis of Variance (ANOVA) of Seeding Rates, Per Donum Seed Cost, Per Donum Total Costs, and Per Donum Grain Production for Barley Enterprises Between Farm Size Quartiles in the Mafraq Region

Strategy and Variable			Test Results	
	Mean	Variance	Test	Probability
Seeding Rates:				
1st Quartile	6.46	5.86		
2nd Quartile	5.59	4.58		
3rd Quartile	5.52	3.11		
4th Quartile	5.92	6.16		
F-test			0.910	0.439
Chi-Square			3.211	0.369
Seeding Costs:				
1st Quartile	0.481	0.034		
2nd Quartile	0.391	0.030		
3rd Quartile	0.384	0.021		
4th Quartile	0.460	0.044		
F-test			1.822	0.148
Chi-Square			3.317	0.345
Total Costs:				
1st Quartile	4.013	5.013		
2nd Quartile	3.261	4.412		
3rd Quartile	3.218	4.596		
4th Quartile	2.794	7.403		
F-test			1.390	0.243
Chi-Square			2.606	0.626
Grain Per Donum:				
1st Quartile	53.96	1554.57		
2nd Quartile	42.80	775.94		
3rd Quartile	59.61	1787.88		
4th Quartile	44.42	1707.03		
F-test			1.089	0.357
Chi-Square			4.726	0.193

NOTES: For the F-test, the probability indicates the likelihood of no significant difference for the variable in question between farmer strategies. The probability for the Chi-Square value (Bartlett test for homogeneity of group variance) shows the likelihood of no significant difference in variance for the variable in question between farmer strategies.

Appendix Table 8A. Distribution of Estimated Tillage Implement Use in Barley Enterprises by Farm Size Quartile in the Mafraq Region of Jordan

Strategy	Tillage Implement			Total
	Harrow	Plow	Both	
1st Quartile	3	9	4	16
2nd Quartile	8	7	1	16
3rd Quartile	7	6	1	14
4th Quartile	13	6	1	20
Total	31	28	7	66

NOTE: Size category one contains all flocks with 1 through 24 members; size category two includes flocks with 25 through 59 ewes and does; size category three contains flocks with 60 through 144 ewes and does; and size category four contains flocks with 145 through 486 members.

Appendix Table 9A. Distribution of Estimated Tillage Implement Use in Barley Enterprises by Farmer Strategy in the Mafraq Region of Jordan, Predicted Values and Standardized Residuals

Strategy	Tillage Implement		
	Harrow	Plow	Both
1st Quartile:			
Predicted Value	11.27	10.54	5.38
Standardized Residual	(-1.35)	(0.68)	(1.01)
2nd Quartile:			
Predicted Value	11.27	10.54	5.38
Standardized Residual	(0.14)	(0.06)	(-.28)
3rd Quartile:			
Predicted Value	10.44	9.76	4.99
Standardized Residual	(0.09)	(-.01)	(-.11)
4th Quartile:			
Predicted Value	12.93	12.09	6.17
Standardized Residual	(1.06)	(-.68)	(-.58)

Test of Model Fit:	Independence Probability
Degrees of Freedom = 6	
Pearson Chi-Square = 5.35	0.500
Likelihood Ratio Chi-Square = 5.48	0.484

NOTE: Standardized Residuals equal the observed value minus the predicted value divided by the square of the predicted value. A change value of 3.73 was added to each predicted value to eliminate sparse predicted values. Probabilities for Pearson and Likelihood Ratio Chi-Square indicate the likelihood of independence between rainfall zone and flock type.

Appendix Table 1B. Analysis of Variance (ANOVA) of Seeding Rates, Per Donum Seed Cost, Per Donum Total Costs, and Per Donum Grain Production for Wheat Enterprises Between Farmer Strategies in the Mafraq Region

Strategy & Variable			Test Results	
	Mean	Variance	Test	Probability
Seeding Rates:				
Crop Only	3.57	12.30		
Crop, Livestock	4.02	13.04		
Crop, Livestock, Olives	3.14	11.22		
Crop, Olives	2.12	7.85		
F-test			1.087	0.358
Chi-Square			1.101	0.777
Total Costs:				
Crop Only	3.190	4.008		
Crop, Livestock	3.182	5.369		
Crop, Livestock, Olives	3.861	5.275		
Crop, Olives	4.029	9.602		
F-test			0.724	0.540
Chi-Square			3.254	0.354
Grain Per Donum:				
Crop Only	63.05	4393.14		
Crop, Livestock	40.08	2536.57		
Crop, Livestock, Olives	27.49	938.22		
Crop, Olives	42.41	311.83		
F-test			0.785	0.510
Chi-Square			5.896	0.117

NOTE: Grain per donum data is for the 1989 crop year only. For the F-test, the probability indicates the likelihood of no significant difference for the variable in question between farmer strategies. The probability for the Chi-Square value (Bartlett test for homogeneity of group variance) shows the likelihood of no significant difference in variance for the variable in question between farmer strategies.

Appendix Table 2B. Distribution of Estimated Tillage Implement Use in Wheat Enterprises by Farmer Strategy in the Mafraq Region of Jordan.

Strategy	Tillage Implement			Total
	Harrow	Plow	Both	
Crop Only	3	3	8	14
Crop, Livestock	14	3	4	21
Crop, Livestock, Olives	1	2	3	6
Crop, Olives	0	1	1	2
Total	18	9	16	43

Appendix Table 3B. Distribution of Estimated Tillage Implement Use in Wheat Enterprises by Strategy in the Mafraq Region of Jordan, Predicted Values and Standardized Residuals

Strategy	Tillage Implement		
	Harrow	Plow	Both
Crop Only:			
Predicted Value	8.45	5.01	7.51
Standardized Residual	(-.85)	(-.45)	(1.27)
Crop, Livestock:			
Predicted Value	12.08	7.15	10.74
Standardized Residual	(1.41)	(-.43)	(-1.14)
Crop, Livestock, Olives:			
Predicted Value	6.44	3.81	5.72
Standardized Residual	(-.96)	(1.12)	(.11)

Test of Model Fit:	Independence Probability
Degrees of Freedom = 4	
Pearson Chi-Square = 8.21	0.084
Likelihood Ratio Chi-Square = 8.04	0.090

NOTE: Standardized Residuals equal the observed value minus the predicted value divided by the square of the predicted value. A change value of 2.99 was added to each predicted value to eliminate sparse predicted values. Probabilities for Pearson and Likelihood Ratio Chi-Square indicate the likelihood of independence between rainfall zone and flock type. Data is for the 1989 crop year only. The crop, olive strategy is excluded from the covariance analysis.

Appendix Table 4B. Analysis of Variance (ANOVA) of Seeding Rates, Per Donum Seed Cost, Per Donum Total Costs, and Per Donum Grain Production for Wheat Enterprises Between Farmers in the Three Rainfall of the Mafraq Region

Strategy and Variable			Test Results	
	Mean	Variance	Test	Probability
Seeding Rates:				
Eastern Zone	3.14	13.46		
Central Zone	4.10	11.80		
Western Zone	2.45	9.07		
F-test			1.99	0.143
Chi-Square			0.88	0.644
Total Costs:				
Eastern Zone	4.068	7.428		
Central Zone	2.893	3.503		
Western Zone	3.929	7.103		
F-test			2.835	0.064
Chi-Square			6.106	0.047
Grain Per Donum				
Eastern Zone	39.41	348.62		
Central Zone	51.17	3592.13		
Western Zone	17.93	843.04		
F-test			1.097	0.344
Chi-Square			12.285	0.002

NOTE: Grain per donum data is for the 1989 crop year only. For the F-test, the probability indicates the likelihood of no significant difference for the variable in question between farmer strategies. The probability for the Chi-Square value (Bartlett test for homogeneity of group variance) shows the likelihood of no significant difference in variance for the variable in question between farmer strategies.

Appendix Table 5B. Distribution of Estimated Tillage Implement Use in Wheat Enterprises by Farmer Rainfall Zone in the Mafraq Region of Jordan

Strategy	Tillage Implement			Total
	Harrow	Plow	Both	
Eastern Zone	4	1	4	9
Central Zone	12	5	11	28
Western Zone	2	3	1	6
Total	18	9	16	43

NOTE: Data is for the 1989 crop year only.

Appendix Table 6B. Distribution of Estimated Tillage Implement Use in Wheat Enterprises by Farmer Rainfall Zone in the Mafraq Region of Jordan, Predicted Values, and Standardized Residuals

Strategy	Tillage Implement		
	Harrow	Plow	Both
Eastern Zone:			
Predicted Value	7.36	5.01	6.83
Standardized Residual	(0.02)	(-.27)	(0.22)
Central Zone:			
Predicted Value	14.64	9.97	13.60
Standardized Residual	(0.20)	(-.50)	(0.22)
Western Zone:			
Predicted Value	6.21	4.23	5.77
Standardized Residual	(-.32)	(1.06)	(-.57)

Test of Model Fit:	Independence Probability
Degrees of Freedom = 4	
Pearson Chi-Square = 2.00	0.736
Likelihood Ratio Chi-Square = 1.90	0.755

NOTE: Standardized Residuals equal the observed value minus the predicted value divided by the square of the predicted value. A change value of 3.4 was added to each predicted value to eliminate sparse predicted values. Probabilities for Pearson and Likelihood Ratio Chi-Square indicate the likelihood of independence between rainfall zone and flock type. Data is for the 1989 crop year only.

Appendix Table 7B. Analysis of Variance (ANOVA) of Seeding Rates, Per Donum Seed Cost, Per Donum Total Costs, and Per Donum Grain Production for Wheat Enterprises Between Farm Size Quartiles in the Mafraq Region

Strategy and Variable			Test Results	
	Mean	Variance	Test	Probability
Seeding Rates:				
1st Quartile	4.93	13.83		
2nd Quartile	4.85	12.44		
3rd Quartile	3.89	11.41		
4th Quartile	3.34	10.14		
F-test			0.952	0.420
Chi-Square			0.457	0.928
Total Costs:				
1st Quartile	3.471	2.919		
2nd Quartile	3.792	6.357		
3rd Quartile	3.633	1.850		
4th Quartile	3.356	4.556		
F-test			0.148	0.931
Chi-Square			2.261	0.454
Grain Per Donum:				
1st Quartile	59.70	4402.00		
2nd Quartile	28.44	881.33		
3rd Quartile	51.17	3343.09		
4th Quartile	35.54	1783.07		
F-test			0.817	0.492
Chi-Square			6.157	0.104

NOTE: Grain per donum data is for the 1989 crop year only. For the F-test, the probability indicates the likelihood of no significant difference for the variable in question between farmer strategies. The probability for the Chi-Square value (Bartlett test for homogeneity of group variance) shows the likelihood of no significant difference in variance for the variable in question between farmer strategies.

Appendix Table 8B. Distribution of Estimated Tillage Implement Use in Wheat Enterprises by Farm Size Quartile in the Mafraq Region of Jordan

Strategy	Tillage Implement			Total
	Harrow	Plow	Both	
1st Quartile	3	1	7	11
2nd Quartile	5	2	4	11
3rd Quartile	5	4	2	11
4th Quartile	5	2	3	10
Total	18	9	16	43

NOTE: Data is for the 1989 crop year only.

Appendix Table 9B. Distribution of Estimated Tillage Implement Use in Wheat Enterprises by Farmer Strategy in the Mafraq Region of Jordan, Predicted Values and Standardized Residuals

Strategy	Tillage Implement		
	Harrow	Plow	Both
1st Quartile:			
Predicted Value	7.29	5.01	6.78
Standardized Residual	(-.59)	(-.59)	(1.12)
2nd Quartile:			
Predicted Value	7.29	5.01	6.78
Standardized Residual	(0.15)	(-.14)	(-.03)
3rd Quartile:			
Predicted Value	7.29	5.01	6.78
Standardized Residual	(0.15)	(0.75)	(-.80)
4th Quartile:			
Predicted Value	6.90	4.74	6.42
Standardized Residual	(0.30)	(-.02)	(-.29)

Test of Model Fit:	Independence Probability
Degrees of Freedom = 6	
Pearson Chi-Square = 3.40	0.758
Likelihood Ratio Chi-Square = 3.34	0.766

NOTE: Standardized Residuals equal the observed value minus the predicted value divided by the square of the predicted value. A change value of 2.69 was added to each predicted value to eliminate sparse predicted values. Probabilities for Pearson and Likelihood Ratio Chi-Square indicate the likelihood of independence between rainfall zone and flock type. Data is for the 1989 crop year only.