An Analysis of Resource Productivity on Farm -Level Data in Jerash Area, 1998, "An Econometric Test"

By

*Majeed Ali Hussain** *Afaf Abdul-Jabbar Saed***

ملخص

تحليل إنتاجية الموارد على مستوى المزرعة في منطقة جرش ، ١٩٩٨ "اختبار قياسي"

تهدف الدراسة إلى اختبار وتحليل إنتاجية الموارد على مستوى المزرعة في منطقة جرش . وقد استند التحليل على بيانات المستخدم ــ المنتج لدالة الإنتاج للعام ١٩٩٨ ، حيث استندت هذه الدراسة على بيانات المقطع العرضي لخمسين مزارعا من خلال القيام بعمل ميداني ، وقد لا تكون هذه الدراسة دليلا مساعدا لمزارعي المنطقة ، بل ممكن أن تساعد في فهم وإدراك تباين إنتاجية الموارد في الاستخدام لتلك المزارع في ظل الهيكل المؤسسي المقدم .

إن فرضية البحث هو وجود فائض في العمل المزرعي وأن عائد الحجم ليس ثابتا بل متزايدا . وقد تم اختبار تلك الفرضية على أساس تحليل دالة الإنتاج .

وخلصت الدراسة بأن نتائج عملية التقدير تشير إلى وجود فائض في العمل المزرعي ، وسوء تخصيص موردي رأس المال والعمل وأن عوائد الحجم متزايدة .

* Assistant Professor of Economics, College of Economic & Administration Science, Jerash University. Jordan.

** Assistant Professor of Economics, College of Economic & Administration Science, Hashimite University. Jordan.

1. Introduction

In developing countries in general and in Jordan in particular the agricultural sector was considered one of the more productive and important sectors, until the end of the sixties because of its significant contribution in the GDP, its contribution has been as much as 22% and it has observed as much as 33% of the labor force (Bani Hani A., 1996, p 4O3). However, from the beginning of the eighties the agricultural sector contribution to the GDF started to decline. It was 7.2% in 1981 and declined to 5.5% in 1996(Central Bank of Jordan,1986, 1996). This decline in agricultural sector is in favor of industries and construction.

The total labor force engaged in agricultural sector has een increased from 39 thousand in 1981 to about 55 thousand in 1996, which represents a decline in a relative share from 9.3% in 1981 to 6.4% of the total labor force in the country in 1993 (Central Bank of Jordan, various issues).

However, the main objectives of the present study are to test the hypothesis of existing a surplus of farm labor and increasing return to scale. Labor surplus has played an important role in theorizing economic development of developing countries. If total agricultural output does not decrease through withdrawal of some laborers (who make no contribution to the output), then national income of the country can be increased by utilizing the surplus of Labor force in alternative occupation.

To study the contribution of labor (family and hired) and then family labor in the production of crops on the farm economies of Jerash area, an attempt has been made to measure the marginal productivity of labor inputs to test the allocative efficiency of inputs. The Log-linear models of the Cobb-

Douglas Production Function are estimated as in equation (2) using cross-section data of 50 farmers in winter 1998, by the method of Ordinary Least Squares (OLS).

2. Review of previous studies

A lot has been written on various aspects of surplus labor in 1950's and thereafter. The empirical studies either establish or reject the surplus labor hypothesis and also attempt to explain the pattern of labor utilized in agriculture.

Several development models have focused on agriculture's potential contribution to economic development. These models are initiated by Western economists such as Lewis (1954) agricultural surplus paper; Nurkse (1955); Mellor (1956); Rodan (1957); and Barker (1961). The Lewis model was elaborated in the mid-1960s by J. Fei and G. Ranis, who support the idea of surplus labor and low marginal productivity of agricultural Labor. Whereas Schultz (1964) and others refuted the idea of low marginal productivity of agricultural Labor. These different concepts are viewed by the above mentioned economists to draw different conclusions. For example, the Lewis Fei and Ranis model describes how an agricultural sector, characterized by surplus labor, can harness its "agricultural surplus" for capital formation. In effect, this model argues that the transfer of surplus workers from agriculture (where they have a zero marginal product) to industry (where their marginal product is positive) can create a surplus for industrial capital formation. Rodan (1957) established that after withdrawing 20 percent of population German-occupied Poland's, agricultural output did not decline. But on the other hand, *Schultz* (1964) in his empirical studies of India and Latin American countries concluded that the removal of labor caused decline in agricultural output.

The agricultural surplus model appeared to provide an attractive alternative for developing countries. The developing countries could pull themselves up by their own bootstraps simply by allocating labor in more efficient way.

3. Data And Methods

Production function analysis is based on the survey data collected selectively from 50 farm holdings of Jerash area in winter months 1998. The survey encompassed fourteen villages in Jerash area: Al-Rashaida; Ttaheyat sad Al-Malek Talal; Al--mestaba; Juba; Al-Kita; Al-Kfair; Al-Abara; Al-Hamam; Al-Alouk; Tawaheen Al-Adwan; Al-Samarah; Al-Sawari; Al-Majdal and Al-Wadi Al-Akther These villages range in the distance from (0.500 Kms to 15 Kms.) from Jerash Governorate

The data were collected through personal interview by comprehensive schedule providing information about the value of output, the land brought under cultivation, the number of family and hired labor, and capital (used value of seeds, fertilizer, and pesticides), and management and distance as well The value of magnitudes were estimated using prevailing market price.

The data were stratified in several ways; Farmers with cultivated holdings less than or equal two Donums(*) were classified as small-scale farmers(**) Those with cultivated holdings greater than two Donums were classified as large-scale farmers. For these groups production functions were estimated

(*)Dounm =1000 Kms

(**)The stratification was done on farmers rather than plots since each farmer had more than one plot, and output had been estimated on each farmer as the relevant economic unit.

with management index and without management index for small and large farm size and for all farms. Other subgroups for which production functions were estimated were farmers with plots less than one km apart, farmers with plots more than one kms a part. The number of farms in each size group was not identical.

During the field survey the enumerators obtained detailed information on farm Labor inputs in terms of hours worked on the farm by the farm operator, his family and hired labor. Labor resources are measured in terms of a standard eight hours work per worker. So the calculation in standard eight hours days, men are weighted one, women *one* and children half (Bliss and Stern, 1988).

As a measure of the management input a management index was included in the analysis. Due to the lack of a suitable measuring scale a relatively simple and unrefined method of evaluation was employed. Each enumerator was instructed to form an opinion of the farmer's managerial ability during the interview and to define his opinion in terms of the following five scores in table (l):

Table (1)

Quality of Management	**Score**
Very poor	1
Below Average	2
Average	3
Above Average	4
Very good	5

Most of the enumerators were literate. A large number of Farmers had worked on farm and were familiar with many of the

day-to-day problems farming. They were instructed to let their opinion be guided by one criterion: a credit rating which ignored capital and personal assets held by the farmer in question. As a rule the enumerators scored the farmers on their degree of alertness, intelligence, technical knowledge, "drive", and ability of coordination. These factors were completely subjective.

It was assumed that these scores for management were normally distributed around the true score. Therefore, the average score was accepted as a representative index in this study. The distribution of this index by farm size and for all farms is shown in table 2.

Table (2) Frequency Distribution of managerial Indices and Average Indices by farm size for All farmers

Table (2)

Managerial Index	Farm size small	Large	All farms
1.0	4	0	4
1.5	2	1	3
2.0	5	1	6
2.5	3	3	6
3.0	7	0	7
3.5	4	2	6
4.0	4	4	8
4.5	1	5	6
5.0	0	4	4
Average Index	3.3	2.2	5.5

Sources: field work. 1998.

To estimate a production Function, in non-logarithmic form, read:

$$Y = e^{\beta_0} K^{\beta_1} L^{\beta_2} A^{\beta_3} M^{\beta_4} Ui \qquad (1)$$

After logarithmic transformation, the production function, linear in logarithms form, was fitted by the method of least squares to the input-output data of these 50 farms as follows:

$$Log\ Y = \beta_0 + \beta_1 \log K + \beta_2 \log L + \beta_3 \log A + \beta_4 \log M \qquad (2)$$

Where Y is farm output in dinar, and K, L, A and M are independent variables capital, Human labor-day, land in donums, and management respectively; Where:

β_1, β_2, β_3 and β_4 are constants, β_0 = constant intercept, β_1 =capital Elasticity; β_3 =Elasticity of human Labor-day, β_3 =Elasticity of Land; β_4 =Elasticity of management Index. ui= error term

4. Results And Discussion

The result of the estimates and computation are shown as follows:

For all farmers including management Index the production function can be seen in table (3) as follows:

Table (3)

	Estimated coefficients	S. E(*)	T - value
Constant	-2.56	0.740	-3.48
Capital (K)	0.84	0.128	6.62
Labor (L)	0.12	0.195	1.29
Land (A)	0.63	0.127	4.94
Management (M)	-0.10	0.019	-1.05
Sum of Elasticities	1.49		
R – Squared	0.96		
No. of observations	50		

(*) S. E = stand for standard error.

According to production function 2 there were increasing return to scale in farm in the survey area. Under condition of increasing return to scale an equiproportion increase in all resource inputs leads to a more than proportionate increase in output.

The elasticity of production i.e. sum of elasticities of the independent variables amounted to 1.49 as shown in the first column of table 3. This value suggests that a 1.00 percent increase in all inputs, raised the output by 1.49 percent.

The coefficients of capital and land are significantly different from zero at 5 percent confidence level. The coefficients of labor and management index are not significantly different from zero at 5 percent confidence. Management inputs is seen as contributing nothing to output as its coefficient is not significantly different from zero.

The question arose why there are increasing returns to scale in this particular case. One possible explanation was that farm machinery could be used much more efficiently on the large-scale farm than on the small-scale farm. To some extent this explanation was supported by the fact that farmers in the survey area shared machinery and equipment quite frequently.

The marginal productivity estimates of the individual resources are shown in table (4). They were derived from equation 2 and represent marginal returns when all inputs were held at their Geometric mean. They imply that ceteris paribus one

Table (4)

Resources	Geometric Mean(*)	Marginal productivity	Market price (Jordanian Denar)
Productivity	3.3063	-	-
Capital	6.1896	0.45	6.0
Labor	1.8399	0.22	3.0
Land	0.5017	4.14	25.0
Management	1.0005	0.31	-

(*) All resource are measured in Jordanian Dinar except for management which is measured by a management index.

extra dinar of capital invested added JD 0.45 to gross returns, one additional hour of labor added JD 0.22 one additional dinar invested in land added JD 4.14, and one more unit of management ability JD 0.314. If the market price chosen were realistic resources were misallocated on these farms because marginal productivities were above or below but not equal to the market price. On the basis of further analysis it could be concluded that there existed a surplus labor relative to capital and land, and management was a limiting factor of production.

The estimated production function for small-scale farmers including management Index can be seen in table (5):

Table (5)

	Estimated coefficients	S. E	T - value
Constant	-0.88	0.778	-1.13
Capital (K)	0.860	0.154	5.59
Labor (L)	0.823	0.159	5.19
Land (A)	0.528	0.135	3.91
Management (M)	-0.059	0.127	0.13
Sum of Elasticities	2.152		
R – Squared	0.91		
No. of observations	30		

The coefficient of capital, labor and land are significantly different from zero at 5 percent confidence level. Only the coefficient of management index was not significantly different from zero at 5 percent confidence level.

For large-scale farmers including management Index the production functions can be seen from table (6):

Table (6)

	Estimated coefficients	S. E	T – value
Constant	2.565	1.34	1.91
Capital (K)	0.462	0.18	2.58
Labor (L)	0.452	0.16	0.80
Land (A)	0.215	0.068	3.16
Management (M)	0.082	0.088	0.64
Sum of Elasticities	1.211		
R – Squared	0.89		
No. of observations	20		

The coefficients of capital, labor and land are significantly different from zero at 5 percent confidence level, except for management which was not significantly different from zero at 5 percent confidence level.

To estimate the return to scale, the sum of coefficient is taken for each group. For all farmers, the coefficient sum is 2.152 showing increasing return to scale. For large-scale farmers, the coefficient sum is 1.211 also showing increasing return to scale.

Using a t-test(*) the returns to scale were tested to see if the diverge significantly differ from unity. The t-value of the coefficient for small-scale farmers is (-0.744) which is not significant at 5 percent confidence level. For large-scale farmers the t-value of the coefficient is (-0.059) which is also not significant at 5 percent confidence level. However, both small scale and large scale-farmers do not diverge significantly from unity.

Also a t-test?? Was applied to see if the return to scale in the different groups are different from each other. The test shows that there is significant difference at 5 percent confidence level between the return to scale in the small -scale farmers holdings. The t-value is (4.073).

(*) $t = \frac{1-\sum_{i}^{vt}=_1\beta}{\sqrt{\text{var}(\sum_{i=1}^{n}\beta i)}}$ where β_i, i = 1, 2, ...n, coefficient; $\sqrt{\text{var}\sum_{i=1}^{n}\beta i}$ = the variance of the sum of the coefficient is the sum of the elements of the variance-covariance matrix printed out in the computer output except that of the intercept term (Heady and Dillon, 1961, pp. 116- 117.

The estimated production function for small-scale farmers excluding management Index as can be seen from table (7):

Table (7)

	Estimated coefficients	S. E	T - value
Constant	-0.91	0.74	-1.22
Capital (K)	0.86	0.15	5.73
Labor (L)	0.82	0.16	5.29
Land (A)	0.52	0.13	4.03
Management (M)	-	-	-
Sum of Elasticities	2.01 0.91		
R – Squared	30		
No. of observations			

The coefficient of capital, labor and land are significantly different from zero at 5 percent confidence level.

The coefficient sum is (2.0l) and shows increasing return to scale. This is not diverge significantly from unity, at 5 percent confidence level with a t-value(**) (-0.74).

(**) $t = \dfrac{\sum_{i=1}^{n} \beta i^1 \sum_{i=2}^{n} \beta i^2}{\sqrt{\text{var}(\sum_{i=1}^{n} \beta i^1) + \text{var}(\sum_{i=2}^{n} \beta i^2)}}$, where $\sum_{i=1}^{n} \beta i^1$ = sum of the coefficient in group 1 , and $\sum_{i=1}^{n} \beta i^2$ = sum of the coefficients in group 2 , and the denominator is an estimate of the standard error of the difference. (Heady and Dillon, p 117).

For the large- scale farmers excluding management Index the production functions can be seen from table (8):

Table (8)

	Estimated coefficients	S. E	T - value
Constant	2.78	1.32	2.40
Capital (K)	0.45	0.18	2.55
Labor (L)	0.42	0.16	2.67
Land (A)	0.23	0.07	3.46
Management (M)	-	-	-
Sum of Elasticities	1.10		
R – Squared	0.89		
No. of observations	20		

The coefficient of capital, labor and land are significantly different from zero at 5 percent confidence level. The coefficient sum is (1.10), which is not significantly different from zero at 5 percent confidence level (t-value -0.062).

On testing the difference in the return to scale between the small scale farmers and large-scale farmers excluding management, the t-value attained is (1.08) which is not significantly different from zero at 5 percent confidence level.

For all farmers excluding management Index the production function as can be seen from table (9):

Table (9)

	Estimated coefficients	S. E	T – value
Constant	-2.54	0.74	-3.43
Capital (K)	0.86	0.13	6.70
Labor (L)	0.13	0.10	1.32
Land (A)	0.63	0.13	4.86
Management (M)	-	-	-
Sum of Elasticities	1.35		
R – Squared	0.96		
No. of observations	50		

The coefficients of capital and land are significantly different from zero at 5 percent confidence level. The coefficient of labor was not significantly different from zero at 5 percent confidence.

The production function for farmers with plots less than or equal two kms apart including management Index, can be seen from table (10):

Table (10)

	Estimated coefficients	S. E	T – value
Constant	2.69	1.68	1.60
Capital (K)	0.46	0.24	1.96
Labor (L)	0.43	0.20	2.20
Land (A)	0.21	0.09	2.35
Management (M)	0.06	0.11	0.57
Sum of Elasticities	1.16		
R – Squared	0.87		
No. of observations	14		

The coefficient of labor and land are significantly different from zero at 5 percent confidence level. The coefficient of capital and management are not significantly different from zero at 5 percent confidence of level.

The production function for the farmers with plots more than two kms apart including management Index, the production function as can be seen from table(11):

Table (11)

	Estimated coefficients	S. E	T - value
Constant	-1.10	0.74	-1.50
Capital (K)	0.94	0.14	6.63
Labor (L)	0.62	0.14	4.35
Land (A)	0.29	0.10	2.82
Management (M)	0.01	0.13	0.09
Sum of Elasticities	1.86		
R – Squared	0.94		
No. of observations	36		

The coefficients of capital, labor and land are significantly different from zero at 5 percent confidence level. Only the coefficient of management was not significantly different from zero at 5 percent confidence level.

To estimate the return to scale, the sum of coefficient is taken for each group. For the farmers with plots less than or equal two kms, the coefficient sum is 1.17 showing increasing return to scale. For the farmers with plots more than two kms apart, the coefficient sum is 1.86 also showing increasing return to scale. However, both groups do not diverge significantly from unity.

Also a t-test was applied to see if the return to scale in the different groups are different from each other. The test shows that there is no significant difference at 5 percent confidence level between the return to scale in both groups. The t-value is (-0.172).

All the production function estimated can be considered reliable on the basis that at least two of the factor coefficients are significantly different from zero at 5 percent confidence level.

In small-scale farmers, the elasticities of both hired and family Labor are found to be significantly different from zero at 5% confidence level, where the sum of elasticities were greater than unity which means that increasing return to scale as seen from table (12).

Table (12): Elasticities of factors of production for small- scale farmers

Item Labor		L^H	L^F	L^H	L^F
Coefficients of Determination	R^2	0.84	0.82	0.84	0.82
Capital (K)	β_1	1.24 (7.25)**	1.29 (6.84)**	1.24 (7.09)**	1.29 (6.70)**
Labor (L)	β_2	0.49 (2.10)*	0.032 (0.19)	0.49 (2.06)*	0.031 (0.18)
Area (A)	β_3	0.34 (2.05)*	0.29 (1.62)	0.034 (1.99)	0.28 (1.56)
Management (M)	β_4	--	--	-0.013 (-0.08)	0.012 (0.07)
Sum of Elasticities		2.03	1.61	2.05	1.61

Notes: L^H =Hired Labor, L^F = Family Labor.
(*) Significantly different from zero at 5% confidence level.
(**) Significantly different from zero at 1% confidence level.
(Figures in Parentheses are T-values).

Whereas, in the large scale farmers, the elasticities for both hired and family labor are found to be not significant at acceptable level, and the sum of elasticities were less than unity, which indicated decreasing return to scale, as seen from table (13).

Table (13): Elasticities of factors production for large- scale farmers.

Item Labor		L^H	L^F	L^H	L^F
Coefficients of Determination	R^2	0.85	0.85	0.83	0.83
Capital (K)	β_1	0.35 (1.79)	0.31 (1.64)	0.35 (1.74)	0.312 (1.42)
Labor (L)	β_2	0.077 (1.56)	-0.025 (-0.31)	0.077 (1.51)	-0.025 (-0.29)
Area (A)	β_3	0.33 (6.05)**	0.36 (5.74)**	0.33 (5.84)**	0.36 (1.42)
Management (M)	β_4	--	--	0.025 (0.26)	0.026 (0.25)
Sum of Elasticities		0.757	0.635	0.782	0.673

See notes on table 12.

All the above production functions show increasing return to scale, except for large- scale farmers with hired and family labor which shows decreasing return to scale as seen in table (13).

5. Concluding Remarks

From the foregoing empirical study of Jerash area, one could note the existence surplus labor. It also shows that the returns to scale were not constant but increasing. It is interesting to point out that the problem of surplus labor exists in the study area, since MP of labor is less than market price.

It is clear from the above analysis that the marginal product of total labor is less than the market price (wage rate)of labor.

The gap arising between marginal productivity of labor and wage rate may be mainly due to the imputation of market wage rate to the family labor. In agriculture, the combined use of hired labor and family labor is a common practice. The employment of hired labor varies from operation to operation. In the operation of harvesting, sowing, weeding, etc., a major portion of hired labor is employed. But in other farm operations main part is played by family labor. In real sense, major portion of labor on farm holdings is self-employed. They hardly bother for the marginal products of labor.

The major criterion in the family is to share the work equally although the productivity of labor is very low. This leads to a situation in which all workers merely appear to be working but actually they are contributing nothing to the output.

In the case of hired labor, too, the farmers do not behave rationally. Actually in the strict theoretical sense, when we assume perfectly competitive labor market, the existence of surplus of hired labor would not be possible. If the assumption of competitive labor is true with the marginal product of labor being zero, the wage rate will also be zero. But in Jordan this assumption does not hold true. Some times farmer has to employ hired labor because some of the inputs are hired. With introducing mechanical input, farmers have to employ family labor and hired labor as well.

Overall analysis gives some interesting inferences. If there is any scope of raising the productivity and labor utilization by rational employment of the existing resources in order to increase the output, then the surplus labor would be reduced.

However in all functions the elasticities of production were significantly different from zero at 5% confidence level except for management. And the sum of elasticities are more than unity, i.e. the hypothesis of increasing returns to scale could be accepted statistically.

It can be concluded that the results of this analysis indicate the existence of a surplus farm labor, and the prevalence of increasing returns to scale. Since management appeared to be a limiting factor of production a credit policy favoring farmers of superior managerial ability may be advocated.

All estimates of resource productivity were derived by production function analysis, only some problems of specification were considered. To what extent the subjective evaluation of management, the aggregation of inputs and outputs and choice of the production affect the reliability of the productivity estimates, remain unknown, Since reliable estimates of resource productivity in agriculture could be of great value, further studies dealing with these problems may prove very useful.

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Appendix

(1) Correlation coefficient Matrix for all farmers including management index.

	Lprod	Lcap	Llab	Lland
Lcap	0.959			
Llab	0.453	0.440		
Lland	0.947	0.931	0.444	
Lindex	0.099	0.069	0.049	0.097

(2) Correlation coefficient Matrix for all farmers excluding management index.

	Lprod	Lcap	Llab	Lland
Lcap	0.959			
Llab	0.453	0.440		
Lland	0.947	0.931	0.444	

(3) Correlation coefficient Matrix for small farmers including management index.

	Lprod	Lcap	Llab	Lland
Lcap	0.893			
Llab	0.604	0.433		
Lland	0.685	0.651	0.444	
Lindex	0.093	0.070	0.014	0.178

(4) Correlation coefficient Matrix for small farmers excluding management index.

	Lprod	Lcap	Llab	Lland
Lcap	0.959			
Llab	0.453	0.440		
Lland	0.947	0.931	0.444	

(5) Correlation coefficient Matrix for large farmers including management index.

	Lprod	Lcap	Llab	Lland
Lcap	0.657			
Llab	0.746	0.448		
Lland	0.896	0.584	0.688	
Lindex	0.123	0.068	- 0.087	0.105

(6) Correlation coefficient Matrix for large farmers excluding management index.

	Lprod	Lcap	Llab
Lcap	0.657		
Llab	0.746	0.448	
Lland	0.896	0.584	0.688

(7) Correlation coefficient Matrix for farms (plots) less than or equal two Kms apart including management index.

	Lprod	Lcap	Llab	Lland
Lcap	0.720			
Llab	0.728	0.329		
Lland	0.874	0.649	0.636	
Lindex	0.0.47	0.042	-0.112	0.008

(8) Correlation coefficient Matrix for farms (plots) more than two Kms apart including management index.

	Lprod	Lcap	Llab	Lland
Lcap	0.937			
Llab	0.770	0.665		
Lland	0.827	0.802	0.522	
Lindex	0.157	0.149	0.073	0.209

Notes:

Lprod = stand for log productivity.
Lcap = stand for log capital.
Llap = stand for log labor.
Lland = stand for log land.
Lindex = stand for log management Index.