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The Impact of Technology on Jordanian Agricultural Sector

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Abstract

The study examined the impact of technology on the Jordanian agricultural sector for the period 1987-2016. This study used the Cobb-Douglas linear regression model to test hypotheses. The study found that employment and capital have a positive and statistical effect on the Jordanian agricultural sector. The effect was insignificant with a value of 0.5997, which is greater than 5%. The results also show that agricultural output works at a declining rate of return for volume as the total elasticity of the two components of production for labor and capital are less than the right one, where agricultural output is growing at a slower rate than the increase in labor and fixed capital. Technology has no significant impact and this may be due to the low knowledge and skills of the labor force. Therefore, it is recommended for those interested in the agricultural sector to increase the skills of agricultural labor and provide them with modern agricultural knowledge.

Introduction

The economic status of nations is almost synonymous with the extent of their progress in the various fields of technology. It is common knowledge that referring to a country as a developing country means that it does not have the technology to elevate it to the ranks of the advanced industrialized countries in the field of technology. Therefore, the concern of developing countries is to take advantage of modern technology in various economic sectors to improve economic growth rates. The agricultural sector is an important sector in the economies of countries because agricultural production is a strategic commodity, because arable land is often limited, water resources are limited, and agricultural production is increased. It is recommended to use the best agricultural technology to ensure productivity and efficiency of the agricultural sector in Jordan, to develop the agricultural sector through legislation and the use of advanced agricultural technology.

The agricultural sector in any country in the world plays an important role in the economic and social development process. Successful development experiences in various countries of the world have shown that the agricultural sector plays a central and pivotal role in the rise of the state and economic and social progress. The importance of the agricultural sector is also increased by contributing to production and employment and increasing the country's GDP, as well as being a major source of food for the population, providing the economic sectors with the necessary productive inputs, in addition to absorbing labor and increasing agricultural exports and their diversity, and 28% of the GDP of other sectors is directly or indirectly dependent on the Jordanian agricultural sector.

Global agriculture, including agriculture in the Arab region and Jordan is one of it, faces many difficulties and challenges such as global climate change and changes in the level and time of rainfall. The Arab region is one of the most agricultural areas that have suffered during the past decades. This has led many researchers to find solutions that reduce these effects, Where the thinking of technology has become a basic and logical solution to these challenges, especially in the light of the large and increasing demand for food as a result of population growth and urbanization.

The purpose of this study is to examine the impact of agricultural technology on the Jordanian agricultural sector. The rest of the study is arranged as follow: section 2, literature review, section 3 data and methodology, section 4 empirical analysis and results discussion and section 5 conclusions.

Literature Review

Studies have shown that agricultural knowledge and science and technology had contributed significantly in increasing agricultural production over time and contributing to food security through reducing cost reduction, increasing of efficiency and productivity improvement of the agriculture sector (Samah et al., 2009; Blattman et al., 2003; Nicholas, 2003; Ramírez; 2007; Díaz, Urquhart, 2009). . Scientists are taking advantage of technological advances in developing long-term food alternatives to alleviate the burden and difficulty of obtaining for their livelihood under the current changes. (Jaafrawi, 2011).

Providing agricultural communities with access to information sources that can lead to the advancement of agricultural sectors and bring about real changes will create many opportunities for improvement at many levels, whether productive or labor, and provide content that was not previously available (Mustafa, 2012).

The challenge facing agriculture in developing countries in the coming years is enormous, Especially if there is no response to the growing demand for food. Because of population growth and rising incomes, demand in developing countries is expected to increase by 59% for cereals, 60% for roots and tubers, and 12% for meat in the coming period. This expansion of demand can not result from any significant expansion of irrigated area due to water competition with urban demand and environmental problems and while it will therefore need to come from growth in yields. It is worth noting that the growth rate of cereals in developing countries is declining From an annual average of 2.9% in the period 1967-1982 to 1.8% in 1982-2001. (Janvry et al., 2001).

Therefore, the decline in the rate of growth in production should be stopped. Increases in yield should be compared to current trends in part. As the rate of growth in production achieved through traditional plant breeding and agricultural practices is declining, the next phase of increases in production. Agriculture should rely on the scientific progress of biotechnology. However, while biotechnology has made impressive progress in agriculture in some of the more developed countries, it has had little impact in most developing countries and therefore the aim of studies should explore the conditions that can help the current technological revolution which is vital in agriculture in developing countries. (Shaibu, et al., 2008).

Empirical Evidence

The study of Milovanović (2016) aimed to analyze the role, potential and contribution of IT in agriculture business. the study find that IT has great potential for supporting farmers and the other stakeholders in improvement of efficiency, effectiveness and productivity of agriculture.

The study of Joseph Chissa, et al., (2013), aimed to prove the relationship between the agricultural production in South Africa and the independent variables represented by credit in banks, agricultural production requirements, and employment as well as rainfall by using Cobb-Douglas production function. The study showed that there was a statistically significant effect of bank credit and agricultural production requirements, while the results of the study did not show a statistically significant effect of both employment and rainfall on agricultural production. The study also found that the estimated production function is of a fixed size.

The study of Jaafrawi and Inas (2011 aimed to study the determinants of the Egyptian agricultural production function for the period(1985-2011). The study assumes that the independent variables (crop intensification, agricultural production requirements, size of agricultural labor, agricultural output of a previous period) have a significant effect on the dependent variable (Egyptian agricultural output). The descriptive approach has been used to present theoretical principle in the economic thought of the production function. In addition to describing the factors of production factors needed to construct the model of the production by using the production function of (Cobb -Douglas) in line with the nature of the Egyptian agricultural sector. In order to study the relationship between the dependent variable and the independent variables by introducing new independent variables, such as the variable of agricultural output for the previous period, and the variable of crop intensification to express the production element of technical technology, in addition to the traditional production elements of capital and labor. The results of the study showed that the crop density, production requirements, agricultural workers and agricultural output for the previous period had a positive and significant effect on the Egyptian agricultural output. The econometric model explains 99% of the change in the Egyptian agricultural output.

The study of Susan (2011) The aim of the study was to measure the economic impact of improved agricultural technologies on cassava productivity in the state of Koji, Nigeria. The results were drawn from a household survey covering the 2009/2010 agricultural season. The data obtained from the interview table were subjected to descriptive and deductive statistical analysis. The descriptive statistics of this study included frequency and percentages. The hypothesis was tested using a Chi box. The results showed that 79.33% of the sample adopted the use of improved diversity during the period under study. Analysis of respondents 'returns before and after the adoption of improved agricultural technology shows that farmers' income after adoption of innovations is better than the income earned prior to the adoption of 2727 IDPs on the average of each farmer. This result shows that the impact of improved agricultural technologies on cassava productivity is positive. In addition, results show the importance of increasing agricultural productivity while introducing improvements in the adoption and use of improved agricultural technologies and their provision to farmers with farmers' ability to store food. The results of this study agreed with several studies in this area, which noted that improved agriculture helped to increase agricultural productivity.

The study of Zaijan (2011) analyzed the Agricultural Input-Output Based on Cobb-Douglas Production Function in Hebei Province, North China. The study used the Cobb-Douglas function to estimate the agricultural output function to study the significant of independent variables represented by cultivated area, irrigation, chemical fertilizers used, agricultural machinery, electricity used in rural areas and labor force during the period 1999-2008. The study showed that there is a great importance for irrigation, where it ranked first in agricultural output, followed by chemical fertilizers used and agricultural mechanization in second and third rank respectively, while the remaining independent variables showed a weak effect in agricultural output. The study recommended increasing the sources of irrigation and investment in technology mechanisms to promote the development of sustainable agriculture in China.

The study of Al-Hallaq (2001) measured the productivity of some productive sectors in the Jordanian economy during the period 1975-1999, including the sectors of industry, agriculture, services and construction. The study found that productivity of labor and capital was fluctuating from one sector to the another, while the industrial sector was characterized by decreasing volume returns. On the contrary, the services and construction sectors were characterized by increased volume returns, while the agricultural sector was consistently stable.

The present study adds further evidence to the impact of technology level on agricultural sector in developing countries. To the best knowledge of the study, this is the first study to be conducted on the impact of technology level on agricultural sector in Jordan.

Data and Methodology

Data:

This study based on the data collection for labor force in the Jordanian agricultural sector and capital on the Jordanian Department of Statistics for the period 2000-2016, while the data related to the production of the Jordanian agricultural sector based on the Central Bank of Jordan Data Base.

3.2 Study Model:

This study used the Cobb-Douglas production function. By taking the natural logarithm of the function in order to convert it into a linear function and thus the study model becomes as follows:

$$LnY = LnT + \beta 1LnL + \beta 2LnK + ui \quad .... (1)$$

where LnY is the value of agricultural production, LnL: number of labor in agriculture sector, LnK: capital, LnT: technological level, ui: Error term.

3.2.1 Variables Definition

Capital: Includes all physical inputs such as machinery, transportation, raw materials and fuel. **Labor**: It refers to the labor force that equipped with various skills and technical skills and knowledge used in the production of goods and services. The improvement of employee productivity can be achieved by investing in workers to increase their skills (Awan, 2013).

Technology: It is the knowledge or technology used to adapt capital and labor, and its use in obtaining production. It is therefore one of the requirements of production. It consists of a package of elements that may be included in capital equipment, but may be included in the human element. It takes the form of improved skills for workers and management, as in applications related to different methods of cropping, which is called the modern crop cycle, whether technology is included or not. Technology is knowledge. It includes each of the following elements: technological knowledge embodied in physical objects, skills that are inseparable from workers, patents , trademarks and unregistered knowledge (Khan, 2002).

3.2.3 Study Hypotheses:
The study examined the following alternative hypotheses:
1. There is a statistically significant effect of technology level on the Jordanian agricultural sector production at a significant level of (α <0.05).
2. There is a statistically significant effect of the number of labor on the Jordanian agricultural sector production at a significant level of (α <0.05). .
3. There is a significant statistical effect of capital on the Jordanian agricultural sector production at a significant level of (α <0.05).

Analysis and Results Discussion
4.1 Unit Root Test Results
To estimate the relationship between agricultural production and technology level We have to test for the presence of unit root. This is necessary to avoid spurious results. We use the Augmented Dickey Fuller (ADF) (Nandha and Hammoudeh 2007; Al-Qudah, 2016).

Thus, the tests were conducted for the study variables at the level. Table 1 shows that all variables are not stable at the level, since the value of both probabilities is greater than 5%. Thus, the null hypothesis that the root of the unit (time series instability) is accepted, Then the re-test, after taking the first difference was shown through the two tests (Augmented Dickey Fuller (ADF) and Phillips Perron) and through the moral value which was less than 5% for both tests, thus rejecting the null hypothesis and accepting the alternative hypothesis which states that there is no root unit, i.e., the time series of variables this study suggests that the effect of all temporary shocks will fade over time in the long term, especially since the Phelps Peron test takes random errors into account and includes the Augmented Dickey Fuller (ADF)test.

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Table (1) Phillips Perron Test (PP) and Augmented Dickey Fuller (ADF) Test (ADF)

Variable		ADF	PP	Result
LnK	Level	-2.562	-2.479	Not stationary
	1rst Difference	-6.928	10.926	Stationary
LnL	Level	-2.019	-2.065	Not stationary
	1rst difference	-5.156	-5.184	Stationary
LnY	Level	-2.071	-2.061	Not stationary
	1rst difference	-7.474	-7.598	Stationary

Residuals Stationary Test.

To make sure whether variables are integrated first degree or not, the study tests the degree of integration residuals as illustrated by the following table.

Table (2): Results of the Residual stationary test

Level			Variables
PP	ADF	Deceleration	
0.0000 ***	0.0000 ***	2	Z = residual

***, **, * indicates that the variables are stationary at a significant level of 1%, 5% and 10%, respectively.

The results obtained in Table (2) show that the residues are stationary.

Co integration Tests Results:

The Co integration test, which is developed by Johansen (1990), is applied to the variables of the study to see whether they are co integrated or not Al-Qudah (2014).

The results of Table (3) indicate that there is no co integration between the study variables at the significant level of (5%), according to (Max Eigen Value Test), and (Trace Test), and therefore we accept the null hypothesis (H0) and reject the alternative hypothesis (H1) which indicates a co integration at 5% significant level. The results of the joint co integration test indicate that there is no long-term equilibrium relationship between the variables of the study, i.e., they do not show similar behavior in the long term.

Table (3) Joint Co integration Test

		Date: 09/15/17 Time: 22:04		
		Sample (adjusted): 1989 2016		
	Included observations: 28 after adjustments			
		Series: LNK LNL LNY		
	Unrestricted Cointegration Rank Test (Trace)			
	0.05	Trace		Hypothesized
Prob.**	Critical Value	Statistic	Eigenvalue	No. of CE(s)
0.3250	29.79707	21.53738	0.391155	None
0.5042	15.49471	7.644030	0.148487	At most 1
0.0762	3.841466	3.143294	0.106189	At most 2

Trace test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
	**MacKinnon-Haug-Michelis (1999) p-values			
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
	0.05	Max-Eigen		Hypothesized
Prob.**	Critical Value	Statistic	Eigenvalue	No. of CE(s)
0.3739	21.13162	13.89335	0.391155	None
0.8031	14.26460	4.500736	0.148487	At most 1
0.0762	3.841466	3.143294	0.106189	At most 2
Max-eigenvalue test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
	**MacKinnon-Haug-Michelis (1999) p-values			
Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):				

The results of both Eigen and Trace test indicates that there is no co integration between the study variables at the 5% significant level.

Normality Test:

Before the regression procedure, it is necessary to perform the four tests in order to obtain real results, not spurious results, such as the normal distribution of data. If the data are not normally distributed , the results of the analysis are inaccurate and unreliable.

The Jarque-Bera test was used to test the extent to which data are followed for normal distribution where the data follow normal distribution when the probability value is greater than the statistical significance level (5%). Table 4 shows the results of the test:

Table 4 The results of the Jarque-Bera test on the follow-up of the study data for normal distribution

Variable	**Jarque-Bera**	**Probability**	**Result**
LnK	2.313115	.414567	normal
LnL	3.045675	.318126	normal
LnY	4.001242	.235442	normal

From the above table, the probability value of all the studied variables is greater than the value of 0.05, meaning that at 95% confidence level there are no statistically significant differences in the distribution of the values of all the variables from the normal distribution. Thus accepting the null hypothesis that the data follow the normal distribution and reject the alternative hypothesis that the data do not follow normal distribution.

4.5 Autocorrelation Test:

The Breusch-Godfrey test was used to ensure that there was no autocorrelation between the errors. Table 5 shows that the Chi-squared probability is more than 5% which means that there is no autocorrelation .Where the null hypothesis is accepted which states that there is no auto-correlation between errors.

Table (5) Results of Autocorrelation Test

	Breusch-Godfrey Serial Correlation LM Test:		
0.897653	Prob. F(2,25)	15.23576	F-statistic
0.765431	Prob. Chi-Square(2)	16.47955	Obs*R-squared

Heteroskedasticity:

The Breusch-Pagan-Godfrey test to check whether the residuals of the model are heteroskedasticity or not. The result in Table 6 shows that the Obs R-squared probability is more than 5% and this mean that the residuals are not heteroskedasticity or they are homoskedasticity.

Table (6) Results of Heteroskedasticity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey				
0.1580	Prob. F(2,27)		1.976901	F-statistic
0.1472	Prob. Chi-Square(2)		3.831970	Obs*R-squared
0.3538	Prob. Chi-Square(2)		2.078123	Scaled explained SS
			Test Equation:	
		Dependent Variable: RESID^2		
		Method: Least Squares		
		Date: 09/15/17 Time: 21:28		
		Sample: 1987 2016		
		Included observations: 30		

4.7Multicolinearity Test:

The correlation coefficient between the independent variables was calculated. The results in Table (7) show that there is no high correlation between independent variables.

Table (7) Results of correlation test between independent variables

LNL	LNK	
0.504	1	LNK
1	0.504	LNL

Multiple Linear Regression Results

Table (8) shows the regression results of the independent variables (technological level, number of workers in the agricultural sector and capital) on the value of agricultural production. The results show a positive and statistically significant effect of the number of workers in the agricultural sector on the value of agricultural production. The increase in the number of workers in the agricultural sector by one unit leads to an increase in the value of agricultural production by (0.43) with other factors remaining constant. The results also show a positive and significant effect of capital on the value of agricultural production, With the coefficient value of 0.133 and a significant level less than 5% Thus, the increase in the value of capital by 1 unit will increase agricultural production by 0.133 with other factors remaining constant, while the technological level coefficient is 1.029 with significant level of 0.5997 is not statistically significant, i.e., it is not statistically different from zero. We cannot confirm the technological impact over time on agricultural production during the study period due to the shortage or unsuitable knowledge or technology used in the adaptation of capital and labor, Note that it is one of the most important inputs in the productive process which takes the form of improved skills for workers and management.

The value of adjusted $R^2 = 0.45$ and it is found that 0.45 of the changes in the value of agricultural production caused by the capital and the number of workers in the agricultural sector, as shown by the value of F (12.7) and its significance (0.00012). The model is valid for measuring the causal relationship between the independent variables and the dependent variable.

The results also show that agricultural output works at a time of decreasing returns to volume since the sum of the elasticity of the two components of production for labor and capital is 56%, which is less than (1) . This means that agricultural output grows at a decreasing rate than the growth rate of labor and fixed capital. The value of β1 / Douglas pointed out that technological change is more intensive to work, at the expense of capital assuming that the technical replacement rate is stable, reflecting the lack of better exploitation of the available production capacities and the economic conditions and crises that the Jordanian economy is exposed to during the study period.

Table (8) Results of Multiple Regression Analysis

		Dependent Variable: LNY		
		Method: Least Squares		
		Date: 09/15/17 Time: 21:26		
		Sample: 1987 2016		
		Included observations: 30		
Prob.	t-Statistic	Std. Error	Coefficient	Variable
0.5997	0.531100	1.939170	1.029894	T
0.0437	2.374413	0.056021	0.133017	LNK
0.0202	2.468066	0.174652	0.431052	LNL
12.74387	F-statistic		0.485594	R-squared
0.000127	Prob(F-statistic)		0.447490	Adjusted R-squared

Conclusion

The current study examined the impact of technology level, Labor and capital on Jordanian agricultural scoter production. the study used the linear multiple regression model for the Cobb-Douglas production function to examine the study hypotheses.

The results indicate that there is a positive and statistically significant effect of the number of labor in the agricultural sector as well as the capital on the value of Jordanian agricultural sector production. while the technological level has not a significant impact on Jordanian agricultural sector production so, we cannot confirm the technological impact over time on agricultural production during the study period due to the shortage or unsuitable knowledge or technology used in the adaptation of capital and labor, which is considered as one of the most important inputs in the agricultural production process. That agricultural output works at a declining rate of return for volume as the sum of the elasticity of the two components of production for labor and capital is less than the right one, where agricultural output grows at a slower pace than the increase in labor and fixed capital.

The implication of the study is that the labor and capital are considered as a policy tool to improve the Jordanian agricultural sector production. Technology has no significant impact and this may be due to the low knowledge and skills of the labor force. Therefore, it is recommended for those interested in the agricultural sector to increase the skills of agricultural labor and provide them with modern agricultural knowledge.

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