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TECHNOLOGY TRANSFER AND AGRICULTURAL GROWTH IN PAKISTAN

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This study was designed to measure the impact of the technologies on agricultural growth. Agricultural technologies and knowledge have been restructured and distributed by public institutions at large scale. But over the past two decades, use of pesticides, fertilizers, tractors and tube wells for agricultural production has increased rapidly, and the world economy has become more efficient and well-organized. These factors have positive impact on investment in agricultural research, technology and have influenced the growth of economy of Pakistan. This study shows empirical relationship between tube wells, pesticides, tractors, fertilizers and agriculture growth over the period 1971-2007. For empirical analysis simple OLS, (Ordinary Least Square), Johnson's Co-integration and Error correction model techniques have been used to find relationship between agriculture growth and explanatory variables. The public sector still has a role to play, particularly in managing the new knowledge, supporting research to fill up the left over gaps, encouraging and regulating farmers associations, and ensuring their effects on the agriculture growth are adequately reviewed.
Keywords: Extension services, agriculture growth, farm machinery, agrochemicals

INTRODUCTION

Pakistan is a developing country and agriculture is the backbone of country's economy. It is currently the seventh most populous country in the world. Its agriculture sector occupies an important position in its economy and contributes about 21 percent of the gross domestic product (Economic Survey, 2007-08). Since the end of World War II, the public institutes of developed countries have helped transfer agricultural technologies to developing countries. During this period, most of the developing countries in Latin America and Africa, as well as some countries in Asia (like India, Thailand and Pakistan), have depended heavily on agricultural production to sustain their economies (Piñeiro, 2007). Robert (2004) and Thurston (1999) state that the fertilizer supplier has been busy, oilseed rape and winter barley is both complete, leaving oats and wheat to be given the balances.

Technologies have become very important in physical products, like farm machinery or agrochemicals. Speedy growth in such sectors has led to a rapid development of private firms that make, produce and sell technology and products based on agrochemicals. Innovation and technology development has always been main source of agriculture because agricultural progress and enlargement depends upon interference of modern technology tools by agricultural scientists and experts. Robbins and Julie (2003) suggest that the increasing use of fertilizers and pesticides to housing lawns, which has started to offset the gains made in reducing the use of chemicals in agriculture, represents a serious environmental hazard in the United States and Pakistan. Clevo (2000) focus attention on the environmental and human costs of commercial agricultural production, especially the Green Revolution technology in South Asia during the last few decades. Modern commercial agricultural practices involving chemical inputs such as fertilizers and pesticides have been associated with huge increases in food production never witnessed before and, in the case of cereal production under Green Revolution technology, recorded spectacular growth. As statistics show, production and productivity have increased. MacDonld (2005) discusses the importance of biotechnology to addressing the problem of universal starvation. Technologies developed at the research institutes remain unproductive if not transferred and adopted by the farmers. Technology transfer projects ensure better and efficient transfer of improved technology from the research institutes to the stakeholders. To increase the production, government has started many projects like farm field schools (FFS) which are also promoted by the World Bank as it is more effective approach to extend the science based knowledge and practices. For an effective transfer of technology, Government of Pakistan has also launched different extension approaches under the umbrella of agriculture department. In government sector many efforts have been made to improve the situation of extension in the country. Inspite of serious deficiencies and financial constraints agricultural extension has made significant contribution in increasing agricultural production. Until 1978, a general extension approach was in operation in the country. This approach was basically one of "Technology Transfer" from government to agriculture sector. Well organized extension services can bridge the gap between the potential productivity and the current productivity Nevertheless the farmers of Pakistan have started to use tractors, pesticides, tube wells and fertilizers to enhance agriculture growth. This will certainly raise the spirit of research for the development and advancement of agriculture in Pakistan. Therefore, we see advancement of Agriculture by using pesticides, fertilizers, tube wells and tractors on nominal agriculture growth of Pakistan. Thomas *et al.* (2007) concludes that optimizing behavior of individual organism's short-run ecosystem equilibrium depends on the farmer's use of fertilizers and pesticides and on the rat's population which is affected by pesticides. The planning and organization of agriculture has been adjusted when prices and markets are introduced into agricultural production and the direct planning is restricted.

The study is an attempt to discover farmer's behaviors with regard to use of agrochemical. They found that judgments on fertilizer, pesticides, and use of agro-film have different impacts on crop pledge contribution, and are influenced by the latter in different ways. It is also implied that comforting farmer's participation in crop insurance under current low-premium and low-indemnity terms does not have a significantly negative impact on the atmosphere Zhong *et al*. **(**2007), Parker (2005), Nanjingad and Fuzhou (2006) however, Childs (2004), Thurston (1999) and Hollis **(**2004) declare that the market performance of the agricultural products depend on use of chemical fertilizers. Growth of the pesticides market in the U.S. may contribute to the decline in U.S. markets for chemical insecticides. Hollis **(**2004) and Doyle (2007) have analyzed the financial risks associated with dependence on purchased farm inputs regardless of the benefits of increased efficiency and greater productivity.

MATERIALS AND METHODS

Inputs are a subset of the independent variables for agricultural out put growth. The concert of the major input factors is an essential indicator to determine the most efficient development interference. These inputs contain pesticides, fertilizers, tractors and tube wells. The productivity of the major crops grown and the following production levels are clearly affected by the combination of resources used. In order to effectively determine the effect of technology transfer on agriculture growth in Pakistan, it is essential that a comprehensive evaluation be taken at the tendencies in aggregate use of inputs in agricultural production in Pakistan. The main group of crops in Pakistan is wheat, cotton, pulses, rice and maize. The emphasis will be given on food crops and other major crops because of the urgent need to re-establish food inefficiency in Pakistan and the consequent poverty situation. The importance and relevance of these factors may differ from country to country and may also change overtime. Time series data are used for the estimation of regression results of dependent and explanatory variables. Therefore, using neoclassical production function, in log-linear form the agricultural growth equation is:

$$\text{Ln (AG)} = \alpha + \beta_1 \ln(\text{Pes}) + \beta_2 \ln(\text{Fer}) + \beta_3 \ln(\text{Tract}) + \beta 4 \ln(\text{Tub}) + €$$

$\beta_1, \beta_2, \beta_3, \beta 4, > 0$

The expected sign of all coefficients are positive.

Where

Ln= natural logarithm

AG = Agriculture growth

Pes = pesticides

Fer = fertilizers

Tract = tractors

Tub = tub wells

€ = white noise error term

The data for agriculture growth, tube wells, fertilizers, pesticides, and tractors had been taken from various "*Economic Surveys of Pakistan"* (1987-88, 1995-96 and 2006-07). The agriculture growth has been taken as dependent variable, while pesticides, fertilizers, tractor and tube wells have been taken as explanatory variables. The units of agriculture growth, pesticides, fertilizers, tractors and tube wells are thousands tons, thousands liters, thousands tons, thousands numbers and thousands numbers respectively. Since quarterly data were not available, therefore annual data had been used. The impact of technology transfer on agriculture growth in Pakistan had been covering the period of 1971 to 2006. All involved series were transformed into log form. Log form was used to reduce the problem of heteroskedasticity. Simple least square regression method, Jhonsen co- integration and error correction model were used to analyze the trends and patterns dependent and explanatory variables in Pakistan.

Unit root, OLS, Johnson's Co integration and Error correction Model

The order of co-integration can be detected by using unit root. If it is found that all series of variables are based on non-stationary at I(0) and are stationary at I(1). Nevertheless, both tests give the same result after first variation of series, that is all series are stationary at I(1). So it is clear that Johnson's co- integration technique can be used to detect the relationship between the variables at I(0). The choice of lag length is based on the lower the values of Akaike and Schwarz statistics. The lowest the value of Akaike and Schwarz shows the goodness of the model.

Before testing the co-integration, first researcher estimated whether the time series was stationary or nonstationary? Several tests had developed to check the stationary or nonstationary status in the time series econometrics literature. In most of these tests the null hypothesis was a unit root, and it was rejected only when there was strong evidence against it. For this purpose, we test each series by well known Augmented Dickey-Fuller unit root test.

$\Delta Y = \alpha_0 + \mu Y_{t-1} + \alpha\sum\Delta Y_{t-1} + €_t$

Where $\Delta Y = Y_t - Y_{t-1}$, $€_t$ is the error term and μ is chosen to ensure serially uncorrelated residuals. The variables containing in Table 1 are examined for stationary.

The OLS results in Table 2 show that from the four basic variables two variables do not have the expected sign, this is so because in case of tractors, some tractors are being used for commercial purpose similarly in case of pesticides, the majority of farmers do not use pesticides as per directions of agriculturist . Nevertheless, two variables have accepted positive sign and they are highly significant. However, there are problems in the above regression results from the point of view of standard econometric assumptions. The equality of R^2 and DW involved that the regression might be spurious regression that arises in the presence of non-stationary variables. Furthermore, the above regression results do not take into consideration dynamic aspects and problem of serially co-related errors making parameters estimates unreasonable.

Breusch-Godfrey serial correlation LM test shows normality of model and also shows that there is no correlation among variables. Though the sample size is not large (37 observations), researcher subjected the residuals of regression (1) to Q-statistics, LM test for serial co-relation and ARCH test. F-version of these tests shows significance. Therefore, results were not appropriate for analysis in this version. The results were displayed in Table.3 and Table.4 respectively. For that reason, the data is reexamined for time series properties.

Table1: **Results of unit root test for examination of stationary**

Variables	With trend level	With trend 1st diff	Without trend Level	Without trend 1st diff
AG	-1.089161	-4.745327	-4.554422	-4.852108
Pes	-1.586693	-10.11765	-4.914867	0.793
Fer	-2.747133	-4.119332	-0.696755	-4.855187
Tract	-2.181647	-6.941059	-2.473929	-7.163104
Tub	-0.220578	-5.107973	-2.223542	-5.033139

AG = Agricultural Growth, Pes = Pesticides, Fer = Fertilizers, Tract = Tractors, Tub = Tube wells

The unit roots results of the Augmented Dickey Fuller test are presented in Table.1 The table shows the results of all variables in level form and at first difference with trend and without trend. To determine the order of integration, we also applied ADF unit root test to examine the variables in their first differences. The null of stationarity is accepted for all the variables for their first differences. Therefore, all the variables are first difference stationary I (0) thus integrated of order 1.

The ordinary least squares (OLS) estimates of equation (1) are as under:

Table 2. Ordinary least squares regression results for selected variables

Predictor	Coef	SE Coef	T	P
Constant	-11.076	0.784	-14.124	0.000
Pes	-0.015	0.058	-0.264	0.793
Fer	0.766	0.112	6.825	0.000
Tract	-0.060	0.052	-1.162	0.254
Tub	1.561	0.126	12.354	0.000
R^2	0.99	D.W	0.78	

Source: Author's own calculations

Table 3. Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	11.94401	Probability	0.000164
Obs*R-squared	16.26018	Probability	0.000295

Table 4. ARCH Test for Significance of the Model

ARCH Test			
F-statistic	8.355065	Probability	0.006752
Obs*R-squared	7.071136	Probability	0.007834

If the hypothesis of nonsatationarity is recognized for the basic variables, it is striking and significant that the time series data are examined for co-integration.

Tabe 5. Johansen Maximum Eigenvalue Test (AG, Pes, Trac, Tub and Fer)

LOG (AG) LOG (Pes) LOG (Trac) LOG (Tub) LOG (Fer)

Lags interval: 1 to 1				
Hypothesized	**Eigenvalue**	**Trace statistics**	**5 Percent**	**Hypothesized**
No. of CE(s)		Critical Value	Critical Value	No. of CE(s)
None **	0.605539	81.70979	68.52	None **
At most 1 *	0.547418	50.08176	47.21	At most 1*
At most 2	0.368149	23.12705	29.68	At most 2
At most 3	0.176351	7.517578	15.41	At most 3
At most 4	0.026731	0.921224	3.76	At most 4

Max-eigenvalue test indicates 2 co-integrating eqn(s) at the 0.05 level
*denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Therefore, the maximum likelihood method of Johansen can be used to find co-integration relationship. The eigenvalue statistic tests Ho that the number of co-integrating vectors is r against the alternative of r +1 co-integrating vectors. In view of the fact that Johansen approach has become standard in the econometric literature. The Johansen co-integration results are shown in Table 5. Trace test indicates two co integrating equations while Maximum-Eigenvalue test also indicates two co-integrating relationship. Therefore, Agriculture growth and tubwell and fertilizer are co-integrated thus having long-run relationship with agriculture growth.

Error-Correction Model

$$\Delta E\, G_t = \alpha + \partial Z_{t+1} + \sum \beta_i \Delta \text{ Ln } EG_{t-i} + \sum \mu_i \text{ Ln } \Delta \text{ (PES)}_{t-l} + \sum \text{€}_i \Delta \text{ Ln (TRACT)}_{t-l} +$$

$$\sum \varphi_i \Delta \text{ Ln (TUBLE)}_{t-l} + \sum \eta_i \Delta \text{Ln (FER)}_{t-l} + \psi_t$$

Zt+1 is the error correction term generate from the Johansen multivariate procedure and the parameter ∂ is the error correction coefficient that measures the response of the regressed in each period to departures from equilibrium. The error correction model's results are shown in Table 6.

To choose a suitable lag length, we used AIC, SC and the optimal lag length was 1. Error correction results show that the error correction term Zt+1 has the correct positive sign and is significant for agriculture growth, tub well and fertilization and indicates the long-run equilibrium relationship between these variables. An estimate of 0.19 for agriculture growth indicates that 19% of the preceding year disequilibrium included in the current year. Moreover, use of fertilization and tub well raise agriculture growth 34% and 19% respectively and they are highly significant. Tractor and pesticides have insignificant impact on agriculture growth; this is so because, many tractors are being used for commercial purpose similarly in case of pesticides, the majority of farmers do not use pesticides as per directions of agriculturist. The results of this study coincide with the empirical consequences of Prakash and Gregory (2004), Thomas et al (2007). Zhong *et al.* **(**2007) respectively.

CONCLUSION

This paper has examined the impact of technology transfer on the agricultural growth of Pakistan for the period 1971-2007. The findings in regression model indicate that the equality of R2 involved that the regression might be spurious regression that arises in the presence of non-stationary variables. Furthermore, the regression results do not take into consideration dynamic aspects. These have problem of serially correlated errors. Johansen's co integration method shows fertilizer and tub well were co-integrated and have long-run equilibrium relationship with agricultural growth, while pesticide and tractor were statistically insignificant and show negative relationship with agricultural growth, notwithstanding, error-correction model results also support the co integration results. It means raise of quantity of tube well and fertilization may increase agricultural growth of the Pakistan and use of tractors and pesticides may be rehabilitated if authorities and farmers give proper attention. Pakistan's economy will definitely get advantage from technology transfer provide that the country chases concrete policies and infrastructures program.

Table 6. Error Correction Results (AG, Tract, Pes, Fer and Tub)

Dependent Variable>	D (LOG(AGRIGROWTH))	D (LOG(TRACTOR))	D(LOG(PES))	D(LOG(FER))	D(LOG(TUBLE))
α	0.196704* (0.04251) (4.62757)	0.511549 (0.36648) (1.39584)	-0.382971 (0.46245) (-0.82814)	0.095092 (0.11080) (0.85820)	-0.060492 (0.05888) (-1.02743)
D(LOG(AGRI GROWTH(-1)	-0.108680 (0.16511) (-0.65823)	-0.585153 (1.42352) (-0.41106)	1.172268 (1.79628) (0.65261)	-0.114248 (0.43039) (-0.26545)	-0.180360 (0.22869) (-0.78866)
D(LOG(AGRI GROWTH(-2)	-0.228043 (0.13274) (-1.71798)	-0.526683 (1.14443) (-0.46021)	0.865931 (1.44412) (0.59963)	0.032529 (0.34601) (0.09401)	0.513436 (0.18386) (2.79257)
D(LOG(TRA(-1)	0.095070* (0.02234) (4.25620)	0.236801 (0.19258) (1.22962)	-0.010037 (0.24301) (-0.04130)	-0.005606 (0.05823) (-0.09627)	-0.048011 (0.03094) (-1.55180)
D(LOG(TRA(-2)	0.002943 (0.02584) (0.11389)	0.001375 (0.22279) (0.00617)	0.051668 (0.28113) (0.18379)	0.122089 (0.06736) (1.81251)	-0.026449 (0.03579) (-0.73896)
D(LOG(PES(-1)	0.016448 (0.01929) (0.85283)	0.060838 (0.16628) (0.36587)	-0.145726 (0.20983) (-0.69450)	-0.021537 (0.05028) (-0.42839)	-0.087004 (0.02671) (-3.25686)
D(LOG(PES(-2)	-0.027267 (0.01830) (-1.48998)	-0.044621 (0.15778) (-0.28281)	-0.137704 (0.19909) (-0.69165)	0.048121 (0.04770) (1.00875)	-0.005237 (0.02535) (-0.20660)
D(LOG(FER(-1)	0.199302* (0.08552) (2.33039)	-1.119562 (0.73735) (-1.51836)	-0.606774 (0.93044) (-0.65214)	0.023610 (0.22293) (0.10590)	-0.092911 (0.11846) (-0.78433)
D(LOG(FER(-2)	0.131683 (0.09153) (1.43869)	-0.853359 (0.78914) (-1.08138)	-0.413528 (0.99578) (-0.41528)	-0.321002 (0.23859) (-1.34540)	0.291011* (0.12678) (2.29544)
D(LOG(TUBLE(-1)	0.347912* (0.14558) (2.38985)	-1.406109 (1.25513) (-1.12029)	1.120997 (1.58381) (0.70779)	0.220010 (0.37948) (0.57976)	0.583383* (0.20164) (2.89316)
D(LOG(TUBLE(-2)	0.142635 (0.14818) (0.96256)	-1.211826 (1.27758) (-0.94853)	2.190824 (1.61213) (1.35896)	-0.326362 (0.38627) (-0.84491)	0.469506* (0.20525) (2.28751)

Note: Standard errors & t-statistics in parentheses**.** Figures within parentheses are t – statistic and * indicates significance at 5%

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