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IMPACT OF MAJOR FARM INPUTS ON TOBACCO PRODUCTIVITY IN PAKISTAN: AN ECONOMETRIC ANALYSIS (1960-2006)

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ABSTRACT

The study conducted during 2008 evaluates the impact of area under tobacco crop and fertilizer off-take on its productivity in Pakistan during 1960-2006 using econometric techniques. The findings revealed that one-hectare increase in area under tobacco cultivation brings 2.47 tonnes increase in total tobacco production. 1% increase in the fertilizer off-take leads to increase tobacco production by 0.05 tones. The coefficients of the explanatory variables are statistically significant at both 5% and 1% level of significance. Due to high value of the coefficient of area under tobacco crop, it is recommended that the government should bring more and more area under tobacco cultivation in the country. Distribution of the fertilizer should be properly managed.

Key Words: Impact; area; fertilizer off-take; tobacco productivity; econometric analysis

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INTRODUCTION

Tobacco is the major cash crop of Pakistan. During the time period 1960-2006, significant fluctuations in tobacco productivity and its area under cultivation took place. In 1960-61, the total area under tobacco crop was 39 thousands hectares which has been increased to 51 thousands hectares in 2006-07. On the other hand, in 1960-61, the total tobacco production was 60 thousands tonnes which has been increased to 105 thousands tonnes in 2006-07 (Statistical Supplement, 2006-07). But still there is increasing pressure on the consumption of tobacco productivity. To increase its productivity, appropriate agriculture input policy in this sector is needed. The key inputs of tobacco productivity are area under tobacco crop and fertilizer off-take.

A very limited researchers conducted studies about the econometric analysis of different aspects of tobacco crop. Keeler *et al.* (1993) applied two-stage generalized least squares including instrumental variables to monthly per capita cigarette consumption data. He used the logarithm of the real cigarette tax per pack as an instrument for real retail cigarette price per pack. He also used first order and secondary autoregressive schemes in his analysis. Bardsley and Olekalns (1999) used General Methods of Moments (GMM) including instrumental variables to time series data on the variables under analysis i.e. real per capita consumption of cigarettes and other tobacco products. He observed that instrumental variables are necessary for dealing with the endogeneity of the consumption made in past and future. Van (2000) used error-correction mechanism of aggregate cigarette consumption estimating the cigarette demand in the form of first difference. All the signs of the model were found according to the expectations. The value of the coefficient lagged residual (–0.633) showed that, on average, about 63 percent of the deviation from long-run equilibrium is compensated for in the following year - representing quick speed of adjustment.

The present study is different from the previous studies as it utilizes econometric techniques to show the impact of area under tobacco crop and fertilizer off-take on it productivity in Pakistan using time series.

MATERIALS AND METHODS

The present study has been conducted in the year 2008 to make econometric analysis of the impact of area under tobacco crop and fertilizer off-take on it productivity in Pakistan. Time series data ranging from 1960 to 2006 on the above variables has been used. The data has been taken from Economic Survey of Pakistan (Statistical Supplement, 2006-07). Augmented Dickey Fuller (ADF) test has been used for checking the stationarity of the data. The Akaike Information Criterion (AIC) has been used to select the optimum ADF lag. Variables which were non-stationary at level have been made stationary after taking first difference and second difference. Furthermore, the Johenson Co-integration test has been used to detect the long-term relationship among the series. To this end, the Likelihood Ratio (LR) statistic is used.

To show the impact of area under tobacco crop and fertilizer off-take (explanatory variables) on total tobacco productivity (dependent variable), the following model was estimated using the method of ordinary least square method.

$$TTP = b_o + b_1AUT + b_2FO \quad (1)$$

Where

TTP = Total tobacco production (000, tonnes) in Pakistan

AUT = Area under tobacco crop (000, hectares) in Pakistan

The problem of autocorrelation has been solved by using Durbin two step methods. At first step, the following model was estimated to find out the value of $\hat{\rho}$ (i.e. coefficient of TTP_{-1}, which is b_1 here).

$$TTP = b_o + b_1TTP_{-1} + b_2AUT + b_3AUT_{-1} + b_3FO + b_4FO_{-1} \quad (2)$$

At second step, TTP* has been regressed on AUT* and FO, where

$$TTP^* = TTP - \hat{\rho}\, TTP_{-1}$$

$$AUT^* = AUT - \hat{\rho}\, AUT_{-1}$$

$$FO^* = FO - \hat{\rho}\, FO_{-1}$$

A statistical package Eview is used for deriving the results.

RESULTS AND DISCUSSION

The ADF test results have been presented in Table I and II. In Table I, the stationarity of the data has been checked including no intercept and no trend while both intercept and trend have been included in Table II. Variables which are not stationary at level have been made stationary after taking the first difference denoted by I(1) and then the second difference i.e. I(2) if needed. The values given in the brackets are the optimum lags selected on the basis of AIC criterion (i.e the lag t which the AIC value is minimum). According to Table I, the variables TTP, AUT and FO are not stationary at level, therefore, these have been made stationary after taking first difference. Including both intercept and trend the variables TTP, AUT and FO are not stationary at level and have been made stationary after taking first difference (Table II).

Table I *ADF test results for stationarity (including intercept and not trend)*

Variable	I (0)		I (1)		Results
	Test Statistic	Critical value	Test Statistic	Critical value	
TTP	-2.898 [1][1]	-3.58	-5.3927 [0]	-3.58	I(1)
AUT	-3.254 [1]	-3.58	-5.8594 [0]	-3.58	I(1)
FO	1.114 [0]	-3.58	-7.194 [0]	-3.58	I(1)

Figures in square brackets besides each statistics represent optimum lags, selected using the minimum AIC value.

Table II *ADF test results for stationarity (including both intercept and trend)*

Variable	I(0)		I(1)		Results
	Test Statistic	Critical value	Test Statistic	Critical value	
TTP	-2.8670 [1][2]	-4.17	-5.3297 [0]	-4.17	I(1)
AUT	-3.3558[1]	-4.17	-5.7963 [0]	-4.17	I(1)
FO	-2.4506 [0]	-4.17	-7.6040 [0]	-4.17	I(1)

Figures in square brackets besides each statistics represent optimum lags, selected using the minimum AIC value.

Furthermore, the regression results may be spurious due to no co-integration among the series. To this end the Jhonson Co-integration test has been used. The likelihood ratios statistic values are given in Table III (including no trend and no intercept) and in Table IV (including both intercept and trend), which indicates the long-term relationship among the variables of the study and rejects the hypothesis of no co-integration. Because most of the absolute values of the LR ratios are greater than their relevant critical values.

Table III *Johansson Co-integration test results including no intercept and no trend*

	Likelihood	5 Percent	1 Percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CE(s)
0.300160	30.58928	24.31	29.75	None*
0.095627	17.528602	12.53	16.31	At most *1
0.000122	0 .005480	3.84	6.51	At most 2

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. 2 cointegration at 5% significance level

Table IV *Johansson Co-integration test results including both intercept and trend*

	Likelihood	5 Percent	1 Percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CE(s)
0.272435	48.50678	42.44	48.45	None*
0.216343	32.19442	25.32	30.45	At most 1*
0.109607	10.224152	12.25	16.26	At most 2*

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. 2 cointegration at 5% significance level

Regression results with AUT and FO as independent variables are given in Table V. The results indicate that one-hectare increase in area under tobacco crop brings 2.47 tonnes increase in total tobacco production. Similarly, 1% increase in the fertilizer off-take leads to increase tobacco production by 0.05 tones. The coefficients of the explanatory variables are statistically significant at both 5% and 1% level of significance. The model is best fitted as indicated by the high value of R-squared (0.897) and adjusted R-squared (0.893), showing that the included explanatory variables are mainly responsible for changes in tobacco productivity in Pakistan.

Table V *Regression results of tobacco production function*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-43.82874	6.718461	-6.523628	0.0000
AUT	2.471381	0.127851	19.33015	0.0000
FO	0.004724	0.000843	5.601574	0.0000
R-squared	0.897336	Mean dependent var		86.61702
Adjusted R-squared	0.892669	S.D. dependent var		19.69391
Durbin-Watson stat	0.464723	Prob(F-statistic)		0.000000

Durbin-Watson value (0.465) suggests positive serial autocorrelation. To take away the autocorrelation, Durbin-two step method is estimated. The results of Durbin-two step method are given in Tables VI and VII. In the newly obtained model, the Durbin-Watson value has been increased to 2.15, which is closer to 2 showing no problem of autocorrelation.

Table VI ***Regression results using Durbin first step***

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-6.616696	6.581778	-1.005305	0.3208
TTP(-1)	0.831896	0.098117	8.478631	0.0000
AUT	2.167354	0.121674	17.81282	0.0000
AUT(-1)	-1.777145	0.246630	-7.205728	0.0000
FO	0.005295	0.004402	1.202655	0.2362
FO(-1)	-0.004150	0.004606	-0.901018	0.3730
R-squared	0.963484	Mean dependent var		87.19565
Adjusted R-squared	0.958920	S.D. dependent var		19.50341
Durbin-Watson stat	2.007272	Prob(F-statistic)		0.000000

Table VII ***Regression results using Durbin second step***

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.913215	1.442620	-3.405759	0.0015
AUT*	2.150979	0.112333	19.14827	0.0000
FO*	0.004607	0.003109	1.481626	0.1459
CD*	4.47E-05	5.99E-05	0.747388	0.4590
R-squared	0.899712	Mean dependent var		15.47178
Adjusted R-squared	0.892549	S.D. dependent var		11.71418
Durbin-Watson stat	2.014197	Prob(F-statistic)		0.000000

CONCLUSION AND RECOMMENDATIONS

From the facts and figures it is clear that tobacco productivity is mostly depended upon its area under cultivation and fertilizer off-take in Pakistan. One-hectare increase in area under tobacco cultivation brings 2.47 tonnes increase in total tobacco production. 1% increase in the fertilizer off-take leads to increase tobacco production by 0.05 tones. The explanatory variables (area under tobacco and fertilizer off-take) are statistically significant and reveal that the included explanatory variable is mostly responsible for variation in the response variable (total tobacco productivity). It is recommended that the government should make efforts to bring more area under tobacco crop in Pakistan through effective initiatives. Usage of appropriate fertilizer off-take should be ensured.

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