Research Article

Allocative Efficiency of Tobacco Production in District Mardan, Pakistan

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Abstract | A state of the economy in which output reflects customer desires is known as allocative efficiency. Every good or service is manufactured until the last unit supplies consumers with a marginal gain equal to the marginal cost of production in an economy. The study in hand was designed to assess the allocative efficiency of tobacco growers during 2019. Primary data was collected through face to face interview and a sample of 120 tobacco growers was selected. These growers were randomly selected from three villages namely Takar Kaly, Garo Shah, and Pasand Kaly of tehsil Takhtbai, district Mardan of Khyber Pakhtunkhwa. Empirical findings reveal that labour, chemical, irrigation, seed, poultry manure, and tractor have positive and statistically significant effects on tobacco production. Results of the study also corroborate an insignificant relationship of fertilizer with tobacco production. Findings of the study also showed that the allocation of inputs utilized during production e.g. labour, irrigation, seed, poultry manure and tractor are under-utilized, chemical is optimally-utilized while fertilizer is over-utilized by the growers in the study area. Therefore, this study suggests a rational use of fertilizer and recommends keeping the quantity of chemical use constant.

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Introduction

Agriculture has a significant role in Pakistan which produces food, fibre and also plays an essential role in up growing economic situation of the country. The total share of agriculture is 18.5% in Gross Domestic Product (GDP), also employed half of the labor force directly or indirectly and counted as a leading source for earning foreign exchange. The major crops wheat, rice, cotton, sugar cane, maize, oilseed, and pulses contribute 4.20% to GDP and 21.73% to the value-added in overall agriculture goods (GoP, 2018-19).

During 2018-19, total tobacco production came to approximately 6.1 ('000' tons), an almost total area of harvested tobacco amounted to about 3.37 ('000' hectares). In Pakistan, the total cultivated area under tobacco was 47('000' hectares) in the year 2019, and during the same year the overall production of tobacco was approximately 110,000 ('000' tons) (GoP, 2018-19).

Khyber Pakhtunkhwa (KP) is considered the largest and good quality tobacco generating province in Pakistan and also a centre of several cigarette industrial units. In KP, area under tobacco is 30.0 ('000' hectares) which produces 85.5 ('000' tons) of tobacco and yields 2840 Kg ha^{-1} (Agriculture Statistics of Pakistan 2017-18). White Patta and Flue-cured Virginia are mostly grown on plane areas such as Charsadda, Mardan, Swabi, and Nowshehra district and Malakand Agency of Khyber Pakhtunkhwa, on an area of 20,000 hectares, produces about 48.0 M.kg (Pakistan Tobacco Company, 2018).

According to Rahman *et al*. (2019) tobacco farming gives an average of 21 to 30 % return. Tobacco farming being labour intensive involves a great number of labors, hence provides more employment opportunities. Despite the health hazards relating to tobacco use, its cultivation is increasing at a rapid pace and it is believed that it will become the main source of income of farming communities in Pakistan shortly. Due to the positive influence on the social status of farmers, and increasing demand for tobacco leaf worldwide, farmers are enthusiastic towards tobacco cultivation; they are replacing other crops with tobacco for increase revenues.

As a number of factors determine the final produce of a crop, a great harvest requires a balance of farming inputs. The balanced allocation of each primary input ensures the farmers targeted yield. Both the under and overuse of inputs will have a negative impact on the total yield, which would be ultimately recompensed by loss in farmers desired output. Keeping in view the rising demand and significance of tobacco farming on farmer's livelihood, the current study evaluated the rational and irrational use of farm inputs in relation to production efficiency of tobacco in district Mardan, Khyber Pakhtunkhwa. Objective of the research endeavour is to assess the allocative efficiency of major inputs utilized for the production of tobacco.

Allocative efficiency theory

A state of the economy in which output reflects customer desires is known as allocative efficiency. Every good or service is manufactured until the last unit supplies consumers with a marginal gain equal to the marginal cost of production. In the single-price model, price is equal to marginal cost at the point of allocative efficiency. At this point, without any deadweight loss, the social surplus is maximized, or the value society places on the amount of output generated minus the cost of resources needed to get that level, yet may also be applied to other things like pollution levels etc. To assess the impact of markets and public policies on societies and subgroups to be made better off or worse off, allocative efficiency plays the rule as a main tool.

Materials and Methods

Study area

District Mardan of Khyber Pakhtunkhwa was selected to carry out this research. Due to environmentally conducive conditions, KP produces 85,000 tons of tobacco at an area of 30,000 hectares which contributes about 78 (%) of total tobacco production in the country. Three districts of KP are the major hubs of tobacco namely Swabi, Mardan, and Charsadda but due to time limitation and budget constraints, only district Mardan was purposively selected for this research study.

Sampling and data collection

For data collection, multistage sampling technique was used. In the first stage district Mardan was selected. In the second stage among five tehsils of district Mardan, tehsil Takhtbhai was purposely selected. In the third stage, a stratified random sampling technique was used to choose the villages of tehsil Takhtbhai. Thus a total of three villages namely Gharoshah, Pasand Kaly, and Takar Kaly were selected. For the purpose of analysis, primary data was collected by interviewing farmers at their homes as well as in fields through face to face interview. For this purpose a well-structured questionnaire was used. Hence a total of 120 tobacco growers were selected from the study area. Table 1 shows sample selected from different tahsil of district Mardan.

Data analysis

For data analysis purpose, descriptive statistics and regression tools were used. Descriptive statistics were used to summarise the data. For the analysis purpose, STATA software was adopted.

Table 1: *Proportional allocation sampling technique.*

Villages	Total population of tobacco growers	Sample size
TakarKaly	209	40
Garoshah	147	28
PasandKaly	276	52
Total	632	120

Source: *Survey data, 2019.*

The proportional allocation sampling technique was applied to get 120 respondents at the fourth phase. Allocation sampling techniques are as follows:

$$ni = (Ni/N) * n \quad ...(1)$$

Where;
n_i = Number of sampled tobacco farmers in the ith village; n= Total sample size; N_i = Total number of tobacco farmers in the ith village; N= Total number of tobacco farmers in the area.

Empirical model
To investigate the effects of independent variables on tobacco output as well as resource efficiency, the following functions were adopted.

$$Y = \beta(L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7eu) \ ...(2)$$

Where;
Y= Production of tobacco in mound per acre; L= Labor days per acre; F= Fertilizer used in Kg/ acre; C= Chemical used in liter/acre; S= Seed used in Gm/ acre; I= Irrigation; PM= Poultry manure used in trolley/acre; TH= Tractor hours/ acre; B= Intercept; δ = The function coefficient; e= Error.

However, to find out the allocative efficiency of tobacco growers, certain physical parameters of the production function, which are quantified in Equation 2, were utilised in the study. These physical parameters are the marginal physical product (MPP), per unit tobacco pricet, and the per-unit cost of every input that is utilized. The MP obtained from Equation 2 for each variable is given below:

$$MP_L = \frac{\partial Y}{\partial L} = \frac{\partial(\beta\ L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7\ eu)}{\partial L} \ ...(2a)$$

$$= \frac{\delta 1\beta\ L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7\ eu)}{L} = \frac{\delta 1\ Y}{L}$$

$$MPF = \frac{\partial Y}{\partial F} = \frac{\partial(\beta\ L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7\ eu)}{\partial F} \ ...(2b)$$

$$= \frac{\delta 2\beta\ L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7\ eu)}{F} = \frac{\delta 2\ Y}{F}$$

$$MP_c = \frac{\partial Y}{\partial C} = \frac{\partial(\beta\ L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7\ eu)}{\partial C} \ ...(2c)$$

$$= \frac{\delta 3\beta\ L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7\ eu)}{C} = \frac{\delta 3\ Y}{C}$$

$$MP_I = \frac{\partial Y}{\partial I} = \frac{\partial(\beta\ L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7\ eu)}{\partial I} \ ...(2d)$$

$$= \frac{\delta 4\beta\ L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7\ eu)}{I} = \frac{\delta 4\ Y}{I}$$

$$MP_s = \frac{\partial Y}{\partial S} = \frac{\partial(\beta\ L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7\ eu)}{\partial S} \ ...(2e)$$

$$= \frac{\delta 5\beta\ L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7\ eu)}{S} = \frac{\delta 5\ Y}{S}$$

$$MP_{PM} = \frac{\partial Y}{\partial PM} = \frac{\partial(\beta\ L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7\ eu)}{\partial PM}$$

$$= \frac{\delta 6\beta\ L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7\ eu)}{PM} = \frac{\delta 6\ Y}{PM}$$

$$MP_{TH} = \frac{\partial Y}{\partial TH} = \frac{\partial(\beta\ L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7\ eu)}{\partial TH} \ ...(2g)$$

$$= \frac{\delta 7\beta\ L\delta 1\ F\delta 2\ C\delta 3\ I\delta 4\ S\delta 5\ PM\delta 6\ TH\delta 7\ eu)}{TH} = \frac{\delta 7\ Y}{TH}$$

As a result, the allocative efficiency of tobacco product inputs can be stated as follows:

$$AL_{ef} = \frac{MPxi * Py}{Pxi} \ ...(3)$$

But, $MP_{Xi} \times Py$ = MVP and P_{xi} = MFC
Therefore, allocative efficiency.

$$AL_{ef} \frac{MVP}{MFC} = \frac{\text{Value of the Margiona lProduct}}{\text{Margional Factor Cost}} \ ...(3a)$$

Where; AL_{ef} = Allocative efficiency of tobacco production; MP_{xi} = Marginal Physical product of the ith input. It can be obtained through a 1st derivative of the production function of Equation 2. It shows the incremental in output produced due to the change in input. P_Y = Price of tobacco per unit. P_{xi} = Cost per unit of the ith input used in the production process.

For the respective inputs in Equation 2, the allocative efficiency is given as:

$$AL_{ef\,(L)} = \frac{\left(\frac{\delta 1\ Y}{L}\right) * Py}{Pl}$$

$$AL_{ef\,(L)} = \frac{\left(\frac{\delta 1\ Y}{f}\right) * Py}{Pf}$$

$$AL_{ef\,(c)} = \frac{\left(\frac{\delta 1\ Y}{c}\right) * Py}{Pc}$$

$$AL_{ef\,(I)} = \frac{\left(\frac{\delta 1\ Y}{I}\right) * Py}{PI}$$

$$AL_{ef\,(s)} = \frac{\left(\frac{\delta 1\ Y}{s}\right) * Py}{Ps}$$

$$AL_{ef\,(PM)} = \frac{\left(\frac{\delta 1\ Y}{PM}\right) * Py}{Ppm}$$

$$AL_{ef\,(th)} = \frac{\left(\frac{\delta 1\ Y}{th}\right) * Py}{Pth} \quad \dots (4)$$

According to Oladeebo *et al.* (2006), Fasasi (2006), Ugwumba (2010), and Afolabi *et al.* (2013), three scenarios can be observed:

$MVP_{Xi}/\ MFC_{Xi} = 1$
$MVP_{Xi}/\ MFC_{Xi} < 1$ indicates that resource X_i is over-utilized
$MVP_{Xi}/\ MFC_{Xi} > 1$ indicates that resource X_i is underutilized

The ordinary least square technique was used to estimate the coefficients of Equation 1 and then was transformed into the logarithm.

$$lnY = \beta 0 + \delta 1L + \delta 2F + \delta 3C + \delta 4I + \delta 5\,S + \delta 6PM + \delta 7\,TH + u \quad \dots (5)$$

Results and Discussion

Socio-economic characteristics of farmer
Table 2 depicts the socioeconomic characteristics of respondents. These socio-economic behaviours influence grower's production, which is important to discuss. The socio-economic characteristics which were taken in consideration during the study included age, education, and experience of the respondents. Education plays a pivotal role in boosting the production, as it would positively influence the farmer's perception towards modern production technologies and could result in more cooperation with extension workers and other sources. The average education level in the study area was 5.61 with a standard deviation of 3.72. These results are in line with Khai and Yabe (2011), and Ali and Khan (2014), who reported that the average education level of a farmer in Vietnam rice production is about 6.27 and 5.61 schooling year. Age plays a central role in efficiency level which is the second attribute of the study. The mean age of the respondents was about 49 years. These results are in parity with those of Rabu and Shah (2013) and Adedoyin *et al.* (2016) they observed that the average age of the farmers is around 51.8 to 54 years. The experience of the farmer is important as above attributes can highly affect the efficiency level and overall production. An experienced farmer can easily tackle a tough situation and he better knows the alternative ways to overcome the difficulty. The result shows that the standard deviation of the experience of the growers is 7.11 ranging from 6 to 39 years with a mean value of 29.18 years which is in coherence with the previous findings of Ali and Khan (2014).

Table 2: *Descriptive statistics of farmer attributes.*

Farmers portfolio	Obs.	Min	Max	Mean	S.D
Education	120	0	13	5.61	3.72
Age	120	32	63	48.54	4.84
Experience	120	13	47	29.18	7.11

Source: *Survey data, 2019.*

Table 3: *Production function analysis.*

Inputs	Coefficient	S.E	t- value	P- value
Constant	0.995	0.187	5.62	0.000
Labor	0.365	0.069	6.14	0.000
Fertilizer	-0.025	0.016	-1.54	0.125
Chemical	0.083	0.025	3.32	0.001
Irrigation	0.181	0.059	3.66	0.000
Seed	0.175	0.039	4.51	0.000
Poultry manure	0.170	0.034	3.81	0.000
Tractor	0.080	0.020	5.62	0.000
$R^2 = 0.81$				

Source: *Survey data, 2019.*

Production function
The results of the Cobb-Douglass production function analysis are shown in Table 3. The size and sign of the regression coefficients fall in before the expectation of the study. The results show that all independent variables are statistically significant except fertilizer which implies that these variables can influence the production of tobacco growers due to a slight change. The estimated coefficient shows the elasticity of the input used in production. If there is a one percent increase in labor days, chemical, irrigation, seed, Poultry Manure, and tractor hours, the production will be increased up to 0.36, 0.08, 0.18, 0.17, 0.17, and 0.08 percent. The coefficient of fertilizer is negative which implies that there is an inverse relation between

the fertilizer used and total production. If the grower increases the use of fertilizer by one percent the total production will be decreased up to 0.03 percent. The results are similar to the previous results of Saddozai *et al*. (2013) and Ali and Khan (2014). The sum of all elasticity is 1.01 which is greater than 1 showing an increasing return to scale. The results are similar to the previous result of Adedoyin*et al*. (2016) and Chiona *et al*. (2014). The estimated R^2 gives a good fit to the model and shows that 81 percent of variation is caused due to independent variables while the remaining 19 percent due to uncontrollable factors or error terms.

Allocative efficiency estimates

The estimated results of the growers' allocation of resources are shown in Table 4. The results show that the allocative efficiency of the variable inputs labor, fertilizer, chemical, irrigation, seed, poultry manure, and tractor hours that are utilized by the farmers are 6.95, -4.42, 1.02, 3.68, 2.16, 1.47, and 1.95, respectively. The result indicates that fertilizers used by the growers are over-utilized which implies that the overused fertilizer can reduce the production. The chemical used by the farmers are optimally used, so there is no need to increase or decrease the number of chemicals that are used during the farming of tobacco. The indices also show that labor, irrigation, seed, poultry manure, and tractor hours are under-utilized which indicates that farmers need to increase the quantity of these inputs to get good results. It is clear after analyzing the study that farmer respondents require to spent more on labor, irrigation, seed, poultry manure, and tractor hours and reduce their cost on fertilizer, such report is discussed in the previous study of Inoni (2007).

Table 4: *Allocative efficiency indices.*

Variable	MVP	MFC	AL	Remarks
Labor	2432.532	350	6.950	Under-Utilized
Fertilizer	-143.519	32.45	-4.422	Over- Utilized
Chemical	2193.691	2150	1.020	Optimally-Utilized
Irrigation	1839.192	450	3.678	Under-Utilized
Seed	2382.747	1100	2.166	Under-Utilized
Poultry manure	2470.631	1675	1.475	Under-Utilized
Tractor hours	2340.500	1200	1.950	Under-Utilized

Source: *Survey data, 2019.*

Conclusions and Recommendations

The purpose of the current study was to examine the production of tobacco under the allocation of various farming inputs, and subsequently its effect on the socio-economic status of the farmers. The socio-economic attributes considered in this research study were education, age and experience of the respondent. It was observed that most of the inputs were under-utilized except chemical which was used in optimum quantity, while the fertilizer was over-utilized. The study presented the gross efficiency of allocation of the inputs among tobacco growers from the selected villages. The production function analysis showed that overdosed fertilizer had non-significant effect on the production, similarly underutilization of other inputs had also a negative influence on the total tobacco production, hence it is concluded and further recommended that the farmers should reduce the quantity of fertilizer and increase the use of other inputs except chemical for improved tobacco crop.

The study examined the efficiency level of inputs being utilized by the growers during the production of tobacco. The study also focused on the important socio-economic attributes of the farmer which is education, age, and experience. The results show the gross efficiency in the allocation of input among tobacco farmers in the study area. Mostly the input used by the farmer in the study area is under-utilized while the chemical used is optimally used and fertilizers are over-utilized. Therefore, it is recommended that the farmer needs to reduce the use of fertilizer and increase the use of other inputs except for chemicals.

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Novelty Statement

This holistic approach adds depth to understand the trade-offs involved in resource allocation, offering insight on potential environmental implications and societal factors associated with tobacco production.

Author's Contribution

Khurram Nawaz Saddozai: Conducted this study, collected the data and wrote the draft of the manuscript.

Muhammad Nasrullah: Wrote a conceptual

framework and specified the model.
Jahangir Khan: Collected and analyzed the data and interpreted the results.
Syed Attaullah Shah: Selected the model and analyzed the data.
Raheel Saqib and Naheed Zahra: Literature review and format setting.
Mansoor Rasheed: Helped in data entry.

Conflict of interest
The authors have declared no conflict of interest.

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