Research Article

Allocative Efficiency Analysis of Tomato Growers in Mohmand Agency, Pakistan

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Abstract | This research study is carried out to examine allocative efficiency among tomato growers in Mohmand Agency, Pakistan. The study is based on primary data, collected through a well designed questionnaire from a sample of 115 tomato growers. A Cobb-Douglas type production model is used to estimate tomato yield and identify important factors affecting yield. Ordinary Least Square estimates for the model indicate that machinery, seed quantity, labor, number of irrigation, chemicals spray and fertilizers have positive significant effects on tomato yield. Allocative efficiency analysis reveals that machinery, seed quantity, number of irrigation, fertilizers and chemicals are underutilized, while labor and FYM are over utilized for tomato production in the study area. The study recommends training for growers and field labors, provision of short-term formal credit and subsidies on seed, chemical spray, fertilizers and other underutilized inputs/ capitals.

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Introduction

Pakistan's agro-climatic conditions are very suitable for crops and vegetables production. Among vegetables, tomatoes, onions and potatoes are grown on larger scale and they are economically more attractive to farmers. They are short duration and can be grown on a small fragment of agricultural land. The cultivation of these vegetables provid employment opportunities to local labor as their production is labor intensive.

Tomatoes are fruiting vegetables used in different types of dishes and consumed fresh in salads. Processed tomatoes are used in ketchup, juices, chutney and soup. They possess 90 percent water and contain about 23 kilocalories per 100g. Tomatoes are rich in sugars, vitamins, dietary fibers, essential amino acids and minerals, and thus their consumption contribute to a healthy and well-balanced diet. They contain important antioxidants, such as Lycopene, Carotenoids and Phenolic compounds, which prevent certain cancers and cardiovascular diseases (Adalid et al., 2004).

The global fresh tomatoes production is approximately 161.96 million tonnes on an area of 4.8 million hectares and with an average yield of 33.6 tonnes per hectare (FAO, 2013). Top producing country is China, followed by India, U.S.A, Turkey, Iran, Italy, Spain, Brazil and Mexico (FAO, 2013). Pakistan comes at 35th position in the Food & Agriculture Organization's ranking (FAO, 2013). In the year 2012-13, tomato was cultivated on 52.3 thousands hectares of land and the total production was 529.9 thousand tones. Tamoto's yield was 10.1 tonnes/ hectare is less than half of the world's average yield. This yield gap

might be due to poor production technologies or underutilization of required inputs. Table 1 show that production wise, the major contributor is Baluchistan followed by Sindh and Khyber Pakhtunkhwa (KP) (GoP, 2012-13).

Table 1: *Tomato productions in Pakistan (2012-13)*

Provinces	Area ('000' Hectares)	Production '000' Tonnes
Punjab	6.7	87.9
Sindh	14.6	114.9
KP	12.6	113.2
Baluchistan	18.4	213.9
Pakistan	52.3	529.9

Source: *Government of Pakistan, 2012-13*

More research work is required to investigate reasons for low tomato yield in Pakistan. A number of studies have examined the technical efficiency of tomato growers; however, only few studies have evaluated their efficiency in inputs/capitals allocation for tomatoes production. That's why this study is designed to identify important inputs/capitals for tomato yield in Mohmand Agency of Pakistan and analyze efficiency in their allocation.

In Mohmand Agency tomatoes are grown twice a year which are called seasonal and off-seasonal crops. For seasonal crop, nursery is raised in December while for off-seasonal crop nursery is raised during August to September. After 30 to 40 days, the plants are transplanted to field. Seasonal tomato picking starts in June, while it is carried out in March for off-seasonal crop. Tomato is a major cash crop and an important source of earning for the farming community. However, majority of the farmers are poor and thus are likely to operate with low level of production inputs. This study forwards policy recommendations on "*how to enable those poor farmers to operate with allocativelly efficient level of the important inputs*".

Matrials and Method

Study area and sample selection

Mohmand Agency is a district in the Federally Administered Tribal Area (FATA) of Pakistan. The total area of the district is 2,296 square kilometers; estimated human population is 627120 and annual population growth rate is 4.28 percent (Census Report, 1998). The district is bounded in north by Bajaur Agency and in south by Khyber Agency. Malakand and Charsadda districts lie towards its east, and Peshawar district to the south east. The agro-climatic conditions of the Agency are very conducive for vegetables cultivation. Kabul and Swat rivers are main sources of water supply for irrigation. Kabul River forms the boundary line between the Khyber agency and the Mohmand agency. Swat River enters in the north of the Agency and flows towards south. Climatic conditions vary from hot and dry summers to cool and sub humid winters. Rainfall is scanty, and most of them occur in winter.

Figure 1: *Mohmand Agency*

A multistage sampling technique was used for sample selection. In the first stage, out of the seven tehsils in Mohmand Agency, Pindiali, Prang Ghar and Ambar were purposively selected based on high number of tomato growers. In the second stage 2 villages were selected randomly from each selected tehsil. In the final stage, tomato growers were randomly selected from each village. The required sample size of 115 tomato growers was decided based on Yamane's method (see Yamane, 1967). A proportional allocation sampling technique (Cochran, 1977) was adopted for choosing the number of tomato growers from each village.

A well-designed questionnaire was used for data collection. Efforts were made to keep it simple and understandable. Data were collected for seasonal crops only. Off-season crops are cost intensive, that's why very few growers produce Off-season tomatoes.

Analytical framework

According to Farrell (1957) economic efficiency of a firm has two components-technical efficiency and allocative efficiency. Technical efficiency is the ability of a firm to produce a maximum output from a given set of inputs, and allocative efficiency is the ability of a firm to produce a given level of output using the

cost-minimizing input ratios (Bukhsh, 2006).

To achieve the objectives of the study, data are analyzed in the following two steps.

Estimation of Cobb-Douglas type Production Function: The following Cobb-Douglas type production model is used to estimate tomato yield and identify important determinants of yield.

$$Ln(Y_j) = \beta_0 + \sum_{i=1}^{n} \beta_i Ln(X_{ij}) + u_j$$

Where;
Ln: log; Y_j: Tomato yield (in kilograms) for j^{th} tomato grower; *i*: 1,2,3…n inputs used in tomato production; β_0: Constant; β_i: Coefficient of the i^{th} input; u_j: Random error term.

Allocative efficiency estimation: The coefficients estimates for the Cobb-Douglas production model are used to estimate allocative efficiency (A.E.) in inputs use. Following Inoni (2007), the A.E. for an i^{th} input is estimated by using the following formula:

$$A.E._{xi} = \frac{MVP_{xi}}{MFC_{xi}} = \frac{MPP_{xi}\, P_y}{P_{xi}} = \frac{(\beta_{xi}\, APP_{xi})\, P_y}{P_{xi}}$$

Where;
B_{xi}: *Coefficient of i^{th} input;* P_{xi}: *Price per unit of i^{th} input;* MPP_{xi}: Marginal physical product of the i^{th} input; $APP_{xi}=y/xi$: Average physical product of the i^{th} input; P_y: Tomato per unit price; MVP_{xi}: Marginal value product of the i^{th} input; $MFC_{xi}= P_{xi}$: Marginal factor cost of the i^{th} input.

If the value is less than 1, the input is over utilized, while a value greater than 1 shows underutilization and thus reveals that the input is efficiently utilized.

Results and Discussion

Growers' characteristics

Data on growers' characteristics, such as their age, education, farming experience in growing tomatoes, their area allocation for tomato and there tenancy status are analyzed using descriptive statistics tools. Results from descriptive statistical analysis are given in (Table 2). The table shows that the age of the tomato growers in the study area is on average 48.68 years and their experience in growing tomato crop is 21.5 years. Most of them are illiterate, and those who are educated, their mean education level are below 5 years. Average farm size in the study area is 3 acres and land allocated to tomato crop 1.16 acres per farm. Most of the growers are owner of their farm land (94 percent are owner while only 6 percent are tenant).

Table 2: *Tomato growers' characteristics*

Characteristics	Mean	Std. Dev.	Minimum	Maximum
Age (years)	48.69	12.42	24.00	75.00
Education (schooling years)	1.63	1.08	1.00	5.00
Farming experience (years)	21.45	8.19	7.00	40.00
Tenancy status (owner percentage)	94%	24	0.00	1.00
Area under tomato crop (acre)	1.16	0.87	0.50	5.00

Source: *Survey data (2015)*

Table 3: *Estimated cobb-douglas production function*

Variables	Coefficient	t-ratio	p-value
Constant	1.85	2.77	0.01
Ln(FYM)	0.02	0.26	0.80
Ln(Seed quantity)	0.27	3.29	0.00
Ln(labor days)	0.19	2.02	0.04
Ln(irrigations)	0.25	3.06	0.00
Ln(chemical spray)	0.15	2.73	0.01
Ln(fertilizer)	0.48	2.33	0.02
Ln(machinery hours)	0.15	2.55	0.01

Source: *Survey Data, 2015*

Estimated cobb-douglas production function

The OLS estimated Cobb-Douglas type production function is given in Table 3. The table list production inputs, their estimated coefficients, t-ratios and p-values. The estimated coefficient for an input represents a percent change in tomato's yield due to 1 percent increase in that input use, when all other inputs are held constant. The estimated coefficients for seed quantity (seedlings), labor days, irrigations, chemical spray, fertilizers, and tillage machinery are positive and statistically significant at less than 5 percent level of significance. These results indicate that tomato yield is more sensitive to these inputs/ capital use and increases with increase in their quantity. FYM has a positive coefficient but statistically insignificant.

The summation of the coefficient values gives return to scale in tomato production. The summation of the estimated coefficients ($\beta_1+\beta_2+\beta_3+\beta_4+\beta_5+\beta_6+\beta_7$) is greater than 1, indicating an increasing return to scale in tomato's production and implies that large scale

Table 4: *Allocative efficiency of tomato growers*

Variable	APP	MPP	MVP	MFC	MVP/MFC
FYM (kilograms)	4.00	0.08	2.08	8.00	0.26
Seed quantity (grams)	77.50	20.54	513.61	140.00	3.67
Labor (man days)	64.07	11.86	296.42	400.00	0.74
Irrigation (numbers)	141.85	35.46	886.50	700.00	1.27
Chemical spray(liter)	2.68	0.39	9.84	2.40	4.10
Chemical Fertilizers (kilograms)	32.55	15.72	393.09	60.00	6.55
Machinery (hours)	1355.90	202.38	5059.51	900.00	5.62

Source: *Survey Data (2015)*

intensive production of tomatoes would be more productive and profitable.

Allocative efficiency of tomato growers

Table 4 lists results from A.E. analysis for inputs use in tomatoes production. The A.E. of seed quantity, irrigations, chemical spray and fertilizers and machinery are 3.67, 1.27, 4.10, 6.55 and 5.62, respectively. These values indicate that these inputs are underutilized. Field observations and discussion with growers revealed that this underutilization are due growers' lack of knowledge in application of these inputs/ capitals, unavailability of seeds and irrigation water and weak financial position of the growers for adopting recommended spray and fertilizers in required doses. The A.E. of FYM is less than 1, showing overutilization of this inputs, and should be reduced up to a level where it's A.E. reaches 1. Labor is another factor for which the A.E. is less than 1, and it might be due to high wage rate in the study area. Labor is an important factor which could significantly increase tomato's yield. Grower's allocative efficiency in labor use could be increased through using labor efficient technologies and improving their skills.

Conclusions and Recommendations

Seed, irrigation, machinery, chemical spray and fertilizers are important determinants of tomato yield. However, these inputs are underutilized by the growers in the study area. Growers lack of knowledge in application of these inputs, unavailability of seeds and irrigation water and their week financial position for adopting the recommended inputs in required amount are the main reasons. To increase the growers' efficiency in tomatoes production, the study recommends government and concerned departments to arrange season long trainings for growers and field labor regarding efficient use of recommended inputs. Inputs should be supplied to growers at subsidized prices and at the right time. Provision of low interest rate short period credit can enhance growers' capability to adopt new production technologies and proper use of recommended inputs.

Authors Contribution

This research paper is a part of the NM's MS research work. AUJ was his major advisor, while SAS, IU, MI and SK helped in data analysis.

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