Research Article

An Analysis of Allocative Efficiency of Growing Onion in District Swat Khyber Pakhtunkhwa

Wajid Shah Yousafzai[1], Irfan Ullah[1]*, Amjad Ali[1], Mahmood Iqbal[2] and Salman Khan[1]

[1]Department of Agricultural and Applied Economics, The University of Agriculture, Peshawar, Pakistan; [2]Department of Agriculture Extension Education and Communication, The University of Agriculture, Peshawar, Pakistan.

Abstract | Agricultural sector is an important component of the Pakistan economy. It has blessed with four seasons, therefore its soil is rich to produce all kinds crops, fruits and vegetables. Agriculture sector contributes to the economic benefit of the farming community in Pakistan, therefore analyzing its potential remain major focus in various studies. Current study has been designed with main aim to estimate the allocative efficiency of onion production in District swat. Using multistage sampling technique cross sectional data was collected from 105 sample respondents in three villages (Aboha, Manyar and Parrai) of Tehsil Barikot, district Swat. Simple Linear Regression Model was employed to individual input contribution in total output. The concept of Marginal Value Products and Marginal Factor Cost was used to calculate Allocative Efficiency. Ordinary Least Square technique was used to drive linear production function. The results revealed that Tractor (hrs), Labor (M-days), FYM (kg), chemical fertilizer (kg), pesticide/weedicide (ml), and irrigation numbers have positive effects on onion production in the research area. Allocative efficiency estimates showed that tractor hours, FYM, chemical fertilizer, and pesticide/weedicide are under-utilized having ratios of 22.15, 8.65, 5.49 and 34.69 respectively. Similarly, seed rate and irrigation numbers are over utilized having values of 0.14 and 0.76 respectively. The allocative efficiency value for labor days was 1.07suggests almost near to allocative efficient level. The study recommends season long trainings for optimal resource allocation, availability of inputs at reasonable prices and facilitation of growers in marketing of output, in order to enhance allocative efficiency of onion growers in the study area.

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***Correspondence** | Irfan Ullah, Department of Agricultural and Applied Economics, The University of Agriculture, Peshawar, Pakistan; **Email:** Irfanullah@aup.edu.pk
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Introduction

Pakistan being predominantly an agrarian country, where majority of the population is directly or indirectly engaged with agriculture. It contributes 20.9% to GDP and absorbs 43.5% of labor force. Besides fulfillment of food necessities, it provides raw material for other industrial markets thus increasing their output level. Growth of agriculture has significant contribution in the economy and improvement of the living standards of rural community (GoP, 2016). Pakistan has total area of about 80 million hectares (79.61 million hectares). Out of these 80 million hectares, total cultivated area is 22.04%, of which 4.27% is under forest, 8.31% is cultivated waste. The remaining area consists of deserts and mountains generally not suited or we can say not used for agricultural purposes. (FAO, 2014).

Onion (*allium cepa*. L) is cash crop. It is usually served cooked as food stuff, as a vegetable or a part prepared savory dishes. Onion crop can be grown under a wide range of climate from temperate to tropical. It is sown in the nursery and transplanted after 45 to 60 days. The length of growing period varies with climate but in general 130 to 175 days are required from sowing to harvest, (FAO, 2014). The total world production of onion is about 86.34 million tones and Pakistan is occupying 8th position with 2.25% share (FAO, 2014). The annual production of onion in Pakistan is estimated at around 1817.3 thousand tons over an area of about 129.7 thousand hectares. Yield per hectares is estimated to be 14.0 tons in 2011-12. Among provinces, Sindh constitutes top position with production of 745.4 million tons followed by Baluchistan (526.1), Punjab (361.8) and Khyber Pakhtunkhwa (11.10). Area allocated, production and yield per hectare of onion are shown in the Table 1. (GoP, 2016).

Table 1 shows that based on both area and production, district Swat constitutes top position with production of 10.02 tons followed by Charsadda (3.56), FATA (2.75), DIR Upper (1.66), DIR Lower (1.35) and Malakand (1.53) (GoKP, 2014).

Justification

In spite of great potential of onion production in the study area factors such as low technical, know how, high cost of production inputs and quantitative determination of allocative efficiency of available resources has not been focused in recent studies. In view of above, current study was designed to determine resource use efficiency in district Swat. This study will facilitate investment decisions making as well as onion growers to reconsider their scarce resource allocation in order to obtain maximum net returns.

Materials and Methods

Universe of the study and sample selection

Data analyzed in this paper comes from a sample of small farms located in district swat, KPK. District swat situated in north of the province was chosen for this study because it is famous for fruits and vegetables production and it plays a key role in local economy. Many other vegetables and fruits like tomato, potato, peaches and apple etc. are grown because the climatic condition is favorable for their production. It supplies, its produce to local as well as across the country and overseas. District swat is further characterized by high pressure of population on agricultural land, low investment in agricultural research and high dependency on multinational companies for seed, pesticides and weedicides. The total area of the district is 5337 square kilometers and the current population is approximately 21.61 million with a density of 236 per square kilometers. Area under cultivation for onion production according to crop statistics of Khyber Pakhtunkhwa (2013-14) is 3185 hectares similarly the total production noted for the same year is 10.024 million tons claiming the highest producing district for onion than any other district.

During the summer 2017, a survey was conducted on a random sample of small farms located in tehsil Barikot villages (Abboha, Parrai and Manyar). Multi-stage sampling technique was applied for sample selection. A well-planned questionnaire was used to obtain data regarding input used and output realized. After discarding the incomplete record, a sample of 105 farms remained for analysis. Of the 105 respondents, 52 percent were found in age range from 31 to 50 years, average onion growing experience was 10 years ranging from minimum of 4 to maximum of 18 years. About 45 percent growers is the study area were found illiterate. Out of 105 respondents 63 were owners and 42 were found tenants.

Methodological framework

Sixty-two years ago, Micheal Farrel (1957) introduced a technique to measure allocative efficiency. According to Farell allocative efficiency represent the ability to produce a given amount of input at least cost or cost minimizing inputs ratios and allocative inefficiency reflects deviation for the minimum cost input ratio (Bravo-Ureta and Pineriro, 1997). Since inception Farell methodology was widely applied regime and improved. In current study model is based on extension proposed by Bravo-Ureta and Rieger (1990), they used stochastic production frontier to remove the random elements before deriving the allocative efficiency indices. The general form of the production function applied is:

$$y = f(X, \beta_i) + \varepsilon \quad \ldots(1)$$

Where;

Y is the output realized by the ith farm; X_i is input used in the ith farm and β is a vector of unknown

parameters; Specifically, the model applied in the current study is as under:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + ei \quad \ldots(2)$$

Where;
Y = Yield of onion in kgs per acre; X_1 = Labor Hours per acre; X_2 = Tractor Hours per acre; X_3 = Fertilizer kgs per acre; X_4 = weedicide/pesticide in milli-liters per acre; X_5 = FYM in kgs per acre; X_6 = Seed rate kgs per acre; X_7 = Number of irrigations; e_i = error term; β_0 = Constant; β_i = Coefficient to be estimated.

From Equation 1 it is possible to derive the allocatively efficient input (x) quantities for a given level of output by determining $MPPX_i$ as follows:

$$MPPx_i - {}^{d_y}/_{d_x} - \frac{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7}{dx_i} - \beta_i \quad \ldots(3)$$

Therefore, allocative efficiency of resources employed in onion production can be expressed as follows: (Inoni, 2007).

$$A.E = \frac{MPPxi \times Py}{Pxi} \quad \ldots.(4)$$

But, MPP_{xi} * Py = MVP and P_{xi}= MFC; therefore, allocative efficiency,

$$A.E = \frac{MVP}{MFC} = \frac{\text{Marginal Value Product}}{\text{Marginal Factor Cost}} \quad \ldots(5)$$

Where;
A.E = Allocative efficiency of Onion production; MPP_{xi}= marginal physical product. Mathematically is can be estimated by taking the derivative of the production function.

Fasasi (2006), Agbamu and Fabusoro (2001) and Oladeebo et al. (2006) has mentioned three scenarios as given below;

$$A.E = \frac{MVPxi}{MFCxi} = 1 \quad \ldots(6)$$

Shows that input Xi is optimally utilized.

$$A.E = \frac{MVPxi}{MFCxi} > 1 \quad \ldots(7)$$

Shows that output Xi is under-utilized.

$$A.E = \frac{MVPxi}{MFCxi} < 1 \quad \ldots.(8)$$

Shows that input Xi is over-utilized.

Table 1: *District wise onion production in Khyber Pakhtunkhwa.*

District	Area (hectares)	Production (Tonnes)
Swat	3815	10.02
Charsadda	2820	3.56
FATA	2242	2.75
Dir Upper	1500	1.66
Dir Lower	1300	1.35
Malakand	1050	1.53

FATA: Federally administrative tribal areas; Source: Government of Khyber Pakhtunkhwa, 2014.

Results and Discussion

Summary statistics of the input utilized by the growers in the study area are shown in Table 2. Seed and rational use of seed play an important role in the production. The results reveal that seed rate used with a minimum of 3.695 to maximum of 7.783 grams in the study area. Tractors were mostly hired and only few farmers have their own tractors, which they used both for commercial purposes and also on their farms with a minimum of 0.693 hours to a maximum of 2.890 hours. Majority of the respondents also used farm yard manure for onion production with a minimum of 3.824 kg to a maximum of 9.146 kg. The use of pesticides was also common in the research area. Most of the respondents used pesticides and weedicides for the elimination and control of pests and weeds with minimum of 5.704 liters and 5.52 liters to maximum of 8.517litres and 8.086 liters respectively. Availability of adequate water on time is immensely important for higher production. The results showed that minimum number of irrigation was 3.367 and maximum of 3.912. The total minimum number of labors involved was 3.912 and a maximum of 5.717 in the study area.

Table 2: *Summary statistics of the input utilized by the growers.*

S. No.	Variables	Min.	Max.	Mean	Std. Deviation
1	Seeds	3.695	7.783	5.467	1.103
2	Tractor (Hrs)	0.693	2.890	1.461	0.514
3	FYM (Kg)	6.824	9.146	7.620	0.606
4	Pesticides (L)	5.704	8.517	6.856	0.698
5	Weedicides (L)	5.521	8.086	6.529	0.666
6	No of Irrigation	3.367	3.912	3.733	0.105
7	Labor Days	3.912	5.717	4.415	0.386

L: stands for liter; Source: Author's calculation from field survey.

Based on the model discussed above Table 3 presents estimates of the production function parameters. These estimates were arrived through ordinary least square estimation techniques. Table shows the significance of each input. Inputs like tractor hrs, labor, FYM, chemical fertilizers, pesticide/weedicide and irrigation are significant having coefficients values of 923.237, 20.100, 1.98262, 13.7402, 3.61377 and 15.9940 respectively. which means that a one percent increase in tractor hours might increase onion yield by 923.237 kg, similarly the others explanatory variables as well. In table 3 the coefficient of determination denoted by "R^2" value is 0.25. According to Gujarati (2012), R^2 is an overall measure of goodness of fit of the estimated regression line and represent the percentage of total variation in dependent variable that is explained by all the repressors. Thus, in current study R^2 value suggest that 25% variation in dependent variable (onion yield) is due to repressors given in Table 3.

Table 3: *Estimates of allocative efficiency of onion growers.*

Variables	Coefficients (B_o)	Std. errors	t values	P-values
Constant	120.643	2265.61	0.05325	0.9576
Tractor (hours)	923.237	437.235	2.112	0.0373
Seed rate (gms)	17.5566	73.9392	0.2374	0.8128
Labor (Man Days)	20.100	9.0826	2.213	0.0310
FYM (Kg)	1.98262	0.981739	2.019	0.0462
Chemical Fertilizers (Kg)	13.7402	6.03037	2.279	0.0249
Pesticide/weedicide (Ltrs)	3.61377	1.71574	2.106	0.0378
Irrigation (No.)	15.9940	7.66380	2.087	0.0395
R^2	0.25			

Source: *Author's own calculation.*

Allocative efficiency estimates

Input allocative efficiency was estimated in two steps. In the first step through linear production function, marginal physical products (MPP) were derived. The second step gives the output and input prices ratio of MVP and MFC was computed. The question as to which of the variable input (tractor hours, seed rate, labor days, FYM, chemical fertilizers, pesticides/ weedicides and irrigation) are used above or below the optimal in the study area. Referring to Equations 6, 7 and 8 as evident from the Table 4 that allocative efficiency value of 22.15 for tractor hours, labour days (1.07), FYM (8.65), chemical fertilizers (5.94) and Pesticides/ weedicides (34.69) are under-utilized. Which means that these variables contributing more to lower allocative efficiency in the study area.

It is obvious that onion cultivation is labor intensive, so their hiring and involvement must be proper. The allocative efficiency for the labors being hired or totally involved in the cultivation process is 1.07 which is almost nearer to the allocatively efficient point. Farm yard manure is as important as chemical fertilizer for the crop as besides making the soil fertile and also increase the water holding capacity of the soil. The allocative efficiency for farmyard manure is 8.65 suggests it's under-utilization. The farmer should increase the utilization of FYM per acre to bring it to an allocatively efficient point which is 1. Chemical fertilizers play a vital role in any crop production as it increases the fertility of the soil by providing more of the required nutrients. In the study area there is under-utilization of chemical fertilizer occur as evident from its allocative efficiency value which is 5.49. Farmers should utilize more of the chemical fertilizer so as to bring it to allocatively efficient point. Unwanted crop in the field retards the growth of the crop in the field and should be removed. There is always the risk and fear of pest attack which need proper management. This management in the study area seem to be poor as evident from the result of allocative efficiency value of 34.69 shows its underutilization. In order to keep the management better and to bring the farmers at the point of allocative efficient they must increase the utilization of weedicide/pesticide.

As discussed in the cost of production section: proper, controlled and frequent water is necessary for onion production. The term controlled is given more stress because it effects the crop extremely as if over irrigated may retard the bulb growth. It seems to be over utilized irrigation number which is clear from the findings and its estimated value which is 0.76. So proper and controlled watering is suggested to the growers of the study area to be allocatively efficient. Results noted regarding under-utilization of inputs (tractor hours, labor days, FYM, chemical fertilizers and pesticides/ weedicides) are in line with Naveed et al. (2017).

Field observations and discussion with onion growers revealed that under-utilization might be due to lack of knowledge regarding application of these inputs, nut mainly due to growers' weak financial position, risk and uncertainty regarding output prices after crop harvest. It was also observed that in the study area growers don't keep written records for inputs used and output realized, this might create measurement problems and gave biased results. It was observed

Table 4: *Allocative efficiency of onion growers in the study area.*

Model	Coefficients (B_i)	Output price	MVP[1]	MFC[2]	A.E[3]
	MPP[4]	P y[5]	MPP* P y	P_X[6]	A.E=MVP/MFC
Tractor (Hrs)	923.237	24	22157.688	1000	22.15
Seed rate (kgs)	17.556	24	421.35	3000	0.14
Labor Days (wages)	20.10	24	482.4	450	1.07
FYM[7]	1.9826	24	47.5828	5.5	8.65
Chemical fertilizer	13.740	24	329.764	60	5.49
Pesticide/weedicide	3.6137	24	86.730	2.5	34.69
Irrigation	15.994	24	383.856	500	0.76

Source: Author's own calculation; [1]Marginal Value Product; [2]Marginal Factor Cost; [3]Allocative Efficiency; [4]Marginal Physical Product; [5]Price Output; [6]Price of Input; [7]Farm Yard Manure.

that small growers and their families are struggling hard to meet their daily requirement they have less or nothing to invest in agriculture. It was also observed that growers approach money lenders of local fruits/vegetables market and at the end they become the actual beneficiary of all the hard work done by the poor farmers.

Similarly, the estimated value of allocative efficiency for the input seed rate was found to be 0.14 which is less than 1 and which suggest it's over utilization. From regression analysis seed rate was found to be insignificant with p-value greater than 0.05 and coefficient value of 17.556. There are two reasons for why seed rate is insignificant and still over-utilized. Firstly, as we are using linear production function, so the farmer might be at first or second stage, quadratic function tells exactly at which stage the farmer is operating. Secondly, farmers sow their own nursery and because of the fear that the seed may or may not sprout completely they sow more seed than the required amount. The required amount for a half acre of area would be, a half-acre field is about 2000m^2, that's about 45m by 45m. If farmer plant the seed 2.5cm apart then it comes 1800 seed per row and if they space the rows 38cm apart then it comes 118 rows that totally add up to about 212000 seeds. So, at 325 seeds per gram or a little over half of kilogram would be sufficient for cultivation assuming every seed sprout.

Conclusions and Recommendations

The paper examined allocative efficiency of resource utilization in onion production in District Swat. The results indicate that tractor hours, labor days, FYM, chemical fertilizers and pesticides/weedicides are important determinants of onion yield, but these inputs are underutilized in the study area. Technical know-how, financial position and low output price may be implicated for under-utilization of these inputs to increase grower's efficiency in onion production there is a need for season long training, availability of inputs at reasonable prices and facilitation in marketing of output. Allocative efficiency indices such as 0.14 and 0.76 for seed rate and irrigation numbers per season were found over utilized. Locally produced low quality of seed and free irrigation water availability may contribute in over-utilization. In order to achieve resource optimality there is a need to reduce the quantity these inputs to raise productivity and consequently improve revenue and net returns of onion growers in the study area.

Novelty Statement

This paper determines resource use efficiency in district Swat which will facilitate investment decisions-making as well as onion growers to reconsider their scarce resource allocation to obtain maximum net returns in the area.

Author's Contribution

Wajid Shah Yousafzai: Conducted the study, reviewed literature, wrote introduction and methodology.
Irfan Ullah: Developed main theme of the research and guidance in model development.
Amjad Ali: Wrote abstract, conclusions and recommendations, provided technical input at every step.
Mahmood Iqbal: Helped in analyzing data.
Salman Khan: Performed proof reading of the draft and corrected references.

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