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Technical Efficiency of Smallholder Wheat Farmers: The Case of Qu Zhou County of China

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Abstract: Wheat is among the main crop produced next to rice and maize, in China. In wheat production, miracle achievement has been achieved, in the last several decades**.** However, the current production of wheat does not sufficiently meet its demand to the expected level. The yield is still low though improved agricultural technologies have been used by the farmers. As the productivity of wheat is not just determined by technological innovation alone but also by the efficiency with which available technologies are used, this study aims to estimate the technical efficiency of wheat producers and to identify the sources of its variation in the Qu Zhou County of China. A single-step stochastic frontier production model is used to analyze the data collected from the respondents through personal interviews. The result shows that the mean technical efficiency of wheat producers is 96 percent, indicating that, farmers have produced 4 percent less than the maximum output that can be produced. This shows that there is room for efficiency improvement and output can be maximized by 4 percent using the existing wheat production technologies without changing. The findings also show that agricultural inputs, in particular, fertilizer and insecticide have negative and significant effects on the wheat yield at 1 and 5 percent significance levels, respectively. This means increases in the amount of these inputs could lead to a reduction in wheat outputs. Conversely, a farm size allocated for wheat production has a positive and significant effect on wheat yield at a 10 percent significance level. Socioeconomic factors, such as education level, farming experience, seed cost, and soil fertility status are also observed sources of inefficiency in the study area. In general, the study has indicated that disparity between actual and potential yield is not a chance alone, but due to inefficiencies among the producers. Therefore, it is possible to make practical and effective interventions by focusing on factors that affect the technical efficiency of the wheat producer in Qu Zhou County.

Keywords: Technical Efficiency, Wheat Producers, Stochastic Frontier Analysis, China

1. Introduction

In the last several decades' astonishing agricultural output has been achieved. However, the increase of observed output did not reach the expected level though the consumption level of agricultural inputs increasingly increased by the users in hoping that excess use of agricultural inputs helps to attain potential output. Increasing production and productivity among smallholder farmers is widely regarded as a key strategy for agricultural development in developing countries [1, 2]. This can be achieved either through introducing modern technology or improving the efficiency of producers with a given level of input and technology [3]. Our study focuses on the second way of boosting productivity as the measurement of efficiency has remained an area of important research. Especially in developing countries, where resources are scanty and not used efficiently.

Regardless of the scarcity of resources, China has managed to feed a quarter of the global population with only 7 percent of arable land in the world. Over the last few decades, China's grain production has increased by more than 50 percent. Particularly since 1980, amazing progress has been made by the agricultural sector, though agricultural pollution became a major problem due to the consumption of excessive chemical inputs that require an immediate solution nowadays [4].

In China, since the green revolution era, significant increases in grain production have been observed. However, keeping continuous raise of total grain output and satisfying food self-sufficiency is still under threat as a result of the transformation of the rural labor force to the non-farm sector, rapid urbanization and industrialization, and living standard improvement of the people [5]. There is no doubt that the application of new improved agricultural technologies boosted crop productivity in China. However, due to several reasons such as drought and excessive use of agricultural chemical inputs, a sustainable increase of crop yield is impeded to reaching the expected level [6]. As pointed out by Zhang et al. [7], agriculture in China, which is dominated by millions of smallholders, consumes 30% of global nitrogen (N) fertilizers and results in a high surplus and vast spatial variability of N fertilizer. This inefficient use of chemical nitrogen in agriculture challenges food security and environmental quality. Especially cereal crops account for nearly 70% of the total planting area, consuming more than half of total N fertilizer. However, the continuous increases in chemical fertilizer consumption no longer increase the output of agriculture but lead to environmental destruction, which is a global problem, particularly in China.

Therefore, the hereafter possible solution that could maximize the output could be through improving the technical efficiency of producers without increasing the level of the inputs that have been used. The so-far miracle achievement obtained by increasing agricultural inputs in China must be repeated by the technical efficiency improvement of producers. Further enhancement of agricultural inputs is no longer needed because of its adverse impact on biodiversity. Therefore, this study is mainly focusing on the investigation of the presence of technical inefficiency of producers among themselves and identifying the source of variation if exists. This study is advantageous to understand and sort out factors that negatively contribute to the output in the study area and suggest a possible solution that could help policymakers as inputs to develop intervention agenda to come up with practical solutions.

Observed achievement in output growth in China's agriculture is through the increases in agricultural inputs, technological progress, and institutional innovations. For instance, 1985-2010 fertilizer and machinery have the most significant and positive contribution to agricultural growth among the other various inputs [8]. In the study area, farmers have been using improved verities with associated agronomic practices. To increase the adoption of agricultural technology, innovative models such as science and technology backyard and other technology transfer methods have been used in the study areas. However, climate-related shocks [6] and improper or excessive use of agricultural inputs, like fertilizer become a serious problem for environmental abnormality which hamper sustainable agricultural production [9, 10]. This implies that farmers are not using modern agricultural technologies efficiently. Moreover, as reported out by Yao & Liu [11] improvement in technical efficiency is an effective approach than input increase to maximize agricultural production and further output growth must rely on improvements in the technical efficiency. To overcome this problem study on technical efficiency is found necessary.

Different studies have been conducted on technical efficiency analysis in different parts of the country [12–18]. However, none of these studies considered the technical efficiency of wheat producers in the study area. The studies mainly focused on the province level and beyond. Since technical efficiency may vary from village to village, even among the producers, this study creates an opportunity to understand the technical efficiency of wheat producers in Qu Zhou County. The specific objectives of the study are:- (1) to estimate the level of technical efficiency of wheat producers, (2) to identify the sources of variations in technical efficiency among the farmers, and (3) to investigate yield gaps due to technical inefficiency in the study area.

2. Research Methodology

2.1. Method of Data Collection and Sampling Technique

This study used primary data collected from farm households in the north China plain of Hebei province, Qu Zhou County in the 2020 cropping season. To collect the needed data structured questionnaire was gotten ready at the beginning and sample farmers were interviewed. The interview method is chosen from the perspective of expecting a significant number of illiterate farm households. Both non-probability and probability sampling techniques were employed in combination under a general multi-stage sampling framework. Initially, the Qu Zhou County has selected using purposive sampling in terms of the presence of science and technology backyard and main crops cultivated in the area. This technique is chosen to address the problems of the majority of the population in the production of their main crops. Then 3 villages are selected purposely based on proximity and produced crop. Finally, sample farmers are selected randomly. However, due to the outbreak of Covid-19 and the subsequent movement restriction made by the Chinese government, we cannot collect the intended number of samples and were obliged to minimize the sample size under the supervision of the respective supervisor. As a result, 36 sample farmers were interviewed from the study area to achieve the intended investigation.

2.2. Method of Data Analysis

Analysis of the data is made using both descriptive and econometric tools. Under the descriptive method, percentages mean standard deviation and frequency analysis were used to analyze the socio-economic characteristic of wheat production of the sample farmers, while inferential statistics such as t-test and Chi-square (X^2) tests were used to undertake statistical tests on different continuous and categorical data, respectively. Besides, I used tabular and graphical presentations of these statistical tools. Regarding the econometric analysis, a single-step stochastic frontier model was employed to estimate the level of technical efficiency of wheat producers. Following [20] the estimation of technical inefficiency of wheat production of smallholder farmers in the study was carried out using a Cobb-Douglas production functional as follows

$$LnYi = \beta o\sum_{n=1}^{N} \beta n \ LnXni+\varepsilon_i \ (V_i - U_i) \quad (1)$$

Where: ln stands for the natural logarithm Y_i is wheat output (kg); β vectors of the parameter to be estimated; X_i is the vector of inputs quantity expected to affect production function; ε_i is error term equals to $(V_i - U_i)$; V_i represents the independently and identically distributed N $(0, \sigma^2)$ random error (statistical noise). It is an asymmetric error term accounting for the deviation from the frontier because of factors that are beyond the control of the farmer and it is randomly distributed in the production process that cannot be influenced by the farmer and is independent of Ui; U_i represents non-negative random variables associated with technical inefficiency in production, independently and identically distributed as half-normal with mean μ, u~ $(N^+ (\mu, \sigma^2 u))$. It measures the deviation from the maximum potential output that is attributable to technical inefficiencies in wheat production,

By using equation 1 [18], and [19] stated the maximum likelihood (ML) estimation of yields estimators for β and γ;

$$\sigma^2 = \sigma^2 v + \sigma^2 u \quad (2)$$

$$\gamma = \lambda^2 (1+ \lambda^2) \text{ or } \gamma= \frac{\sigma 2u}{\sigma 2v+ \sigma 2u} \quad (3)$$

Where the value of γ is $0 \leq \gamma \leq 1$. This means the deviation of output of the firm from the frontier is entirely due to statistical noise if the value of γ is equal to zero. Again, the value of one would indicate that all the differences occurred as a result of technical inefficiency [22, 23]. As stated by Aigner et al. [20], the stochastic frontier production function technical efficiency of the i^{th} farmer given the level of inputs is defined as follow;

$$TE_i = \frac{y_i}{f(x_i; \beta) \exp(v_i)} = \exp(-U_i) \quad (4)$$

Technical inefficiency effect is also expressed as follow

$$U_i = Z_i \delta + W \quad (5)$$

Z_i is a vector of explanatory variables associated with the technical inefficiency effects, and δ is a vector of unknown parameters to be estimated, and W_i represents unobservable random variables, which are assumed to be identically distributed. They are obtained by truncation of the normal distribution with mean zero and unknown variance σ, such that UI is non-negative. TE refers to the technical efficiency of the i^{th} farmer. Y is the observed output f (xi; β) indicates the deterministic part that is common to all producers, exp (v_i) is a producer-specific part, which captures the effect of random noise on each producer. From equation (4) we can observe that technical efficiency is the ratio of observed output to maximum feasible output in an environment characterized by exp (v_i). Furthermore, after the score of technical efficiency of sample farmers was estimated, the potential output of wheat production in the study area was calculated through the following formula.

$$\text{Potential output} = \frac{Actual\ output}{Technical\ Efficiency} \quad (6)$$

To evaluate the interaction among the variable used in the model, the Multicollinearity test of the variable used in the model was carried out through variance inflation factor (VIF) of variables. According to Akinwande et al. [24], if the variance inflation factor of variables is equal to 1, there is Multicollinearity among variables but if the VIF is greater than 1, the variables may be moderately correlated. A VIF between 5 and 10 indicates a high correlation that may be problematic. And if the VIF goes above 10, it can be assumed that the regression coefficients are poorly estimated due to Multicollinearity which should be handled accordingly. After the estimation of technical efficiency of wheat, producers are undertaken and the presence of technical inefficiency of wheat producers is confirmed among the sample household, identifying socioeconomic factors that contribute to farmers' inefficiency is the next most important step intended by the study. To identify the source of variation in the study area ten inefficiency variables of household, education, family size, year of farming experience, farm size, credit access, extension service, distance from market, soil fertility, irrigation facility, and seed cost was applied using a generalized linear regression model.

3. Results and Discussion

3.1. Demographic Characteristics of Sample Households

The age of the household is one of the essential factors that determine the farming experiences of the farmers. The mean age of the sampled household heads is about 56 years with a standard deviation of 12 years. Of the sampled household the minimum and maximum age of the respondents are 30 and 75 years respectively.

Education is the best tool to improve the knowledge and managerial skill of farmers in agricultural activity which results in enhancement in agricultural production and productivity. Education level could influence the production and productivity of the farming community. The finding of the survey illustrates that the average year of schooling of the sample farmers is about 4 years with a zero-year minimum (illiterate) and nine years maximum as indicated in table 1. During the survey time, there is a two years schooling variation among the farmers. Concerning, the family size of the household, a 6 mean value with a minimum of 2 and a maximum of 10 is observed. The average farming experience of sample farmers in wheat production is 34 years with a minimum of 10 and a maximum of 50 years. The survey result shows that the farming experience deviates by 12 years among the household (Table 1). The average landholding of the respondents in the study area is 0.8 hectares. The minimum and maximum sizes of landholding are 0.13 and 2.33 hectares, respectively. In the study area, about 33.2 percent of sample farmers have land less than 0.5 hectares, about 41.8 percent of sample farmers have 0.5 to 1 hectare of land and about 22 percent of respondent farmers have greater than 1 hectare. Distance from the market is also another factor that could affect the efficiency of wheat-producing farmers as it is a place where some agricultural inputs are bought. As is shown in the table below the mean value of distance one individual takes to access a local market is about 2.17 km with a standard deviation of 1.3.

Table 1. *Household characteristic variable.*

Variable description	Minimum	Maximum	Mean	Std. deviation
Age of HH	30	75	56	12
Education level of HH	0	9	4	2
Family size of HH	2	10	6	2
Farming experience of HH in yrs.	10	50	34	12
the Total area of land	0.13	2.33	0.8	0.5
Distance from the market in km	1	3	2.17	1.3

Source own occupation 2020.

As table 2 shows, out of the total respondent interviewed for this study, the majority of the farmers are male-headed households (83%) while the remaining that is 17% is women-headed households. Relation to the marital status of the respondents 94% and 6% are respectively married and widowed. The education status of the sampled farmers is also considered and the result revealed that 22.2% of the interviewed farmers are illiterate. That is they did not attend a school. However. From the total respondents, 75% of interviewees were attending elementary school while 2.8% of sampled farmers could attend secondary school. According to the current finding majority of the farmers got access to education which could help them in improving in agricultural management and related decision.

Table 2. *Sex, marital status, and education status of sampled farmers.*

Sex, marital status, and education level	category	Percentage (%)
Sex	Male	83.3
	Female	16.7
Marital status	Married	94
	Widowed	6
Education status	Illiterate	22.2
	Primary (1-8)	75
	Secondary (9-10)	2.8

Source: own occupation, 2020.

Some dummy variables answered with yes or no responses are described in the below table. Of the variables considered for this study purpose, the soil fertility status of the farming community under wheat production is requested. Accordingly, 97.2 percent of the respondents stated that they have fertile wheat plots while the rest have infertile plots. In the study area, there is no provision of formal credit services to the farmers. However, farmers may receive credit from informal institutions like friends and relatives, in case they face a budget shortage. As it is shown in the table below, the majority of the wheat producers do not need credit service as can satisfy home consumption and cash needs induced by the production cycle characterize agriculture without any credit service. They can purchase inputs in need and can increase agricultural productivity without the use of credit services. The survey result shows that about 83.3 percent of sample farmers reported that they did not obtain credit from credit-providing institutions whereas, the remaining 16.7 percent of sample producers received credit from relatives and friends.

In respective to accessing extension services, only 11.1 percent of farmers have extension contact whereas the rest of the sample farmers have not. In the study area, extension service toward the wheat producers was found rare. Regarding the irrigation facility for wheat production, all sample farmers in the study area use irrigation. As rain is scarce, wheat production is supplemented by irrigation. To obtain cash income that helps them to purchase needed inputs Sample farmers in the study area participate in various agricultural activities in addition to their main farming activities like daily labor. About 94.4 percent of sample farmers have participated in an off-farm activity, while the rest of the farmers do not participate in the off-farm activity.

Table 3. *Descriptive summary of technical efficiency variables.*

Dummy Variables	percentage of mean answered	
	No	yes
Soil fertility status	2.8	97.2
Have access to credit	83.3	16.7
Have extension service	88.9	11.1
Have access to irrigation	0	100
Engaged in Off-farm income	6	94

Source: own occupation 2020.

3.2. Descriptive Results of Wheat Output and Input Variables Used in the Model

Wheat output is used as a dependent variable in the production function. During survey time the average wheat output produced by the household is about 8,271 kg/ha. The output of wheat production could vary among the wheat producers by 78 kg. According to this study, the mean area of land allocated for wheat cultivation is 0.8 ha with a variation of 0.5 ha among the household. The mean value of seed and fertilizers inputs sown by wheat producers are 223.74 and 754.17 kg per hectare with 52.47 and 93.06 quantity of difference among the farmers. About fertilizer type, farmers are using blended fertilize while other agricultural chemicals like herbicides and insecticides were widely used in the study area. On average, the farmers use 1.28 herbicides and 0.96 insecticides per hectare, with standard deviations of 0.56 and 0.32, respectively.

Table 4. *Descriptive statistics of both inputs and output variables.*

Variables	number	mean	Std. Deviation
Output (kg)	36	8271.11	78.0
Area (ha)	36	0.8	0.5
Seed (kg)	36	223.74	52.47
Blended fertilizer (kg)	36	754.17	93.06
Herbicides (L)	36	1. 28	0.56
Insecticide (L)	36	0.96	0.32

Source: own occupation, 2020.

3.3. Result of Econometric Analysis

3.3.1. Parameter Estimates of the SPF Model

Before starting to the estimation of SFM and technical efficiency of the level of farmers, seeing the Multicollinearity problem among variables used in the model is found to be important. Accordingly, Variance of inflation factor (VIF) was undertaken to test the Multicollinearity of input and continuous variables. The result of the study revealed that input variables fell in the range of 1.05 to 1.66 which is below 10, above 1, while the VIF of continuous variables was 1.05 to 1.26 implying moderate correlation among the variables. Multicollinearity problem among the variables is not observed.

To achieve the intended objective, a single-stage maximum likelihood estimation procedure was employed to estimate the stochastic frontier production function among the wheat producer of the study area. The result indicates that all inputs used in the model indicate negative signs other than input land (wheat cultivated area). Inputs factors, such as wheat cultivated area, fertilizer, and insecticide have a considerable influence on the wheat output. The result found that wheat output was negatively and significantly affected by fertilizer and insecticide inputs at 1% and 5%, respectively. That is, these inputs were utilized improperly in wheat production and depicts that increasing these inputs could result in a reduction in wheat output. Therefore, a reduction in these (fertilizer and insecticide) input consumption is required in the study area rather than their expansion. As of this finding increasing the levels of fertilizer, and insecticide can shift production function downward by estimated coefficient levels of 0.46, and 0.13 table 5. This finding partly agreed with Rukwe & Zubairu, [25] which found a negative sign for fertilizer and positive for herbicide, and disagreed with the finding of [26] who indicated that agro-chemicals positively affect output in the case of Cameron. Moreover, the result also revealed that the cultivated area of wheat production has a positive and significant influence on wheat output at a 10% significance level. This implies that expanding land area allocated for wheat production increases wheat output by 0.05 level of estimated coefficient. This finding is in line with the finding of [27–29]. The result also indicates that seed has a negative effect on yield, unlike herbicide which positively affects the wheat output. However, the result did not prove the significant effect they have on it, which shows that the amount of seed rate and herbicide did not affect wheat output in the study area. As the magnitude of the coefficient of inputs has relative contributions on wheat output, out of the factor of production used in the model, blended fertilizer has the highest coefficient value, depicting that, it is the main determinant of wheat production from the rest of the inputs. That is, the wheat output is relatively sensitive with blended fertilizer than the rest of the inputs. Again, the finding also tells us that, the estimated values of Sigma-u and Sigma-v are 0.92 and 0.09 respectively, indicating that the variation between the observed (actual) and frontier (potential) output are due to inefficiency not chance alone.

Table 5. *Maximum likelihood estimates of Cobb-Douglas SPF model.*

Variable	coefficient	Std. Err
Constant	10.71	omitted
Ln (area)	.05*	0.03
Ln (Blended fertilizer)	-.46***	.09
Ln (seed)	-.06	.09
Ln (herbicide)	.01	.04
Ln (insecticide)	-.13 **	.06
Sigma-u	.92 **	.38
Sigma-v	.09 ***	.01
Lambda	9.83***	.38
Log-likelihood function		31.3

Source: own occupation, 2020
***, **, and * indicate significant levels at α=1%. α=5% and α=10% respectively.

3.3.2. Estimates of Technical Efficiency

The survey result indicates that the estimated level of technical efficiency of sample farmers was found to be 96 percent on average implies that farmers in the study area produced 4 percent less than maximum output (frontier). 4 percent of wheat output is lost as a result of inefficiency among the farmers. According to this result, there is room to maximize wheat output by improving the technical efficiency of wheat producers without changing the level of existing inputs. This means the farmers can increase the output by 4 percent without additional resources but through proper use of existing inputs and technology. In the study area, the most efficient farmer was able to produce 98 percent, which was only 2 percent less than potential output while the least efficient farmer produced 79 percent, which is 21 percent below frontier. About 27.8 percent of wheat growing farmers were producing wheat yield blow the mean technical efficiency level of farmers whereas the rest percent (i.e. 72.2) of wheat growing farmers were able to produce wheat yield above the mean efficiency level of sample farmers. As shown in figure 1, the technical efficiency of the majority of wheat producers ranged above an average of producers' efficiency.

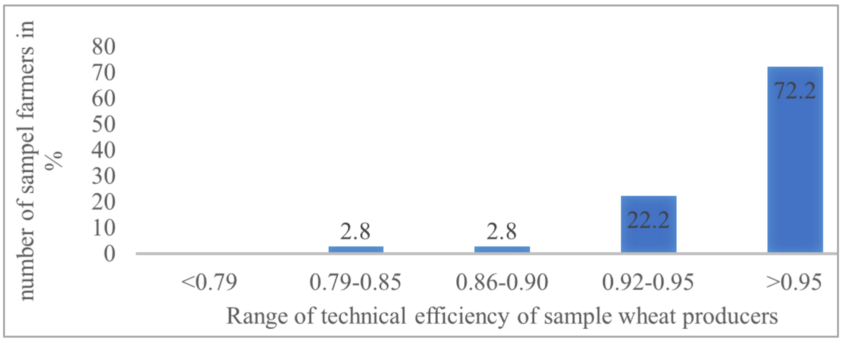

Figure 1. *Distribution of sample farmers by technical.*

3.3.3. Determinants of Technical Efficiency of Wheat Producers

In the attempt made to identify the source of inefficiency in wheat production, the result found out the variables that significantly lead to inefficiency in the study area. Table 6, shows that education level has a negative and significant influence on the technical inefficiency of wheat producers. The variable indicated considerable effect at a 5 percent level of significance, implying that literate farmers are technically less inefficient than uneducated farmers. The finding obtained by [30–32] concurred with our founding but contradict [33, 34]. In the study area promoting education is found to be important to decrease the technical inefficiency of wheat producers. Therefore, the concerned body should enhance the education status of farmers by any means that help them improve their efficiency. For instance by providing agricultural-related education and training so that technical inefficiency among farmers will be reduced.

Another important factor that affects the technical efficiency of wheat producers is the farming experience of the sample farmers. This variable positively and significantly influence wheat producers' technical efficiency at a 1 percent significance level illustrates that farmers with more experience are more technically efficient than farmers with less experience. This could be happening because more experienced farmers could have the capacity to assess the complexity of the good farming decision. They are more technically efficient in resource allocation as well. The Previous studies carried out by [25, 31], [35–39] are in line with our findings.

Soil fertility status was found to have a positive contribution to the technical efficiency of wheat producers. The result illustrates that the status of soil fertility has a positive and significant effect on the technical efficiency of wheat producers at a 1 percent level of significance, suggesting that farmers who maintained their soil fertility are more efficient than those who maintained less [40] has reported the same result we found while [41] reported the result to contradict our finding**.** Moreover, the cost of seed is found to improve the inefficiency of farmers. As of this study, seed cost is negatively significant with technical efficiency at a 10% level. Implies that the increase of prices of seed decrease the efficiency of farmers as some farmers cannot afford it [42] this finding has consistency with the present study.

Table 6. *Estimates of technical inefficiency variables.*

Inefficiency variables	**coefficient**	**Std. Err**
Constant	1.157052***	.3356882
Education	-.0946781**	.0424041
Ln family size	.0015222	.0117593
Ln experience	-.0961151 ***	.0213785
Ln farm size	.0015222	.0117593
Credit access	.0141867	.0141319
Extension service	.0064224	.0193796
Distance from market	.0026432	.0060683
Soil fertility	-.0508293***	.017511
Ln fertilizer cost	-.0296873	.0724497
Ln seed cost	.0299885*	.0164102

Source: Own estimation, 2020.

3.3.4. Potential Output and Yield Gap Due to Technical Inefficiency

As the presence of technical inefficiency among the wheat producers was justified, the estimation of the yield gap due to technical ineffіcacy was found to be an important matter. The Yield gap resulted from the technical inefficiency of farmers is computed using the difference between potential output and actual yield. Potential output is estimated employing actual output and estimated score of technical efficiency of sample farmers' since yield gap is a result of technical inefficiency. The mean result was shown in table 7. The result indicates that technically fully efficient typical farmers can produce 8615.6 kg/ha. But, the observed yield was 8271.1 kg/ha. In the study area, the mean value of the yield gap was found to be 344.5 kg/ha implies that there is a required effort to close this gap. Therefore, to reach the production possibility frontier of the wheat production from this low level, enhancing efficient utilization and allocation of resources is a crucial issue in China as well as in the study area.

Table 7. *Potential output and yield gap as a result of technical inefficiency.*

Variable	**number of respondents**	**mean**
Actual output in kg	36	8271.1
Mean TE	36	0.96
Potential output in kg	36	8615.6
Yield gap in kg	36	344.5

Source: own occupation, 2020.

4. Conclusion and Recommendation

This study has analyzed the technical efficiency of wheat producers in Quzhou County of China.

The study aimed to estimate the technical efficiency of farmers and identify factors that contribute to technical inefficiency. In the meantime, the yield gap observed as a result of technical inefficiency was also estimated. To achieve this, a multi-stage sampling technique was used to select the sample households. The data were collected through the personal interviews method with the sample farmers using structured interview questionnaires in 2020. The collected data were analyzed using descriptive statistics and a stochastic frontier model. Estimation of technical efficiency of wheat producers in the study area was conducted adopting Cobb Douglas functional form in stochastic frontier model with single-stage estimation method. The survey result illustrates that inputs variables (land size, insecticide, and blended fertilizer) significantly influenced wheat production at 10, 5, and 1 percent significance levels, respectively. Land size shows positive relation while blended fertilizer and insecticides have a negative correlation with wheat production during the study time. The result also indicated the presence of technical inefficiency among the wheat producers with the ranges from 0.79 -0.98 technical efficiency at the mean value of 0.96. Socio-economic variables (Education level, farming experience, soil fertility, and cost of seed) were found to be the source of variation in the study area. These variables significantly and positively influence wheat production at 5, 1, 1, and 10 percent of significant level respectively. Yield gap due to inefficiency among wheat producers in the study area was investigated and 345 kg/ha of wheat output was found. This implies that there is a yield gap need to be improved by improving technical efficiency of farmers so that this yield gap would be narrowed with the existing level of inputs in use.

Wheat is among the main crop produced, next to rice and maize, in China. The increase of wheat production in the last several decades was amazing and considerable change has been made using improved agricultural inputs. However, the current production of wheat does not sufficiently meet its demand to the expected level. The yield was low though improved agricultural technologies have been used by the farmers. The productivity of wheat is still below frontier yield. The productivity of wheat is not just determined by technological innovation alone but also by efficiency with which available technologies are used. Farmers' levels of use of production inputs, and management depend on their socioeconomic institutional and environmental condition. In the study area due to their inefficiency wheat farmers have various efficiency level. The observed result indicates that there is a potential to increase wheat yield on average by 4 percent, without changing the existing input levels or farmers in the study area can decrease inputs consumption by 4 percent with no reduction in current wheat yield.

Farmers' technical inefficiency resulted under wheat production suggesting that there is an opportunity to increase wheat production by improving technical efficiency of wheat producers in the study area. This study identified factors that cause technical inefficiency that have policy implication. Following the finding, important policy recommendations were given below. The government should advise farmers' proper use of agricultural inputs (fertilizer, herbicides, and pesticides) and follow up the implementation accordingly. So that proper agricultural inputs will be used, thereby adverse factors following inappropriate use of these inputs could be minimized, The result witnessed that education and technical efficiency have a positive correlation in wheat production, therefore, consistent and sustainable agriculture-related education should be provided by local government so that farmers can use the available inputs more efficiently under the existing technology. Soil fertility status is also another factor that negatively affects the technical inefficiency of wheat producers. Farmers that could maintain their soil fertility found to be more efficient and encouraging farmers to practice soil fertility improving approach, cropping system and another associated method that recommended by research is requested and the local government should provide due attention towards it.

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