SAARC J. Agric., 23(1): 25-39 (2025) *DOI: https://doi.org/10.3329/sja.v23i1.76657*

SAARC Journal of Agriculture

Journal Homage: https://www.banglajol.info/index.php/SJA

Determinants of Technical Efficiency of Wheat Producers of Kailali District, Nepal

A. K. Upadhaya and K. P. Bhatta*

Faculty of Agriculture, Far Western University, Kailali, Nepal

Abstract

Wheat is one of the major staple crops of Nepal, so it is inevitable to increase its productivity for sustainable food supply. The national average wheat productivity is quite below compared to neighboring countries. Therefore, this study envisages measuring technical efficiency of wheat farmers to understand its determinants, using randomly selected household data from 101 wheat farmers of Dhangadhi Sub Metropolitan city. Results showed that average technical efficiency is 90% and hence there is a chance to increase wheat production by up to 10% through appropriate crop management practices. All the inputs variables viz. land, labor and capital, had positive and significant relation with the production model and hence were vital for increasing productivity and income of wheat growers. The technical inefficiency model showed that age, education, and experience of household heads had a significant role. The most striking finding of this research was the role of seed replacement, which was found to have significant positive relations that increased the technical efficiency of the wheat growing farmers. This shows that farmers who replaced seed frequently (after every 1-5 years) had a high probability of increasing the efficiency in wheat production. However, availability of quality seeds at an affordable price is of the utmost concern. Government research institutions need to focus on increasing outreach of quality seeds and extension institutes need to focus on creating awareness of the farmers about the importance of seed replacement.

Keywords: Agricultural inputs, Inefficiency model, Irrigation, Seed replacement rate, Stochastic frontier production function

* Corresponding author: kiran.p.bhatta@gmail.com

Received: 05.10.2024 *Accepted: 08.01.2025*

Introduction

To address increasing food insecurity, sustainability in agriculture production and enhanced productivity is essential (Jaleta et al., 2013). Nepal ranks 69 out of 125 countries in global hunger ranking (Von Grebmer et al., 2023). Wheat is one of the major cereal crops and globally known as the king of cereals (Mahara et al, 2023). Wheat crop shares 16% and 20% of the total calorie and total protein in the Nepalese diet (Khanal et al., 2012) and hence it is vital for nutritional security of the Nepalese population. The byproducts of wheat such as husk and bran are also important for humans as well as livestock (Kumar et al., 2011). In Nepal, it is ranked third position after rice and maize in terms of area and production (AITC, 2024). Wheat is grown on 28% of the cultivated land of Nepal (around 697,762 ha) with production of about 2,098,462 tonnes, having productivity of around 3.00 t/ha (MoALD, 2022). The productivity of wheat in Nepal (2.99 t/ha) is lower than that of India (3.54 t/ha) and China (5.86 t/ha), which are also few of the main wheat producing countries of the world (FAO, 2024).

Wheat is also the important winter cereal crop of Kailali district, but producers were facing different problems. There are many factors responsible for low wheat crop productivity in Nepal like lack of appropriate year-round irrigation facilities, lesser availability of fertilizers, pesticides, and insecticides, problem of stray cattle, unfavorable weather conditions, lower seed replacement rate, timely unavailability of human labor and lack of proper access to agricultural machines (Subedi et al., 2019; Adhikari et al., 2021; Mahara et al., 2023). Another reason for lower yield and productivity is the inability of farmers to fully utilize the available resources up to their potentiality (Najjuma et al., 2016).

Technical efficiency refers to the capacity of any farm enterprise to produce the maximum possible level of output from available inputs and production technology (Ullah et al., 2018). It can be understood as the blending of capacity and ability of economic units to produce the maximum level of output from a minimum number of inputs and available technology (Yekti et al., 2015). Efficiency improvement allows growers to increase their output without adding more inputs (Bravo-Uretra & Pinheiro, 1997). Wheat efficiency was affected by various farm-specific factors such as seed type, sowing date, seed rate, fertilizer dose, farm size, family size, credit accessible to farmers, technical support, land type, land use pattern, etc. Improvement in efficiency is an option to increase agricultural productivity in the short run (Khanal et al., 2012). Farrell (1957) proposed two parts of economic efficiency i.e. technical efficiency and allocative efficiency. Technical efficiency is the ability to produce the greatest possible output from the use of available sets of inputs and existing technology. Allocative efficiency uses least cost combination to refer to the ability of a firm to produce. Measuring efficiency is a common approach to understand the performance of farmers in mobilizing their resources in the given technology, and understanding factors influencing those efficiencies which are important for developing countries like Nepal.

Several research results show that seed is the most vital among all inputs. However, in countries like Nepal, the use of seeds collected by farmers themselves from their own field is the major source of seed for the next season. Although, seed replacement rate is increasing from last few years from 15% in 2017/18 to 22% in 2021/22 (MoALD, 2022) however still around 80% farmers use locally sourced seed, which may have lower potential. Other studies also show that seed is vital for crop productivity. According to Singh & Singh, (2016) Seed replacement rate has a strong positive correlation with the productivity and production of crops. Hussain et al., (2012) found that inefficiency in wheat crop production was due to the poor quality of seed and for production increment, replacement of poor-quality seed with higher quality seed, new varieties and improved varieties available in the market may be important. Seed quality deterioration may happen in field, threshing yard and during storage, which may result in the form of reduced genetic vigor, reduced germination and this physical admixture finally leads to low crop production (Singh and Sahoo, 2019). This shows that locally procured seed may not have the same potential as commercially available seeds in the market, as quality of seed is most important for enhancing agriculture production. Farm-Saved Seeds (FSS) is a prominent source of seed to raise crops year after year and ultimately FSS leads to low SRR (Srivastava, 2018). Varietal Replacement Rate (VRR) is one of the other important factors for improved productivity. The pace of progress in productivity is largely dependent on the progress of seed programmed, which can supply good quality seed of high yielding varieties having superior genetics (Sharma et al., 2020). Hence, it is imperative to focus on seed, especially SRR if the aim is to improve the wheat crop productivity. This research endeavors to find out the technical efficiency of wheat farmers and the factors affecting it, with especial emphasis on SRR. It also tries to explore the major problem, which is being faced by the wheat grower that is hindering the achievement of potential production of wheat in selected sites. Assumption in this study is that there is a significant relationship between SRR and the technical efficiency of wheat producing farmers. As previously no such kind of study has been reported in these selected sites, it is expected that this study will help not only the farmers but also the policy makers to decide appropriately on whether or not to promote seed replacement in the wheat growing farmers to achieve local, regional and national food security.

Methodology

Site selection and sampling

Kailali district was purposely selected from the Sudurpaschim province of Nepal for this study. For the survey ward number 11 was selected randomly and in this ward, there are 17 Toles (Settlements) out of which again 3 toles (Badayan Tole, Belatal Tole & Jokieya Tole) were randomly selected as shown in Figure 1.

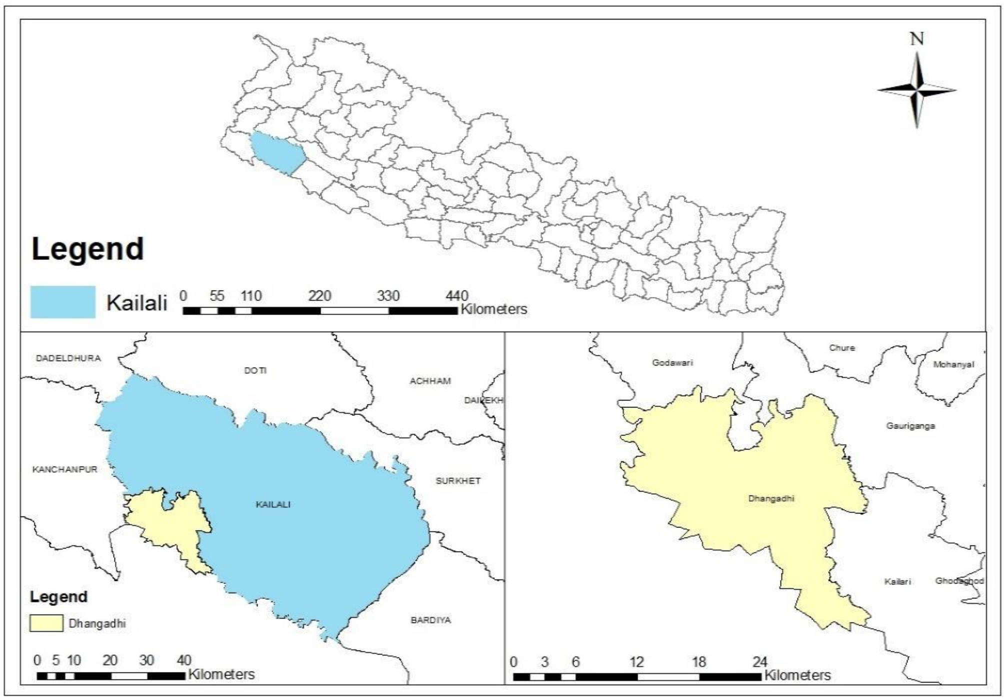

Fig. 1. Site map of survey area (ArcGIS)

The simple random sampling method was used for sampling the farming households to be interviewed for collecting data required for this study. The total population size of the survey area was 136. With this sampling frame and with the help of Raosoft software we get the sample size of 101 households (5% margin of error and 95% confidence level). The random sampling presented us with 40% households from Jokieya tole, 32% from Belatal tole and 28% from Badayan tole.

Data collection and analysis

For the primary data collection, sampled households were surveyed utilizing a pre-tested semi-structured questionnaire module about various aspects of wheat cultivation. This study adopted both a descriptive and inferential analysis approach to data analysis which facilitated a comprehensive portrayal of specific phenomena of the target population. It compasses the characteristics, attitudes, behaviors and opinion present within the surveyed sample households. Defining objectives, target population, unbiased survey questions as well as pretesting, collecting, analyzing & interpreting of data should be done in this research design.

The data were collected using Kobo Collect app/software. Then collected data were downloaded directly on MS Excel. Data management such as refining, cleaning, and editing was done to get the final set of data for analysis. For descriptive statistics average, frequencies, percentage, standard deviation etc. were used. For technical efficiency analysis, stochastic frontier production function model (analyzed with the help of Frontier 4.1 software) was employed to measure the level of technical inefficiency as well as its determinants.

Model used for production function analysis

Technical efficiency refers to measure, that how well an organization, process, or system utilizes its resources to produce a given level of output. It specially focuses on the relationship between inputs and outputs in a way that maximizes output while using the minimum number of inputs. In other words, technical efficiency is about achieving the highest possible output from a given set of inputs, without wasting any resources. Battese and Coelli (1988) gave SFPF model to estimate the technical efficiency of farms. It is a parametric approach that uses standard production function methodology and explicitly accounts statistical noise as given below:

$$\ln Y_i = \beta_0 + \beta_1 (Ln\_LAND) + \beta_2 (Ln\_HFLABOR) + \beta_3 (Ln\_CAPITAL) + v_i - u_i$$

Where,

Y_i is the output of the farm (and "i" represents the farms/farmers);

$\beta(.)$s are unknown parameters to be estimated;

v_i is a random error that may be due to model specification;

u_i is the technical inefficiency term;

Ln_LAND, Ln HFLABOR and Ln_CAPITAL are inputs which represent logs of land, labor and capital, respectively. Also, the inefficiency model is given by (which is assumed to be half-normally distributed):

$$u_i = \delta_0 + \delta_1(BADAYAN\_TOLE) + \delta_2(JOKAIYA\_TOLE) + \delta_3(HHH\_AGE) + \delta_4(<12\_EDU) + \delta_5(<5YEARS\_EXP) + \delta_6(LIVESTOCKHOLDING) + \delta_7(OFF\_ENGAGEMENT) + \delta_8(CREDIT) + \delta_9(NO\_SRR) + \delta_{10}(SEEDTREATED) + \delta_{11}(END\_KARTIK) + \delta_{12}(IRRI\_TIMEs) + e_i$$

Here, $\delta(.)$ are the parameters that are unknown and needs to be estimated. BADYAN_TOLE and JOKAIYA_TOLE represents respective location of the sampled farmers among the survey area, and HHH_AGE represent the age of the household head in years. We also use <12_EDU and <5YEARS_EXP, which represents education of household heads (Education below 12 level =1, 0 otherwise) and cultivation experience below 5 years (=1, 0 otherwise). LIVESTOCKHOLDING means farmers who had livestock (=1, 0 otherwise). OFF_ENGAGEMENT represents the engagement of farm in other occupations than agriculture (=1, 0 otherwise). CREDIT and NO_SRR represent farmer who have credit access (=1, 0 otherwise) and farmer who use their own seed or who are not used to replace their seeds (=1, 0 otherwise) respectively, SEEDTREATED, END_KARTIK and IRRI_TIMEs represent farmers treating their seed with pesticide (=1, 0 otherwise), sowing time at end of Kartik (=1, 0 otherwise; Kartik is the 7th month of Nepali BS calendar coinciding somewhere around October/November of AD calendar) and number of irrigations respectively. Finally, e_i is a random error term.

Results and Discussion

Some of the socio-demographic and economic statistics of the sampled households, mostly those variables used later in the production function were analysed (Table 1). In terms of gender, there were more male-headed households (71.28%) than females in the surveyed area. The average age of the household head is around 43 years (23-79 years), which indicates that farmers of this area are generally young. Most of the household heads have lower educational level (i.e. around 85% have educational level below 12 years of schooling). The average family size of this study area is around 6.59 (however, the average family size of this area ranges from 2 member households to up to 20 members). Ethnicity analysis showed that most of the farmers are Janajati (43.56%) followed by Chhetri, Brahmin and Dalit.

Table 1. Descriptive statistics of wheat farmers in Kailali District of Nepal

Variables	Avg.	Min.	Max.	S.D.
Gender Dummy (Male=1 and Female=0)	0.71	0	1	-
Age of household Head (Years)	43.26	23	79	12.9
Education level (<12 years=1 and >12=0)	0.85	0	1	0.36
Family size	6.59	2	20	2.87
Ethnicity				
Ethnic Category	Brahmin	Chhetri	Janajati	Dalits
Distribution (%)	21.78	26.73	43.56	7.92

Further, from the study, it is found that the average land holding of the farmers of this area was 0.48 ha although wheat is cultivated only in around 0.32 ha, ranging from 0.03 to 2.17 ha (Table 2). Average quantity of seed used in this area is about 150 kg/ha, however its use ranges from 60 to 300 kg/ha. Tillage is performed 1 to 4 times depending upon the land and soil type with average around 2.48. Chemical fertilizers usage ranges from as low as 74 to as high as 1140 kg/ha, especially the households with lower acreage to wheat are found to be using excessive chemical fertilizers. The average usage is around 290 kg/ha. Farmers used to irrigate their field from 1 to 4 times (around 1.27 times on average) and although ground water availability is abundant but its pumping is a problem. Wheat is sown around Kartik and the next month in most cases and the farmers sowing it around the Kartik end was 26%. Farmers also have their own livestock and around 86% have one or more types and number of livestock animals at their farms. It was also found that around 67% of the sampled farmers had taken loan from local institutions (i.e. Groups, associations, Cooperatives, etc.) or even from the bank and financial institutions. Wheat income ranges from around Rs. 56,400 to up to 398,500 per ha (with an average around 129,739). It seems that some farmers, especially landlords, are using the resources irrationally and are underperforming in terms of wheat yield.

Table 2. Information about wheat cultivation

Variables	Avg.	Min.	Max.	S.D.
Total land holding (ha)	0.48	0.07	3.33	0.51
Total wheat area (ha)	0.32	0.03	2.17	0.32
Seed quantity (kg/ha)	150.65	60	300	44.76
Number of tillage operations	2.48	1	4	0.62
Total inorganic fertilizer (kg/ha) Please recheck Fert.	289.83	74	1140	213.81
Number of irrigations	1.27	1	4	0.56
Wheat sowing time (before Kartik-end=1, after=0)	0.26	0	1	0.439
Livestock Holding (Have livestock: Yes=1; No=0)	0.86	0	1	0.35
Agri. Credit Dummy (Have taken loan: Yes=1; No=0)	0.67	0	1	0.47
Total wheat income (Rs. /ha)	129,739	56,400	398,500	48,250

The major problems being faced by wheat growers were also analyzed (Table 3). The results showed that the major problems of the wheat farmers in the study area include availability of limited irrigation facilities/infrastructures (with index value of 0.92) followed by insect pest and rodent damage (0.68) and unavailability of inputs (0.67). In the peak seasons farmers also face labor shortage and occasionally during the wheat cultivation period they also face unfavorable weather conditions.

Table 3. Problems faced by wheat producers

Problems	Frequency					Index Score	Rank
	1	2	3	4	5		
Limited irrigation facilities	74	18	07	02	00	0.92	I
Insect pest and rodent damage	18	28	36	15	04	0.68	II
Unavailability of inputs	08	42	33	13	05	0.67	III
Labor shortage	01	11	15	31	43	0.39	IV
Unfavorable weather condition	00	02	10	40	49	0.33	V

Stochastic Frontier Production Function (SFPF) Analysis

The stochastic frontier production model showed that the highest output elasticity is for land (0.46), which is highly significant too (at 1%) and it is contributing positively to increasing wheat production (Table 4). The result implies that with a 1% increase in land inputs, wheat production increased by about 0.46%. It just shows that land is one of the crucial inputs for agriculture. Ali and Khan (2014) research also showed that explanatory variables land under wheat crop, labor, chemical fertilizer, etc. to be statistically significant contributing positively to wheat production. Some other researchers have also reported similar results (Girma et al., 2024; Ahmad et al., 2018). Similarly, both labor and capital are also positive and have significant impact on wheat production, at 10% and 1% significance levels, respectively. The coefficient of labor (0.17) is too low and it may be owing to the fact that it seems to be over-specified or under-utilized, which is a common phenomenon in developing countries like Nepal. Sapkota and Joshi (2021) and Ali and Khan (2014) also found labor to have smaller coefficient compared to other inputs. Wilson et al., (2001) also found labor to have positive but insignificant impact. Capital, meaning the use of external inputs, have relatively higher coefficient (0.43), which corrugates to Bhatta et al. (2006) who also found capital to have the highest as well as statistically significant impact on crop production. Results of Faruq-Uz-Zaman (2021) also showed that fertilizer, which is one of the major capital inputs, have the highest as well as significant impact on crop productivity. External inputs are precious for smallholder farmers and hence using it may have resulted in higher returns. Overall, the sum of all input's elasticity is close to 1.06 indicating somewhat constant returns to scale. Thus, if all the inputs are doubled, output will be slightly more than the double (6% more).

The estimation of the inefficiency model showed age of the household head, treatment of seed with chemicals, especially fungicides, sowing of wheat around Kartik-end, and number of irrigations have positive impact on wheat production efficiency. The negative sign of these variables shows that they reduce the technical inefficiency thereby increasing efficiency in wheat production. However, among these, age is significant at 5% and number of irrigations at 1%. This implies that there is a negative relationship between age and technical inefficiency in wheat crop production. As the age of the household head increases, their learnings from their experience also increases and hence the inefficiency may decline (Dessale, 2019; Ali & Khan, 2014; Gelaw and Emana, 2008). Similarly, as the number of irrigations increase, wheat crop production efficiency also increases, which may be due to the fact that irrigation assists plants to absorb nutrients available in the soil which ultimately increase production (Adhikari et al., 2021). This is also in line with the findings of Hussain et al. (2012), who found a higher number of irrigations to have a positive effect on wheat crop productivity. Since, irrigation is one of the important determinants for wheat crop production, availability of irrigation infrastructures or machineries has a positive impact on overall wheat crop production and hence need consideration by developmental agencies.

On the other hand, both the location specific variables, education below higher secondary level (less than 12 years of schooling), experience below 5 years, having livestock, having off-farm employment, having taken loan/credit and lack of seed replacement, all were found to be increasing inefficiency in wheat crop production. Badayan toll seems to have lower technical efficiency in wheat production compared to other two locations (significant at 10%). Similarly, education is one of the major determinants of technical efficiency and lower the education higher is the inefficiency in wheat production (at 1%). Educated farmers may have better and easier access to new technologies and have a better understanding of farming technology. Better educated farmers have eagerness to adopt modern inputs capacity, to learn new technology more optimally and efficiently (Dessale, 2019: Ahmad et al., 2018; Shahi et al., 2014; Bhatta et al., 2006). However, the government of Nepal had already made the policy of education up to 12 years of schooling as mandatory and it is free. Farming experience was also positive and statistically significant at 10% level of significance, which means that inefficiency increased, with decrease in the farmers' experience, which is in line with the findings of Ali and Khan (2014). Mirza et al., (2015) stated that experience provides tough life lessons to the farmers and makes them able to handle difficult situations so experience has a positive relation with technical efficiency.

Interestingly, the farmers who do not replace their seed frequently were also found to have lower technical efficiency in wheat production (1% significance level). The higher coefficient (0.37) also shows that seed replacement is crucial for better wheat production. Singh and Singh (2016) mentioned that seed replacement rate improves productivity of crops like rice, wheat and oilseed. Seed replacement rate is found to have positive and mostly significant impact on the yield of rice (Bhandari et al., 2021; Kakoty & Barman, 2015). If farmers do not use quality seed, then yield is destined to be reduced. So, the use of quality seeds and replacing it at regular intervals ensured better performance of crops. Hussain et al., (2012) found that inefficiency in wheat production was due to poor quality of seed so for production increment replacement of poor-quality seed with quality seed is very important.

Subedi et al., (2019) also found that lack of proper access to quality seeds, fertilizers, and timely available irrigation facilities, etc. were the major problems linked with the wheat production. So, if the farmers get assured of the availability of these facilities, improved seeds and fertilizers, it mostly leads to increased wheat crop production.

During the discussion, it was found that several farmers are using unauthorized seed and finding quality seed at an affordable price is difficult. So, it is imperative that the government should invest in research to keep on developing high yielding wheat varieties for different locations, as there are big differences in climatic and soil conditions even within a district. Appropriate government institutions mandated for wheat research should mainly focus on such things. Extension may also be required to enhance the awareness of wheat growers regarding the role that the seed replacement can play an important role in enhancing wheat production and productivity. Training and awareness programs targeted to the wheat growers are highly needed.

Finally, the value of variance parameter (gamma value) is found to be around 0.41 as well as highly significant (at 1%) and hence we can conclude that the technical inefficiency model is significant in explaining the levels and variations in wheat production of the selected farmers/farms.

Table 4. Stochastic frontier production function (SFPF) analysis

Variables	Coefficient	Standard-error	t-ratio
Stochastic Frontier Model			
Constant	1.00	0.36	***2.76
Ln_LAND	0.46	0.12	***3.80
Ln_HFLABOR	0.17	0.10	*1.77
Ln_CAPITAL	0.43	0.09	***4.78
Technical Inefficiency Model			
Constant	-0.39	0.40	-0.97
BADYAN_TOLE	0.36	0.20	*1.74
JOKAIYA_TOLE	0.10	0.18	0.53
HHH_AGE	-0.01	0.01	**-2.22
<12_EDU	0.73	0.24	***3.07
<5YEARS_EXP	0.27	0.16	*1.70
LIVESTOCK HOLDING Y=1/N=0	0.20	0.16	1.22
OFF_ENGAGEMENT	0.09	0.14	0.60
CREDIT Y=1/N=0	0.04	0.15	0.29

Variables	Coefficient	Standard-error	t-ratio
NO_SRR	0.37	0.13	***2.83
SEED TREATED N=0/Y=1	-0.11	0.16	-0.70
END_KARTIK	-0.28	0.17	-1.62
IRRI_TIMEs	-0.41	0.15	***-2.81
sigma-squared	0.09	0.01	***9.35
gamma	0.41	0.08	***5.00

Note: *significant at 10%, **significant at 5%, and ***significant at 1%

The technical efficiency level of the farmers was also categorized, (Table 5) and it shows that the average technical efficiency of the wheat farmers is around 90% (ranging between 58% and 98%). Several researchers also found the technical efficiency in wheat production to be around 90% (96% by Feyisa et al., 2022; 87% by Wilson et al., 2001; 86%-94% by Kaur et al., 2010; and 94% by Ahmad et al., 2018). However, some researchers have also found it to be quite lower than our findings in wheat or other similar crops like maize, etc. (82% by Girma et al., 2024; 47% by Hussain et al., 2012; and even 36% by Buriro et al., 2013).

The findings show that there is a scope for improving the performance of wheat crop by up to 10%, which means that about 10% increase in wheat yield could be attained by improving technical efficiency. Adhikari et al. (2021) also emphasized that improved efficiency would reduce production cost, whereas it will increase wheat production and incomes.

Table 5. Technical efficiency of the sampled farmers

Technical efficiency	Frequency	Percentage
More than 0.91	66	65.35
0.81 - 0.90	23	22.77
0.71 - 0.80	6	5.94
0.61 - 0.70	5	4.94
0.51 - 0.60	1	1.00
Less than 0.50	0	0.00
Average		0.90
Minimum		0.58
Maximum		0.98
S.D.		0.08

Conclusion

Average wheat productivity of Nepalese farmers is significantly less than the neighboring countries. The results of this study also showed that the technical efficiency of selected wheat growers is around 90% indicating that still there is the potential to increase the production of wheat crop by up to 10% with the use of appropriate management practices. From the production function analysis, it was found that irrigation is a crucial input for wheat crop and hence the government should focus on investment in the irrigation infrastructures development. It has also been found that the farmers who have replaced the seed frequently (at least every 1-5 years) have higher efficiency in wheat production. So, there is a need for research for the development of location-specific high yielding wheat varieties. And concerned government research institutions which are mandated for wheat crop research should mainly focus on the development of such kind of wheat varieties. Training of the farmers and extension for creating awareness on the role of seed replacement can also have a positive impact in enhancing wheat crop production and its productivity.

References

Adhikari, S. P., Ghimire, Y. N., Timsina, K. P., Subedi, S., & Kharel, M. (2021). Technical efficiency of wheat growing farmers of Nepal. *Journal of Agriculture and Natural Resources*, *4*(2), 246–254. https://doi.org/10.3126/janr.v4i2.33857

Ahmad, N., Sinha, D. K. & Singh K. M. (2018). Productivity and resource use efficiency in wheat: a stochastic production frontier approach. *Economic Affairs*, *63*(3): 01-06. https://doi.org/10.30954/0424-2513.3.2018.3

AITC. (2024). *Krishi tatha pashupanchhi diary 2080 (Agriculture and livestock diary 2023)*. Ministry of Agriculture and Livestock Development, Agriculture Information and Training Center, Lalitpur, Nepal. https://aitc.gov.np/

Ali, S., & Khan, M. (2014). Estimation of technical efficiency of wheat farming in Khyber Pakhtunkhwa, Pakistan: A stochastic frontier approach. *International Journal of Innovation and Applied Studies*, *8*(1), 177. https://ijias.issr-journals.org/abstract.php?article=IJIAS-14-221-13

Bam, R., Mahara, G., Khanal, K., Kattel, R., & Bhattarai, S. (2023). Analysis of resource use efficiency and profitability of wheat production in Kailali district of Nepal, *The Journal of Agriculture and Environment*, *24*, 11-21. https://www.nepjol.info/index.php/AEJ/article/view/57885

Battlese, G. E, & Coell, T. J (1988). Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data. *Journal of Econometrics*, *38*: 387-399. https://doi.org/10.1016/0304-4076(88)90053-X

Bhandari, D., Bhattarai, C., Dahal, Bhishma, D. R., Gautam, A., & Joshi, P. P. (2021). Determinants of Seed Replacement Rate (SRR) of rice in Kanchanpur district of Nepal. N*epalese Journal of Agricultural Sciences, 20*, 59-69. https://nepjas.com/uploads/article/pdf/2338467b4b89101749b671953d691e2a293b28ef.pdf

Bhatt, P., Bist, P., & Ojha, L. N. (2020). Farmers' preferences of improved wheat varieties in wheat subsector Kailali, Nepal. *International Journal of Applied Sciences and Biotechnology*, *8*(4), 432–436. https://doi.org/10.3126/ijasbt.v8i4.33671

Bhatta, K. P., Ishida, A., Taniguchi, K., & Sharma, R. (2006). Technical efficiency of rural Nepalese farmers as affected by farm family education and extension services. *Journal of Rural Economics*, *Special Issue,* 316-323. https://www.researchgate.net/%20publication/256032177

Bravo-Ureta B. E., & Pinheiro, A. E. (1997) Technical, economic and allocative efficiency in peasant farming: evidence from the Dominican Republic, Development Economics, *34*, 48–67. https://doi.org/10.1111/j.1746-1049.1997.tb01186.x

Buriro, R. A., Khooharo, A. A., Talpur, G. H., & Rajput, M. I. (2013). Technical efficiency of wheat farming in Sindh province of Pakistan. Pakistan Journal of Agriculture Engineering and Veterinary Science, 29, 77-87.

Dessale, M. (2019). Analysis of technical efficiency of small holder wheat-growing farmers of Jamma district, Ethiopia. *Agriculture & Food Security*, *8*, 1-8. https://doi.org/10.1186/s40066-018-0250-9

FAO. 2024. *FAOSTAT*. Food and Agriculture Organization of the United Nation, Rome, Italy. https://www.fao.org/statistics/en.

Farrell, M. J. (1957). The Measurement of Productive Efficiency, *Journal of the Royal Statistical Society*, *120*, 253-290. https://doi.org/10.2307/2343100

Faruq-Uz-Zaman, Muhammad. (2021), Contribution of Factors Affecting Crop Production in Bangladesh: An Empirical Analysis with Production Function Approach. In: Economics and Business Quarterly Reviews, Vol.4, No.2, 59-67. DOI: 10.31014/aior.1992.04.02.345

Feyisa, D. S., Jiao, X., & Mojo, D (2022). Technical Efficiency of Smallholder Wheat Farmers: The Case of Qu Zhou County of China. S*cience Publishing Group, 7*(1), 11-19. DOI: 10.11648/j.ijae.20220701.13

Gelaw, F., & Bezabih, E. (2008). Analysis of technical efficiency of wheat production: a study in machakel woreda, Ethiopia. *Ethiopian Journal of Agriculture Economics, 7*(2).: https://www.researchgate.net/publication/260173756

Girma, M., Mehare, A., & Ketema, M. (2024). Wheat crop producers' technical efficiency and its determinants in Oromia region of Ethiopia: evidence from West Shewa zone. *Cogent Social Sciences*, *10*(1), 2329791. https://doi.org/10.1080/23311886. 2024.2329791

https://moald.gov.np/wp-content/uploads/2023/08/Statistical-Information-on-Nepalese-Agriculture-2078-79-2021-22.pdf

Hussain, A., Saboor, A., Khan, M. A., Mohsin, A. Q., & Hassan, F. (2012). Technical efficiency of wheat production in rain-fed areas: a case study of Punjab, Pakistan. *Pakistan Journal of Agricultural Sciences*, *49*(3), 411-417. https://www.pakjas.com.pk

Jaleta, M., Yirga, C., Kassie, M., De Groote, H., & Shiferaw, B. (2013). Knowledge, adoption and use intensity of improved maize technologies in Ethiopia. https://doi.org/10.22004/ ag. econ.161483

Kakoty, M., & Barman, U. (2015). Sources of seeds and reasons of low seed replacement rate of paddy seed: a case study in Assam. *Journal of Academia and Industrial Research. 4*(1), 34-36. http://jairjp.com/JUNE%202015/08%20KAKOTY.pdf

Kaur, M., Mahal, A. K., Sekhon, M. K., & Kingra, H. S. (2010). Technical efficiency of wheat production in Punjab: A Regional Analysis. *Agricultural Economics Research review*, *23*(1), 173-179. https://ideas.repec.org/a/ags/aerrae/92165.html

Khanal, N. P., Maharjan, K. L., & Sapkota, A. (2012). Technical efficiency in wheat seed production: a case study from Terai region of Nepal. *Journal of international development and cooperation*, *19*(1), 41-50. https://core.ac.uk/download/pdf/222950642.pdf

Kumar, P., Yadava, R. K., Gollen, B., Kumar, S., Verma, R. K., & Yadav, S. (2011). Nutritional contents and medicinal properties of wheat: a review. *Life Sciences and Medicine Research*, *22*(1), 1-10. https://doi.org/10.1007/s42690-022-00848-w

Mirza, F. M., Najam, N., Mehdi, M., & Ahmad, B. (2015). Determinants of technical efficiency of wheat farms in Pakistan. *Pakistan Journal of Agriculture Science, 52*(2), 565-570. https://www.pakjas.com.pk

MoALD. (2023). *Statistical information on Nepalese agriculture 2078/79 (2021/22)*. Ministry of Agriculture and Livestock Development, Government of Nepal, Kathmandu, Nepal. https://moald.gov.np/wp-content/uploads/2023/08/Statistical-Information-on-Nepalese-Agriculture-2078-79-2021-22.pdf

Najjuma, E., Kavoi, M. M., & Mbeche, R. (2016). Assessment of technical efficiency of open field production in Kiambu country, Kenya (Stochastic frontier approach). *Journal of Agriculture Science and Technology, 17*(2), 21-39. https://www.ajol.info/index.php/jagst/article/view/219177

Sapkota, M., & Joshi, N. P. (2021). Factors Associated with the Technical Efficiency of Maize Seed Production in the Mid-Hills of Nepal: Empirical Analysis. *International Journal of Agronomy*, *2021*(1), 5542024. https://doi.org/10.1155/2021/5542024

Shahid, A and Munir, M. (2014). Technical efficiency of wheat production in district Peshawar, Khyber Pakhtunkhwa, Pakistan. *Sarhad Journal of Agriculture*, *30*(4): 433-441. DOI: 10.17582/journal.sja/2019/35.4.1336.1343

Sharma A. K., Mishra C. N., Singh B.P., Singh S.K. and Singh G. P. (2020). Perspective of enhancing wheat production and productivity in Uttar Pradesh by improving varietal replacement rate. *Journal of Cereal Research*, *12*(1), 19-22. http://doi.org/10.25174 /2582-2675/2020/100826

Singh, N. P. & Sahoo, S. (2019). Studies on the replacement and management of wheat seed by farmers of Udham Singh, Nagar district of Uttarakhand. *Journal of Pharmacognosy and Phytochemistry*, *8*(1), 1776-1778. https://www.phytojournal.com/archives/2019/vol8issue1/PartAD/8-1-151-388.pdf

Singh, R.P. & Singh, S. (2016). Optimizing seed replacement rates in Jharkhand: present scenario, challenges and opportunities. *Jharkhand Journal of Development and Management Studies, 14*(2), 6987-7007. https://www.xiss.ac.in/ JJDMS/archives/data/21#

Srivastava, A. K. (2018). Seed replacement for boosting food grains production in Dhanbad district of Jharkhand. *Journal of Pharmacognosy and Phytochemistry*, *7*(1S), 2433-2439. https://www.phytojournal.com/archives/2018/vol7issue1S/PartAJ/SP-7-1-751.pdf

Subedi, S., Ghimire, Y. N., Adhikari, S. P., Devkota, D., Shrestha, J., Poudel, H. K., & Sapkota, B. K. (2019). Adoption of certain improved varieties of wheat (*Triticum aestivum L.*) in seven different provinces of Nepal. *Archives of Agriculture and Environmental Science, 4*(4) 404-409. https://doi.org/10.26832/24566632.2019.040406

Ullah, A., Khan, D., & Zheng, S. (2018). The determinants of technical efficiency of peach growers: evidence from Khyber Pakhtunkhwa, Pakistan. *Custos e Agronegócio, 13*(4), 211-238. http://www.custoseagronegocioonline.com.br/numero4v13/OK%2011%20peach%20english.pdf

Von Grebmer, K., Bernstein, J., Geza, W., Ndlovu, M., Wiemers, M., Reiner, L., Bachmeier, M., Hanano, A., Ní Chéilleachair, R., Sheehan, T., Foley, C., Gitter, S., Larocque, G. and Fritschel, H. (2023). 2023 Global Hunger Index: The Power of Youth in Shaping Food Systems. Bonn: Welthungerhilfe (WHH); Dublin: Concern Worldwide. https://www.globalhungerindex.org/pdf/en/2023.pdf

Wilson, P., Hadley, D., & Asby, C. (2001). The influence of management characteristics on the technical efficiency of wheat farmers in eastern England. *Agricultural Economics*, *24*(3), 329-338. https://doi.org/10.1111/j.1574-0862.2001.tb00034.x

Yekti, A., Darwanto, D. H., Jamhari, J., & Hartono, S. (2015). Technical efficiency of melon farming in Kulon Progo: a stochastic frontier approach (SFA). *International Journal of Computer Applications*, *132*(6), 15-19. https://www.ijcaonline.org/research/volume132/number6/yekti-2015-ijca-907428.pdf