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The Nature and Extent of Technical Efficiency of Maize Production for Smallholder Farmers in Conflict-Prone Areas

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Abstract: The aim of this study was to evaluate the nature and extent of technical efficiency of maize production in Afghanistan. A multi-stage sampling framework was used to randomly select 250 farm households, and a Cobb-Douglas production function was applied to the data collected. The results revealed that land, labor, seed, fertilizer, and pesticides significantly influence maize productivity. Additionally, 25% of the variations in output among maize producers are due to uncontrollable factors, such as unpredictable weather, pest and disease attacks, water scarcity, and frequent changes in agricultural policies by the government. Interestingly, the range of technical efficiency was between 0.21 – 0.97, and the average technical efficiency (0.86) of all farmers implies that they can still increase their maize production by 14% with the same available inputs and given technology. This is an important finding, especially for an economy that has been severely devastated by war. Furthermore, the study establishes that various socioeconomic and institutional variables influence the technical efficiency of small maize farmers in these conflict-prone areas. Given the United Nations' call to achieve zero hunger and alleviate populations from poverty despite climate change and other conflicts through the Sustainable Development Goals (SDG), the study offers insightful recommendations.

Keywords: conflict prone areas, technical efficiency, maize production, Afghanistan

1. Introduction

Improvement in the technical efficiency of farmers can be a crucial factor in enhancing productivity within existing technology. This, in turn, can create employment opportunities in the agricultural sector, increase household income, and facilitate food security. However, this is not always the case in conflict-prone areas, where such assessments have never benefited from empirical analysis. Given the prevailing circumstances of food insecurity around the globe, policymakers and researchers are increasingly concerned about the nature and extent of productivity in developing countries with perpetual conflicts (Ben Hassen & El Bilali, 2022; Cohen & Pinstrup-Andersen, 1999). In addition, numerous empirical studies have shown that many developing and underdeveloped economies still face the chronic problem of extreme poverty (Dixon et al., 2001; Hite & Seitz, 2021; Hulme & Shepherd, 2003). Afghanistan is a case in point, where over 54% of the population lives below the poverty line due to limited resources caused by the ongoing war that has lasted for more than two decades (CIA, 2019). The agricultural sector has been severely affected, leading to dietary changes among the population to survive.

Maize is a strategic crop identified in Afghanistan that has the potential to triple benefits, including increasing income, ensuring food security, and providing employment opportunities for the citizens. Currently, maize is a multipurpose crop that is extensively consumed as a staple food by more than 50% of the world's population (Erenstein et al., 2022; Ngabitsinze, 2014; Obaidi et al., 2012). When traditional cereals such as wheat and rice are scarce, maize is used as an alternative source of food. In addition to its use as food, maize contributes significantly to poultry, biofuels, animal feed, and industrial use (Blümmel et al., 2013; Kelly, 2016; Sibhatu et al., 2015). Therefore, maize is the third

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Blümmel most important cereal crop in Afghanistan, accounting for 4.9% of cereal production and about 1.1% of value-added agriculture (FAOSTAT, 2016; Elham et al., 2020; Samim et al., 2021).

However, despite the potential of maize production to provide income for farm households, ensure food security, and create employment opportunities for rural populations, maize productivity has been declining in Afghanistan, as shown in Figure 1. For instance, in 2017, the production of maize was 0.174 million tons, indicating a 44% decline compared to 0.312 million tons in 2016 (FAOSTAT, 2017). Some studies have identified problems such as lack of capitalization, fluctuating prices, crop storage facility, inefficient agronomic methods, poor management practices, low rooting of hybrid seeds, frequent use of conventional seeds, high input costs, low adoption of advanced technology, and sudden temperature changes that affect efficiency and result in low productivity (Ahmadzai, 2017; Mangal et al., 2017; Rajiv Sharma, 2018; Rahman, 2003). Other scholars have also highlighted many issues, including mismanagement practices at farms, higher fragmentation of land, less availability of credit, high prices of inputs, lower adoption of technology, socio economic, farmers' educational level, lack of extension services, access to advanced agricultural technology and roads, and transport infrastructure from farms to central markets, as the major causes of inefficient agricultural production in Afghanistan (Olakunle et al., 2022; Jilani et al., 2013; Maletta & Favre, 2003; Tavva et al., 2017)

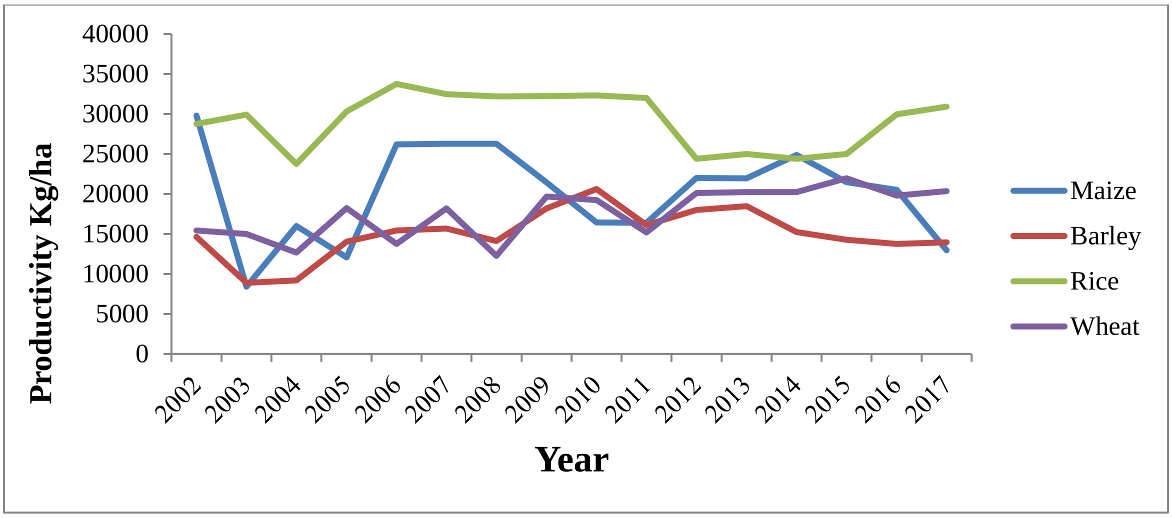

Fig. 1: Historical Trend of Grain Crops in Afghanistan (FAOSTAT, 2017)

To address the knowledge gap, this study evaluates the nature and extent of technical efficiency among smallholder maize farmers in war-torn, landlocked Afghanistan. The motivation behind the assessment of maize productivity is that maize contributes significantly to food supply, nutrition, poverty reduction, food security, and income augmentation of rural populations in Afghanistan, as concluded by van den Briel et al. (2007). Given its importance to the welfare of the people, maize productivity in Afghanistan has serious policy implications (Samim & Zhiquan, 2020). The study uses cross-sectional data from 250 smallholder farmers and finds that there is still room to improve maize production with the currently available agricultural inputs being used.

This study contributes to the literature by identifying the factors affecting the technical efficiency of an important staple crop in a country where food security was compromised due to past wars. This will help to recuperate the dynamism in maize production. The information given in the study will assist maize-related research and support extension institutions in developing appropriate training programs for different groups of farmers based on their socioeconomic status. To the best of our knowledge, such a study emphasizing technical efficiency with a robust empirical strategy has never been done in Afghanistan in previous studies (Ahmadzai, 2017; Tavva et al., 2017). Therefore, the findings of the study have valuable implications for policymakers by integrating institutional recommendations for increasing high-yield maize technology adoption, improving productivity, and per unit area maize production.

The rest of the paper is organized as follows: Section 2 presents the materials and methods used in this study; Section 3 provides the results with associated discussion, and finally, Section 4 gives the take-home message of the study and the related policy implications.

2. Materials and Methods

2.1 Description of Study Area

The study was conducted in Helmand province, which is the second-largest producer of maize in the southwest region of Afghanistan, with an annual production of 4,361 tons in 2010 (Ahmad & George, 2016). The province is one of the largest in Afghanistan, covering an area of 58,584 square kilometres, and has a rich history of agricultural production due to an extensive irrigation system installed by the United States 40 years ago. This irrigation system supports the production of various crops such as barley, mung beans, maize, and wheat. It is noteworthy that out of an estimated 850,000 residents in the province, 94% live in remote areas and have a low literacy rate (Ahmad & George, 2016). This low literacy rate significantly contributes to the limited adoption of advanced agricultural technologies in the province. For further details about the study site, refer to Elham et al. (2020).

2.2 Data

The data for this study was obtained from a farm household survey conducted during the 2019 summer production season with 250 smallholder maize farmers. A pretested questionnaire was utilized as the primary tool for data collection, which covered various aspects including socioeconomic and demographic characteristics of the farmers, farm attributes, input usage, output obtained, connections with extension institutions, and marketing aspects of the product. To ensure the quality of data collected, trained research assistants were hired from the Ministry of Agriculture. The selection of participating farmers was done randomly using a farmers' list. The farmers were invited to participate in the study voluntarily, and all selected farmers agreed to take part in the study, in compliance with research ethics.

A multi-stage sampling technique was used to select the farmers. The farming areas in the province were first divided into five distinct regions based on their socio-economic conditions and infrastructural services. Subsequently, one farming camp from each of the five regions was randomly chosen, and 50 farmers from each camp were randomly selected using the farmers' list generated by the Ministry of Agriculture. This approach ensured that the sample was representative, as every farmer within the selected camps had an equal chance of being selected

2.3 Empirical Strategy

To estimate the technical efficiency, the stochastic production frontier model derived from Cobb-Douglas production function was applied. Specifically, one step approach was used to investigate the impact of independent variables on farmer's technical efficiency. The STATA version 15.1 was used to draw the appropriate results from collected data.

2.3.1. Model Specification for Technical Efficiency

Aigner et al. (1977) and Meeusen and van Den Broeck (1977) developed Stochastic Frontier Analysis (SFA) which was used in this study. For measuring technical efficiency Cobb–Douglas production function is appropriate for this study due to simple estimation and interpretation. Furthermore, problem of multi-collinearity can also be solved by elastic functional form. Assuming a suitable production equation, the functional form of SFA has been defined as given below:

$$Y_i = X_i + \beta_i + \varepsilon_i \qquad (i = 1,2,3, \dots \dots \dots \dots . . n) \tag{1}$$

Where,
Y_i = Maize output produced by i^{th} maize farmer
X_i = Representing the inputs used for maize production by i^{th} farmer
β_i = coefficient parameters to be estimated
ε_i= Unsystematic collected errors and $\varepsilon_i = v_i - \mu_i$
v_i is symmetric and capturing factors not controlled by farmers such as climate changes and natural disasters. It is also identically and independently distributed N (0, $\sigma^2 v$) (Gujarati, 2003). Technical inefficiency for farm can be symbolized by μ_i. Whereas, it also highlighted the gap between output (Y_i) and potential optimal output supposed by the stochastic frontier analysis (Aigner et al., 1977). μ_i identically and independently normally distributed as N(0, $\sigma^2\mu$) and half normally distributed with less than 0 (Kumbhakar & Lovell, 2003). Both v_i and μ_i are independent for inputs (X_i) variables.
From Equation 1, Battese and Coelli (1995) indicate that the factors influencing technical efficiency can be estimated as follows:

$$u_i = f(\mu_i, \alpha). \tag{2}$$

Finally, TE is given by Equation 3

$$\mathrm{TE_i} = \frac{y_i}{y_i^*} = \frac{\mathrm{f}(x_i,\beta)\exp(\mathrm{v}_i - u_i)}{\mathrm{f}(x_i,\beta)\exp(\mathrm{v}_i)} = \exp(-u_i) \quad (3)$$

Where y_i = $\mathrm{f}(x_i, \beta)\exp(v_i - u_i)$ is the observed production with inefficiency and y_i^*= $\mathrm{f}(x_i, \beta)\exp(v_i)$ is the frontier output quantity with no inefficiency.

The LR test is employed as a statistical test to compare the goodness of fit of translog production function and the Cobb Douglas production function. Based on the likelihood ratio, a null model is compared to an alternative model. Despite the translog function being a general form in most productivity analyses, the parameters of CD are appropriate and suitable in our case, as confirmed by the statistical insignificance (0.864) of the LR test. The CD function and its respective inefficiency function are specified as follows:

$$lnY_i = \beta_0 + \beta_i \sum_{i=1}^{4} lnX_i + v_i - \mu_i, \quad (4)$$

Where,
Ln = natural logarithm, Y_i = maize output in kgs, X_1 = land for maize production in hectares
X_2 = quantity of seed in kgs, X_3 = labor used for maize production (man-days), X_4 = amount of fertilizer used for maize crop in kgs, X_5 = agrochemicals (pesticides) quantity used for maize production in liters (L), B_0 = Intercept/constant term, β_i = parameters to be estimated.

2.3.2. Estimation of Factors Affecting the Technical Efficiency

The model specified for estimation of technical efficiency was established in which the random error term v_i is normally distributed with N (0, σ^2_v) while μ_i is half normally distributed with N (0, σ^2_u). Thus,

$$\mu_i = \alpha_0 + \sum \alpha_i Z_i + \delta_i, \quad (5)$$

Where, μ_i is representing the explicit technical inefficiency of maize production, α_0–α_{10} are the coefficient parameters to be estimated and δ_i denoting the error term with random normal distribution.
Z_i is a vector representing the several factors of inefficiency ($Z_1 - Z_{10}$. And these factors include the different variables of socioeconomic and demographic characteristics with the linkage of institutional factors.
Z_1 = Farmer's Age (years)
Z_2 = No of family members in the farm household
Z_3 = Formal education of the respondents/farmer (years)
Z_4 = Experience of farmer to produce maize crop (years)
Z_5 = farm size/total landholding for cultivation (Hectare)
Z_6 = Contact with extension service (frequency/number of times)
Z_7 = Credit availability from bank or other sources (dummy variable)
Z_8 = Membership of association/organization/farmers group (dummy variable)
Z_9 = Distance from farm to nearest local inputs market (Kilo-Meters)
Z_{10} = Mobile phone or internet usage for attaining information about maize production (dummy)

3. Results and Discussion

The structure of the results section is as follows: First, a presentation of summary statistics on the socio-economic and institutional access characteristics is given. Then, the factors affecting maize productivity and technical efficiency are presented using the results from the two-stage Cobb Douglas Production model.

3.1 Summary Statistics

3.1.1 Socioeconomic Characteristics of farmers in conflict prone areas

The study identified some socioeconomic and demographic characteristics of maize farmers in the conflict-prone area, and the findings are presented in Table 1. The results showed that 19% of maize producers are young, while 34% are adults between 41 to 50 years old. Interestingly, elderly farmers (14%) are still involved in maize production due to various reasons and circumstances.

The study also revealed that about 35% of the farmers have 9-11 family members, indicating that farmers have sufficient family labor supply to perform different activities in the maize production process. This finding is consistent with the study by Seidu (2008), who determined that larger family size is helpful in improving the technical efficiency of farms.

Education plays a vital role in the development of a nation and individual performance. However, adult literacy rates in Afghanistan, particularly in rural areas, are very low. The study found that more than 50% of the sampled respondents are illiterate, while only 10% of farmers have university education. Given that agricultural productivity is positively influenced by education and better understanding of best cultural practices, control of pests and diseases, appropriate management of farms, and adoption of advanced agricultural technologies, the low level of education may explain why adoption of useful agricultural technologies is lacking in conflict-prone areas (Ahmadzai, 2017).

Regarding farming experience, the results revealed that almost 55% of farmers have been cultivating maize for more than 15 years, while only 5.6% are new in maize production with less than 5 years of farming experience. Scholars consider farming experience to be an important factor in augmenting maize productivity and efficiency because farmers learn from their mistakes over the years and improve efficiency in production (Abdulai et al., 2017; Ahmadzai, 2017; Hamidullah Elham, 2020; Mwalupaso, Wang, et al., 2019).

Table 1: Summary Statistics of Maize Farmers

Characteristics/ Variable	Frequency	Percentage
Age of respondents (years)		
20−30	47	18.8
31−40	40	16.0
41−50	86	34.3
51−60	42	16.8
Above 60	35	14.0
Family Members/Size		
1−5	8	3.2
6−8	28	11.2
9−11	88	35.2
12−14	72	28.8
Above 14	54	21.6
Educational Level		
Illiterate	128	51.2
Primary	9	3.6
Secondary	45	18.0
Intermediate	44	17.6
University	24	9.6
Farming Experience (years)		
1−5	14	5.6
6−10	58	23.2
11−15	40	16.0
Above 15	138	55.2

3.1.2 Farmers Access to Infrastructure/Institutional Services

Institutional and infrastructural services play a vital role in agriculture. Adequate provision of services and institutional linkages enable farmers to increase their confidence, efficiency, and reduce production costs. Agricultural production requires sufficient funds at each stage of crop cultivation. However, most small farmers face severe shortages of funds to enhance their farm production, leading to reduced efficiency. Farmers can get credit from various sources, such as formal (banks and NGOs) and informal (relatives or local agricultural inputs output dealers). Figure 2 reveals that more than 54% of farmers enjoy easy credit access from various sources. This enables them to buy inputs timely, extend their farm, and improve the agricultural system by purchasing advanced technological tools like tractors, land laser levelers, harvesters, etc. for better production. In contrast, 46% of farmers have no access to credit availability, which can hinder their productivity and efficiency.

Farmers' participation in an organization or association/group is a significant indicator that can strengthen farmers because they can get better institutional services like extension services and purchase inputs at a lower price. The results indicate that 71% of farmers have joined some farmer's association or group. However, 29% have not participated in any organization or farmer's group. It is necessary for small farmers to participate in farmer's organizations' activities as this can minimize production costs and increase efficiency and profitability through learning from progressive farmers in the group (Hamidullah Elham, 2020).

The usage of mobile phones or the internet for the sake of production information is becoming necessary in the recent era of technology. Through these advanced devices, farmers get updated with information from authorized sources conveniently and timely (Li, 2009; Mwalupaso, Wang, et al., 2019). By getting timely information regarding sowing, irrigation, and weather forecast, farmers can enhance their maize productivity as well as technical efficiency. Recent studies have found that farm households who smartly engage in exchanging text messages, setting up their calls to extension officers and friends in farmer's organizations, and some highly educated farmers who retrieve information from internet sources such as Facebook groups, WhatsApp groups, and other social media platforms, and can receive money through mobile cash services, tend to be more technically efficient with improved income and nutrition (Mwalupaso, Wang, et al., 2019; Sekabira & Qaim, 2017a). However, almost 50% of farmers in the study area are illiterate, limiting their use of mobile phones or the internet for maize production.

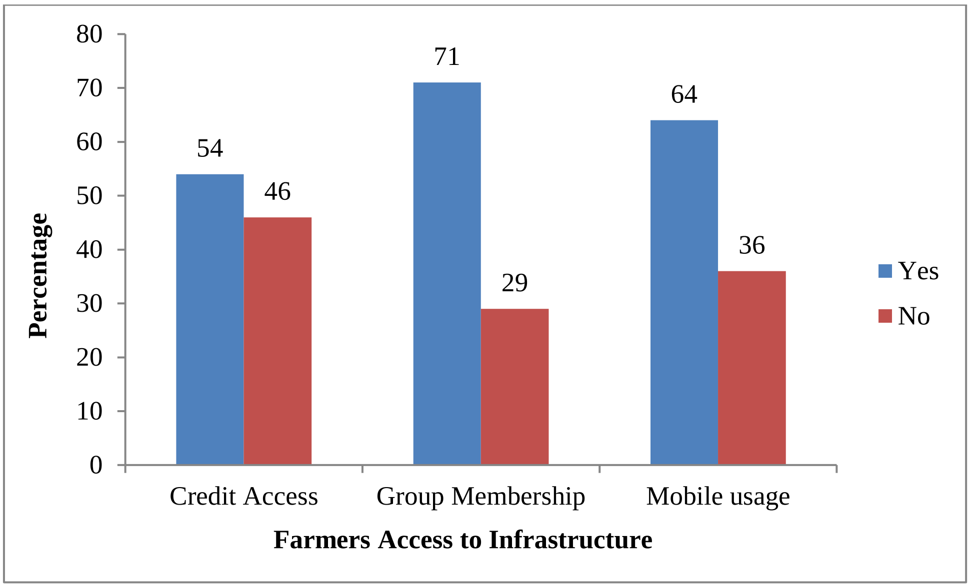

Fig. 2: Farmers' Access to Institutional Services

On the other hand, Figure 3 shows the distribution of farmers based on their frequency of contact with extension service officers/agents. The results indicate that more than 30% of farmers have no contact or access to extension services. About 41% of farmers have been visited or contacted by extension officers for 1-3 times during the 2019 summer cropping season. Only 17% of farmers have had contact with extension services for 4-6 times during the cropping season and received useful recommendations and suggestions on land preparation, improved seed, and pest and disease control for better maize yield.

Institutional linkage, such as contact with extension services, plays a crucial role in improving agricultural production and increasing the efficiency of maize farmers (Ahmadzai, 2017). This is because farmers' ability to efficiently utilize input resources by adopting improved and advanced production techniques is enhanced. Extension contacts facilitate and recommend that farmers do not use outdated and traditional production methods amidst a changing climate, as this may lead to declining productivity and efficiency (Mwalupaso, Korotoumou, et al., 2019).

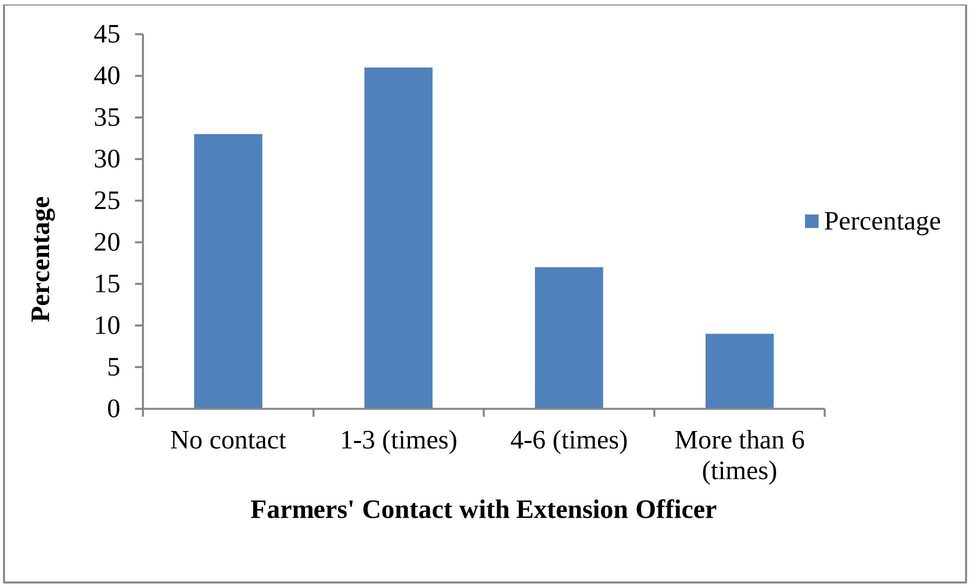

Fig. 3: Farmers' Contact with Extension Services

3.2 Empirical Results of Cobb-Douglas Production Function

In this section the empirical result presenting the agricultural inputs affecting the output is given and also the distribution of the technical efficiency scores.

3.2.1 Maximum Likelihood Estimates

The maximum likelihood estimates of the Cobb-Douglas stochastic production frontier model are presented in Table 2. The estimated results show that four out of five input variables used in the Cobb-Douglas production function were statistically significant and had a positive influence, while only one variable was found to be negative and insignificant. This indicates a strong relationship between the agricultural inputs and output.

To ensure the reliability of the findings, the calculated variance ratio (γ) was found to be significant with a value of 0.749, indicating that 74.9% of the variation in maize yield is due to deviations in technical efficiencies of maize-producing farms. A high value of γ indicates that the sampled maize farms in the study area have significant differences in technical efficiency. About 25.1% of the variation in maize yield among maize farmers is due to some uncontrollable factors such as unpredictable climate, sudden attacks of pests and diseases, and inaccuracies in data collection. The parameter γ represents the comparative magnitude of inefficiency variance and is linked with the frontier model by showing no inefficiency in the model. On the other hand, the significant value of sigma squared ($\delta 2$) is 2.95 (at the 5% significance level). As its value is not zero, the composite error term is a good fit and has a proper distributional form.

The elasticities of all inputs estimated by the Maximum Likelihood method were greater than one for maize production, while the partial elasticity for each input was observed to be less than one. Therefore, the elasticity of each input can be interpreted as follows: if an input is increased by one unit, the maize output will increase by less than one unit. Among all the inputs, land elasticity was found to be the highest (0.93). This supports the argument that land is the most necessary and basic input for maize production. The result shows that seed elasticity was the second-highest (0.41) in maize production, and fertilizer elasticity (0.35) was determined to be the third most important input. The elasticity of land is significant at the 1% significance level and has a positive impact on maize production. The 0.93 land elasticity explains that an increase in one unit of land (hectare) can increase maize production by 93%, verifying the authenticity of land as the most essential input. These results also confirm the empirical findings of some studies that estimate the economic analysis of different crops in different regions of the world (Dessale, 2019; Felicia, 2015; Ngango & Kim, 2019).

The other essential input found in stochastic production frontier estimation for maize production is fertilizer. Its positive elasticity value is statistically significant at the 1% significance level in maize production, indicating that maize output is highly influenced by fertilizer. Particularly, if fertilizer increases by one percent, a 35% increase in maize production will be observed. From this result, we can infer that small farmers are underutilizing this input. Many studies have measured technical efficiency by estimating the same results explained above (Aboki et al., 2013; Diallo, 2020; Elham, 2020; Lema et al., 2017). The elasticity for labor input was found to be negative and insignificant for maize production, implying that labor input is inefficiently used by the farmers. The result is proof that this input is overutilized by maize producers, and farmers must reduce the usage of extra labor because it is decreasing the output and creating losses for farm households. Tavva et al. (2017) found the negative effect of labor on wheat production in Afghanistan, supporting the finding in this study, especially as it is an abundant resource and over utile.

Table 2: Maximum Likelihood Estimates of Stochastic Production Frontier

Variables	Parameters	Coefficients	Standard Error
Intercept	B_0	4.83***	0.44
LnLand	B_1	0.93***	0.07
LnLabor	B_2	- 0.03	0.09
LnSeed	B_3	0.41***	0.10
LnFertilizer	B_4	0.35***	0.02
LnPesticide	B_5	0.28**	0.14
Diagnostics Tests			
Log Likelihood		120.67	
Γ		0.749	
$Ln\sigma^2$		2.95	0.27**
Heteroscedasticity	F-value = 0.827, P-value = 0.518		

Notes: ***, ** and * representing significance level of 1%, 5% and 10%.

3.2.2 Differences in Technical Efficiency among Farms in conflict prone areas

The predicted results presented in Table 3 depicted great differences in technical efficiency. It is a valid to ask questions as to why some of the producer obtain maximum yield with high technical efficiency while others produced with less efficiently. Variation in farm characteristics and management decisions influence the farmers' capacity to effectively utilize the available technology that led to differences in small maize farmers' technical efficiency.

Technical efficiency scores were estimated with help of log linear Cobb-Douglas stochastic production frontier. Results indicate that the range of technical efficiency is between 0.21 – 0.97. Therefore, those farms which are producing with low level of technical efficiency are considered as technically inefficient. The maximum estimated level of technical efficiency is 0.97 which is just 3% less from the frontier level. We can surely call these farms as the most efficient farm. The average technical efficiency of all sampled farms is 0.86. This value is higher than the scores of efficiency found in other studies that were conducted for different crops and areas. For example Tavva et al. (2017) found 0.67 as the average technical efficiency for wheat growers of Afghanistan while Ahmadzai (2017) found 0.69 for crop diversified farms in Afghanistan.

Table 3: Farms distribution according to Technical Efficiency Scores

T.E Score	Frequency	Percentage	Cumulative %
≤0.20	0	0.0	0.0
0.21-0.30	5	2.0	2.0
0.31-0.40	8	3.2	5.2
0.41-0.50	3	1.2	6.4
0.51-0.60	7	2.8	9.2
0.61-0.70	40	16.0	25.2
0.71-0.80	50	20.0	45.2
0.81-0.90	100	40.0	85.2
0.91-1.00	37	14.8	100.0
Average/mean	0.86		
Minimum	0.21		
Maximum	0.97		
Standard Deviation	0.11		

The average technical efficiency 0.86 implies that still 14% extra output can be produced with the given resources if farmers follow the best and efficient agricultural practices. Estimates of technical efficiency indicate that many farms are not utilizing their available resources efficiently. Still there are some opportunities existing through which they can enhance their technical efficiency level. By improving the technical efficiency, the farmers can achieve the optimal output with the given amount of inputs and can increase income and reduce poverty.

Figure 4 reveals that about 100 sampled farms (40%) in the study area producing maize with efficiency level between 0.81-0.90 which is the highest proportion of farms lies in this category of efficiency scores. The second highest concentration (20%) of all farms falls in the efficiency class 0.71-0.80 whereas, only 14.8% farms have achieved the more than 0.90 efficiency score.

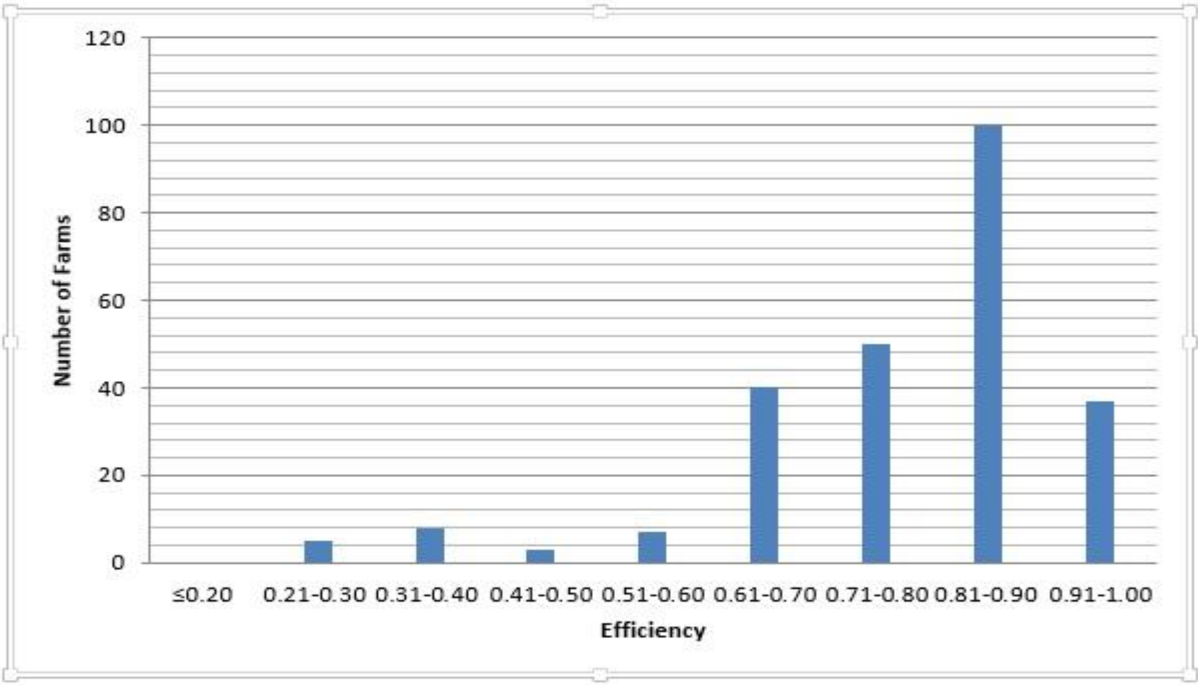

Fig. 4: Farms Distribution according to Level of Technical Efficiency

3.3 Factors Influencing the Technical Efficiency

Regarding the determinants of technical inefficiency, the signs of the coefficients are considered (Coelli, 1996). This implies that if the estimated coefficient in the model is positive, then it increases the farmer's inefficiency, and if the parameter coefficient is negative, then it decreases the technical inefficiency. Table 3 identifies the determinants of technical inefficiency of maize production in conflict-prone areas. Particularly, nine out of the ten variables used in the model were significant and included education, household size, farmers' experience, contact with extension services, farmers' group membership, market distance, access to credit, and usage of mobile/internet. Thus, indicating that these are the major influencing factors of technical efficiency of smallholder maize farmers. The positive but insignificant value of the age variable indicates that the physical strength and farming experience of young farmers are more than older farmers. Farmer's physical strength begins to decline as they become more skilled. Also, with age, the learning effect weakens (Abdulai & Huffman, 2000; Liu & Zhuang, 2000).

It has also been found that the technical efficiency of maize producers is positively impacted by family size at the 1% significance level. As the number of family members increases, especially during peak periods, the distribution of labor between agricultural activities becomes more equitable. Improvement in the distribution of labor at the farm leads them to focus on the assigned task carefully, thereby increasing productivity. The capital activities replaced by labor and more family labor applied to maize production, so family labor is an important factor for increasing farm productivity. As a result, this alleviates the work constraints that most smallholder farmers face. In Afghanistan, a major portion of the population lives in rural areas with large family settings, and this increases their labor force for farming activities. Given the prevailing war, large family labor is very important for food security. Results of the study are consistent with the hypothesis that large households have more family labor to deploy at the farm, especially in the time of labor shortage (Asefa, 2011; Aye & Mungatana, 2011; Debebe et al., 2015; Elibariki et al., 2008). A study conducted on small vegetable farmers in Ethiopia also found a significant and positive effect of household size on farmers' technical efficiency (Haji, 2007).

Another factor is the education level of household heads as it influences the technical efficiency of farmers and enhances their productivity. Results reveal that education negatively affects the technical inefficiency of maize producers at the 1% level of significance. More years spent in school can enhance the understanding and knowledge about agricultural activities and help them to adopt and operate advanced technologies which ultimately increase their productivity and efficiency. In support, Jaime and Salazar (2011) noted that the education status of farmers increases information sharing, learning capacity, access to information, develops an attitude for future planning, and facilitates managing the farm with proper allocation of resources. This result is also reinforced by these studies Solís et al. (2009) and (2004). While some researchers (Anang et al., 2016; Asante et al., 2014; Donkoh et al., 2013) also reported contrary findings as they are more engaged in off-farm employments which may deter their farming activities. Therefore, increasing the educational level of Helmand province farmers by training or some other way will improve their technical efficiency. Farm size is found to be significant and negatively affects the maize farmers' technical inefficiency. Farmers having small landholdings exhibit high efficiency due to low transaction cost and easy management (Adebanjo Otitoju & Arene, 2010; Amos, 2007; Elibariki et al., 2008).

One of the major factors contributing to institutional linkage is extension services that play a critical role in agricultural production. This variable was found to be negative and significant at a 1% significance level, impacting the technical inefficiency of Helmand's maize producers. More frequent contact with extension services provides farmers with useful instructions, improving input allocation, reducing costs, and augmenting production (Abdulai et al., 2017; Aboki et al., 2013; Debebe et al., 2015; Peprah, 2010; Sapkota et al., 2017; Sibiko, 2012). It has also been found that after adequate contact with extension services, farmers are capable of adopting advanced technologies for input mobilization, becoming skilled in using inputs appropriately, and controlling pests and diseases effectively (Al-Hassan, 2008).

Credit is an imperative component in agricultural production structures. It helps producers to fulfil their needs for the production process. With access to credit, farmers' efficiency can be increased by solving the shortage of funds/working capital. In the present study, it was assumed that if farmers have more access to formal and non-formal credit sources, they will be more efficient. The study's analysis estimated the negative and significant influence of credit access on farmers' technical efficiency at a 1% significance level. It is clear that farmers may purchase inputs for maize production timely and effectively when they have easy access to credit facilities. Empirical studies investigated by a good number of scholars revealed that sufficient provision of credit significantly and positively enhanced farmers' technical efficiency (Ahmed et al., 2014; Biam et al., 2016; Gebregziabher et al., 2012).

Market distance, another factor considered in the inefficiency model, was measured in kilometres between the farm and the nearest local inputs market. However, the distance from the markets is one of the barriers for obtaining inputs and extension services, which ultimately affects farmers' technical efficiency (Anang et al., 2016; Martey, 2019; Ng'ombe & Kalinda, 2015). Some researchers argue that farms that are not far from the inputs market are found to be more efficient than the distant farms because they are more updated about the market information and participate in formal and non-formal activities that motivate them to utilize more input resources timely, leading to an increase in their technical efficiency. This study also determined that more distant farms are less efficient and have a significant and positive association with technical inefficiency.

The participation of farmers in farmer groups/associations may also affect technical efficiency. It was clear from the results that there is a significant and positive relationship between farmers' technical efficiency and their participation in organizations/groups. Farmers who joined any farmers' group/organization increased their technical efficiency by 6.6% (Idiong, 2007). Onyenweaku & Nwaru (2005) also examined that member farmers of organizations or farmers' groups facilitated by many ways, such as; access to knowledge and updated information, learning skills and advanced techniques from their colleagues, and also enjoyed economies of scale for obtaining inputs from markets, which reduced their cost of production and increased productivity and technical efficiency.

It was analyzed that there is a significant and positive effect of mobile/internet usage on technical efficiency, as shown in Table 4. It was hypothesized in the study that farmers who have access to mobile phones/internet for agricultural information purposes will hold a higher efficiency level as compared to non-users. With the help of quick and real-time information exchange, farmers can get access to and avail themselves of advanced farming practices and also avoid making wrong decisions (Sekabira & Qaim, 2017b)

Table 4: Estimated Parameters of Inefficiency Model

Variable	Parameter	Coefficient	Standard Error
Socioeconomic and Demographic Factors related to Farmers			
Constant/Intercept	α_0	8.387 **	3.755
Age (years)	α_1	0.172	0.518
Family Size (No. of members in family)	α_2	−0.076***	0.026
Education (Years spent in school)	α_3	0.373***	0.113
Farm Size (Maize Field in summer 2019 season)	α_4	0.695*	0.406
Farming Experience (in years)	α_5	-0.392 ***	0.118
Institutional Factors related to Farmers			
Contact with Extension Services (Frequency of Contact)	α_6	-0.103***	0.035
Membership of Association (Dummy)	α_7	−0.440*	0.244
Access to Credit (Dummy)	α_8	−0.181***	0.030
Market Distance (Distance between Farm and Input Market in KM)	α_9	0.205**	0.091
Mobile/Internet Usage (Dummy)	α_{10}	−0.418 ***	0.118

Notes: ***, ** and * representing significance level of 1%, 5% and 10%.

4. Conclusion

Maize is a strategic crop and staple food in many parts of the world. However, its declining productivity in recent years poses a great threat to poverty reduction and hunger eradication, especially in conflict-prone countries. Therefore, this study empirically examines the technical efficiency of maize production using stochastic frontier analysis based on data collected from Afghanistan. The results indicate that all typical inputs significantly contribute to maize productivity except for labor, which is in excessive supply and overutilized by producers. Meanwhile, land, fertilizer, and seed have a greater impact on maize productivity in the study area. The average technical efficiency level (TE = 0.86) reveals that there is potential to increase maize output by optimizing input structure and adopting production technology to improve technical efficiency. In general, it is concluded that farmers' productivity for maize production and technical efficiency is low due to the underutilization and excessive use of resources at the farm level. Farmers' productivity and technical efficiency are also influenced by specific socioeconomic and institutional factors. Therefore, to avoid the technical inefficiencies of smallholder maize farmers, the study proposes some recommendations as follows:

Firstly, policies should be formulated to encourage efficient and affordable labor for agricultural production. According to the findings of the study, labor is found to be unresponsive in maize production because of overutilization by producers. Thus, there must be a strategy to transfer more labor to other labor-intensive sectors, which can be achieved by creating more opportunities for off-farm employment.

Secondly, the government should ease access to credit conditions and increase the limit of financial support for smallholder maize farmers. With the availability of funds, farmers can increase the acquisition of farm capital equipment and learn about new production technologies. These types of policies will enhance technical efficiency as well as productivity because most farmers are financially constrained, especially after the war. Access to credit is also essential for technological innovation, as yield-enhancing inputs are more costly than conventional inputs and can entirely shift the input-output relationship.

Thirdly, another key area is ensuring farmers are well-informed through the creation of reliable information access platforms. For instance, results indicate that access to agricultural information through the mobile phone and extension contact improves technical efficiency. Thus, prioritization of information access will empower maize farmers with information on how to best allocate their inputs, leading to greater production.

Lastly, since education is a significant determinant of technical efficiency, the government must make strides to ensure its farming communities attain basic education. As a matter of fact, many scholars have pointed out that education facilitates the adoption of improved production technologies, which is pivotal in realizing optimal output. For example, rural literacy programs would greatly improve education levels, thereby increasing the propensity to achieve higher productivity and efficiency levels.

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