Journal of Medicinal Plants and By-products (2024) 1: 209-218
https://doi.org/10.22034/jmpb.2023.358017.1459

Original Article

Smallholder Farmers Technical Efficiency and Production Constraints in Turmeric Production: in South-western Ethiopia

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Article History

Received: 02 March 2022
Accepted: 01 September 2023

Keywords
Cobb-Douglas
Stochastic
Technical efficiency
Production constraint
Turmeric

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ABSTRACT

The primary goal of the research was to quantify the technical efficiency and to identify its causes in the production of turmeric production in Sheko and Yeki districts. Three hundred sixty sample household heads were chosen using a two-stage random sampling procedure. Descriptive statistics and econometrics models like, Cobb-Douglas and Tobit's models were used to examine efficiency and determination respectively. As a result, the average technical efficiency was 73.72. The average technical efficiency suggests that it is possible to raise turmeric production by 26.28 percent without utilizing additional inputs. Land, labor, oxen, seeds, herbicide, and urea all had a big impact on how much turmeric was produced. The Tobit model revealed that gender, age, household size, the number of plots, and market information substantially impacted technical efficiency. Policies aimed at motivating and strengthening the existing agricultural extension system, and providing appropriate marketing information, are required to improve turmeric growers' production efficiency.

INTRODUCTION

Agriculture is the mainstay of the Ethiopian economy. More than 66% of the population is employed in agriculture directly or indirectly, which accounts for the sector's approximate 33% of the nation's GDP. The sector also produces 76 % of the nation's foreign exchange profits [1]. Although agriculture has a high contribution, it is characterized by low production because of technical and socioeconomic reasons. Due to ineffective management, limited use of contemporary agricultural technologies, outmoded farming methods, inadequate supplemental services like extension, credit, marketing, and infrastructure, as well as subpar and biased agricultural policies, most farmers with the same resources produce different outputs [2].

Ethiopia's agricultural policy is focused on increasing the production of marketable farm goods for both internal and international markets. In this sense, spices are high-value crops grown in a market with significant potential. This is a chance for the country to more effectively connect its numerous farmers to domestic and international markets [3].

In Ethiopia's southern nation nationality people's region, Oromia, and Amhara regions were the main spice producers. They supplied 37, 32, and 25 percent, respectively, of the average annual spice production [4]. In addition to coffee, the production of spices has provided a different chance to expand smallholders' involvement in commercial agriculture in southwest Ethiopia. Smallholders working on tiny parcels of land near homesteads, as well as certain state and private farms, grow the majority of these spices [3]. One of the spices turmeric (*Curcuma Longa*) is a common spice that is used as curry powder, ground spice, food coloring, a component in textile dyes, and a traditional treatment for several illnesses [5]. Turmeric is the most productive spice in the world, second only to ginger, with 65 quintals per hectare or 6500 kilograms per hectare, which product is 45 quintals per hectare, and this spice can be or 4500 kilograms per hectare considered a strategic spice for boosting the productivity and output of spices in the globe. Its relevance has grown in global markets, with the majority of demand coming from households as a coloring agent in food items. Aside from food, it has also been employed in the pharmaceutical and dyeing industries. In terms of the importance of turmeric production, smallholder farmers have produced the plant in various agroecological zones, primarily as a source of revenue as well as food [6]. However, as compared to other nations turmeric productivity in Ethiopia is very low. For instance, Ethiopia produced 24 q/ha of turmeric on average, compared to 40 quintals per hectare or 4000 kilograms per hectare in India [7].

Policymakers and researchers are motivated to find a method to increase productivity as a result of declining productivity. The measurement of technical efficiency and its determinants among various types of farmers and countries is a useful source of information for this investigation. Efficiency is relative in this research, though, and it frequently varies depending on the farmer groups involved in the product and the country under investigation. Socioeconomic issues, demographic factors, institutional factors, and management inefficiencies all have an impact on agricultural productivity [8]–[17]. Measures of efficiency are crucial because they provide both performance indicators and success indicators, according to [18]. It is impossible to test theories concerning the causes of efficiency differentials without first measuring efficiency and distinguishing its impacts from those of the production environment Efficiency measurement aids decision-makers in monitoring the performance of the agriculture sectors. When the causes of inefficiency are identified, a policy that seeks to improve farmers' performance may be implemented effectively. To boost the efficiency of the production of turmeric, it is necessary to measure production efficiency and pinpoint the causes of inefficiency. The information from this study helped the government and NGOs make decisions about changing existing regulations and coming up with new ones to improve the performance of the turmeric sub-sector. Therefore, the objectives of this study were to assess the scope and major causes of technical inefficiencies in the Sheko and Yaki areas' turmeric producers.

MATERIALS AND METHODS

Description of the Research Area

This research was carried out in the Southern Nation Nationality People Region (SNNPR), Bench-Sheko, and Sheka zones. Where the cultivation of spices, notably turmeric, is widespread. Both zones are well-known for their extensive forest resources and strong potential for coffee and spice production. In the research regions, the majority of smallholder farmers grow coffee, grains, spices, and animals. Coffee and lowland spices constitute the majority of monetary earnings, whereas maize, sorghum, and imitation banana are primarily grown for domestic use. Furthermore, the research location is one of the most appealing in the southern nation nationality people region for purchasing many large-scale commercial farms and committing a significant quantity of land to commercial agriculture [19].

The Sheka and Bench-Sheko zones cover around 30.9 percent of the region's total area, with a total size of 225,966.23, square meters. The two zones receive evenly enough distributed rainfall with only a brief dry period and moderate to hot temperatures. With an average rainfall of 400 to 2200 mm, the zones' mean temperatures range from 10.1 to 29.5 °C (SNNPRs website). The two zones' combined population is expected to be 1,017,260 people, with 501,630 men and 515,630 women; 15.8% of the population resides in cities, while 84.2% lives in rural areas (CSA, 2013).

Data Type and Source

Primary and secondary sources of data were used to examine the technical efficiency of turmeric in the Bench-Sheko and Sheka zones, both qualitatively and quantitatively. Personal interviews with farmers and a questionnaire with semi-structured were used to obtain primary data. These questionnaires were used to gather demographic, institutional, farm features, and socioeconomic aspects and turmeric yields and inputs used by each household head to cultivate turmeric. A focus group discussion and key informant interview with model farmers, agricultural office representatives, and a few chosen household heads (HH) with knowledge of turmeric cultivation were conducted.

Data Collecting Method

Following the necessary adjustments and updates to the questionnaire were administered throughout the research zone by enumerators. The data was collected from the sample respondent with the help of a semi-structured questionnaire. The sample farmers or participants were selected based on each kebele’s sample frame and codes were assigned to each participant. Participant information like name, marital status, and farming experience was also collected. There was also a written agreement to conduct this study with real data.

Sampling Technique and Sample Size Determination

To generate an adequate sample, a purposive sampling strategy was applied. To generate an appropriate sample, the Bench-Sheko and Sheka zones were chosen. Because of the massive amount of output, geographical distribution, and large number of turmeric growers. The Sheko and Yeki districts were chosen at random from the Bench-Sheko and Sheka zones based on the study goals. Sheko and Sheka zones. Turmeric is grown in 10 of 24 kebeles in the Sheko district and 20 of the 22 kebeles in the Yeki district. Because the focus of this study was on the efficiency of smallholder turmeric growers, the key goals in sample selection were turmeric producer kebeles. In the first step, two kebeles from the Sheko and four from the Yeki districts were picked at random from the total number of turmeric-producing kebeles.

Data Analysis Method

The data were examined using econometric models and descriptive statistics. To identify farming practices in the research regions and support the conclusions of the econometric model, descriptive statistics (mean, standard deviation, frequency, and percentage) were used.

Model Specification

We can test for the optimal specification while taking measurement error and random effects into account using the stochastic frontier technique. As a result, the stochastic frontiers approach was employed in this work because of the unpredictability of agricultural productivity. The stochastic technique accounts for both random error and the inefficiency component [20]. The functional form of the model for this investigation was established following [21].

$$y_i = f(X_i.\beta) + \varepsilon_i \quad 1$$

Where: - y_i = the ith sample farmer's outcome , Xi = vector and f()=functional form and ε_i=error terms.

The Cobb-Douglas and Translog functions have been the most commonly employed functional forms for an estimate in empirical production analysis research. There are benefits and drawbacks to each active kind. Some academics contend that the Cobb-Douglas functional form has an advantage over others. It permits a comparison of suitable data fit and computational efficiency. In terms of degrees of freedom, it is relatively conservative and good for interpreting production elasticity. It is frequently used to study border production processes [22]. However, the elasticity of substitution is equal to one, this simplicity has severe drawbacks [23]. The Cobb-Douglas model is specified as:

$$\mathrm{Y_i} = \beta_o * \prod_{i=1}^{n} \mathrm{X_i^{\beta_i}} * \mathrm{e}^{(\mathrm{V_i}} - \mathrm{U_i}) \quad 2$$

To "estimate the level of efficiency in turmeric production of smallholder farmers in the research region," a stochastic frontier with a Cobb-Douglas production function type was transformed into a double log-linear form using the methods of [13] and [16].

$$lny_i = In\beta_0 + \sum_{j=1}^{6} \beta_j \, lnx_{ij} + v_i - u_i \quad 3$$

Where: ln = natural logarithm; Y = the output; X_1 = the area in ha;X_2 = the number of man-days employed by hired and family labor; $X_3 =$ kg of seed used; X_4 = the kilograms of fertilizers (Urea) used; X_5 =herbicide in a litter X_6= the amount of oxen, j = is a vector of parameters that need to be estimated. V_i is an asymmetric error term that accounts for the departure from the frontier caused by variables beyond the farmer's control.

The Translog functional form, on the other hand, has no constraints on returns to scale or replacement options. The problem of degrees of freedom and multicollinearity, on the other hand, is a severe issue with the Translog production function [23].

After evaluating the Ho using the GLR test, the optimum functional form for the data was chosen, taking into account the benefits and drawbacks of both functional forms. The GLR statistic was created to test the hypothesis that all interaction terms, including the square root specification (in the translog functional form), are equal to zero (H O = ij = 0).

LR= -2[L (T*l*)-L (CD)] 4

Where: LR = Generalized log-likelihood ratio

L (Tl) = Translog's log-likelihood value

L (Cd) = Cobb-Douglas log-likelihood value

This number is then compared to the upper 5% point for 2 distributions, and a choice is taken based on the results. The ratio of observed production values to the estimated frontier values yields the technical efficiency (TE) for specific farms. If and only if TE_i=1, the value obtains its maximum possible value; otherwise, TE_i.=0. The TE for the i[th] farm may be calculated as follows:

$$\text{Technical Efficiency} = \frac{\log y_i = \beta_0 + \sum_{j=1}^{n} \beta_j \, logx_{ij} + v_i - u_i}{\log y_i = \beta_0 + \sum_{j=1}^{n} \beta_j \, logx_{ij} + v_i} \quad 5$$

RESULTS

Age distribution of sample households: Clearly, agricultural activities are more significant in rural areas than in urban ones. The results of Ethiopia's rural socioeconomic survey show that the country's rural population is primarily between the ages of 15 and 64 (CSA,2013). The sample households' average age throughout the survey was 46.33 years, with a standard deviation of 12.50 years. According to this, the bulk of farmers are still in their prime earning years and are therefore expected to have a favorable impact on turmeric production.

In the sample, the average household size was 5.57 people and 4.95 man-equivalents, with a standard deviation of 3.70. According to the data, the mean household size in the research region was 5.57, which was much bigger than the country's average agricultural household size of roughly 5.2 members per family [24].

The extension service provided advice on critical agronomic operations such as field preparation, chemical application, fertilizer preparation and application, post-harvest management, and soil and water conservation methods. The woreda gave each Kebeles a development agent. Extension agents are the primary suppliers of agricultural knowledge for farmers. Farmers who maintain frequent communication with extension agents are more aware of adopting new technology, which allows them to enhance agricultural production and productivity. The frequency of the extension agents' visits to farms varies; some are visited more regularly than others, while others are not. The frequency of extension contact observed during the production year for turmeric in 2020–21 varied from 0 to 3, with a mean of 1.25 times.

Smallholder farmers' sex: In terms of gender, about (57) 15.83 percent of smallholder farmers were female, while the rest (303) 84.17 percent were male (Table 1). Female smallholder farmers confront more hurdles in agricultural output than their male colleagues. Females may struggle to execute farming tasks quickly and effectively because they are responsible for many household chores. Additionally, compared to male smallholder farmers, female smallholder farmers are more likely to use fewer inputs and have less practical knowledge of farming practices. This outcome is also consistent with the Ethiopian socioeconomic survey from 2013, which said Approximately 68 percent of men and 48 percent of women worked in agriculture in rural areas [25]. In addition, Aschalew discovered that having a man rather than a female household head can boost farming production. Men spend the majority of their time involved in agricultural activities in the investigated locations, where it was also regarded to be males' work, because men dominate outside activities, with agriculture being the most important one [26,27].

Obtaining market information: Access to market information is one of the most significant barriers to smallholder farmers' successful involvement in market-focused agricultural output. Furthermore, the level of their integration is strongly reliant on market access. Market information is one of the primary policy target factors that must be considered in activities to improve smallholder farmers' marketing, resource use efficiency, and production. Consequently, the survey results show that 48 (13.33 percent) of farmers have access to accurate market information about turmeric output. However, the remaining 312 (86.67) did not obtain information (Table 1). The outcome was in line with Shanmugaraja's 2020 Constraints conclusion. The main marketing barrier mentioned by the vast majority of respondents was the substantial price fluctuation experienced by turmeric growers in the Namakkal District of Tamil Nadu (75%). Price changes for turmeric significantly before and after harvest. Due to the abundance of produce arriving on the market during the post-harvest period, farmers receive reduced pricing for their goods [28].

As shown in Table 2, one of the key issues impeding turmeric production in the research region was the high labor force needed for turmeric production. This outcome was also corroborated by the information gathered during the focus group discussion. Because turmeric is a bulky product, it needs additional effort for digging, collecting, watering, boiling, polishing, and drying. The second significant limitation was low pricing, followed by a lack of market knowledge, a lack of transportation, a scarcity of water, and a lack of storage facilities, resulting in low turmeric crop yield. This result was similar to Govindasamy *et al*., (2022) and Abdul and Jaclyn 2020 findings, which reported as among the various constraints, the problem of the high cost of labor stood second with a mean value of (52.67) followed by lack of proper storage facilities with a mean value 41.89 and 90.2% of respondents stated that the product's low pricing is one of the producers' other issues[3,29].

Econometric Results and Test of the Hypothesis

Before determining the model parameters from which individual-level efficiencies were derived, numerous model definition assumptions must be considered. As a result, two possibilities were investigated as indicated in table 3.

First, it was investigated whether there is a functional difference between the restricted Cobb-Douglas production function and the non-restrictive Translog production function.

Production Function Estimation

The calculated model's dependent variable was turmeric output (Qt) produced during the 2020/21 production year. The area under turmeric (ha), labor (man-days), two oxen-days, urea (kg), seed (kg), and herbicide (L/kg) were the input factors.

According to the findings of the frontier model study, all of the input variables in the production function, including land under turmeric, oxen power, labor, seed, herbicide, and urea, had a positive and substantial impact on the output level of turmeric. The production function's coefficients serve as a representation of elastic properties. Because of this, the output of oxen was highly elastic, which demonstrated how sensitive the production of turmeric was to oxen power (0.281). A 1% increase in oxen power over two oxen days resulted in a 0.281% increase in turmeric production, all other factors being held constant. Instead, this shows that oxen power was more sensitive to turmeric output by 0.243, 0.243, 0.171, 0.131, 0.032, and 0.015 percent than labor, land, seed, herbicide, and area.

To ascertain if technical inefficiency occurred or not, the study used the critical log-likelihood parameter in the half-normal model, which is equal to u/v. [21] claimed that if there were no impacts of technical inefficiency and all deviations from the frontier were caused by noise, the estimated value of Lambda = 1.319 would be significantly different from zero. The null hypothesis that there would be no influence from inefficiency was rejected, demonstrating that inefficiency affected farmers in the Sheko and Yeki areas. The level of significance is set at 5%.

Another important analysis was returned to scale. To determine total factor productivity, use this formula [30]. The coefficients were found to be 0.845, indicating a declining trend in the returns to scale. Moreover, it shows that when all other inputs are held constant, a 1% increase in the number of seeds used to produce turmeric results in a 0.845% increase in turmeric output. In other words, output increases more slowly than proportionate change in all inputs. This could be a result of the expensive costs involved in the labor-intensive manufacture of turmeric as well as the costs of boiling, polishing, and drying. To put it another way, a 1% increase in all inputs boosted total output by 0.845%. The results of [31] on the economic efficiency in Bangladesh's Northern Region, [32] on the technical efficiency of maize production in South Africa, and [33] on the maize production in Boricha Woreda in the Sidama zone, where returns to scale were 0.9588, falling in stage II of the production surface, are all in agreement with this finding.

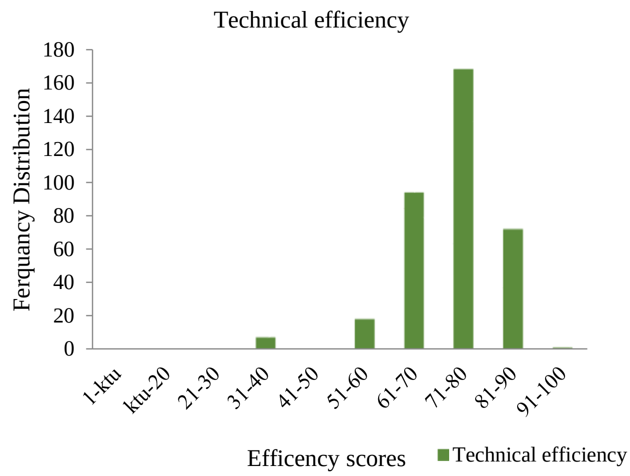

Fig. 1 Frequency distribution of technical efficiency

Efficiency Range and Levels of Sample Households

According to efficiency ratings, there were significant disparities in TE across turmeric producer families, and TE was found to have a mean of 73.72 percent. The average TE shows that if farmers use inputs efficiently, they could reduce inputs (land, Urea oxen, labor, herbicide, and seed) by 26.28 percent to produce the same yield as they do now. According to the model output (Table 5), sample homes in the study region were reasonably proficient in TE.

Most sample homes have a technical efficiency score between 71 and 80 percent, according to the frequency distribution of those values in Figure 1. However, several study households only had TE levels between 31 and 70, or 33.06 percent. Sample homes in this group have the potential to increase their output of turmeric by an average of at least 30%. 0.28 percent of the households in the entire sample have TEs that are higher than 90%. It suggests that approximately 99.27 percent of sample homes can boost their output by 10%.

Technical Efficiency Factors in Turmeric Production

Table 1 Descriptive analysis results of the dummy variables

Variables		No. of HH,	Percent,
Sex	Male	303	84.17
	Female	57	15.83
Market information	Yes	48	13.33
	No	312	86.67

Source: Own computation (2021)

Table 2 Major turmeric production constraints

Major constraint	Rank	Their share %
Labor consuming	I	53
Low price	II	20
Lack of market information	III	11
Lack of transportation	IV	9
Water scarcity	V	5
Lack of storage facilities	VI	2

Table 3 GLR hypothesis testing for SPF parameters

Null hypothesis	LH_O	LH_1	Calculated X^2 (LR) value	Critical value ($\chi 2$, 0.95)	Decision
H0: = β_{ij} = 0	-214.89	-230.54	31.3	40.11	Accept
H0: = $\boldsymbol{\delta_1} = \boldsymbol{\delta_2} \dots = \boldsymbol{\delta_{10}} = 0$	-230.54	-198.05	64.98	16.92	Reject Ho

Source: model output (2021)

DISCUSSION

The findings of the Tobit model are reported in (Table 6), and only the important explanatory factors expected to influence the technical efficacy of smallholder turmeric producers were investigated.

The hypothesis stated that the head of the household's sex would significantly and favorably affect TE at a rate of 5%. The results indicated that male HH had greater success than female HH. The most likely justification is that males handled most farm work, particularly land preparation, and had more regular follow-up and farm supervision, allowing them to carry out agricultural tasks more rapidly and effectively than female smallholder farmers. The likelihood that male farmers will be wealthy and able to use new, expensive agricultural technology may also have a favorable impact. This result contrasts with that of Muluken and Twodros, who showed that the sex of the household head had a statistically significant negative impact on technical inefficiency at a 10% level of significance. It provides a great opportunity for female-led farmers to regularly monitor and oversee their crops [34] and also [35] showed that when families were headed by a man, their level of efficiency was generally higher than when they were headed by a woman.

Table 4 Estimation of the Cobb-Douglas function

Ln Output	Coefficient	Standard error
Cons	1.447 ***	0.302
LN Seed	0.131 **	0.054
LN Land	0.143 ***	0.036
LN Oxen power	0.281 ***	0.055
LN Labor	0.243 ***	0.059
LN Urea	0.015 ***	0.005
LN Herbicide	0.032 ***	0.008
Sigma v	0.3706	0.0327
Sigma u	0.4222	0.0801
sigma2	0.32 ***	0.100
Lambda	1.14	0.110
Log-likelihood function	-230.89	-
Return to scale	0.845	-

Source: Model output; ***, ** denotes significance at 1 and 5 percent (2021)

Table 5 Efficiency level summary of the sample respondents

Efficiency scores	Technical efficiency	Mean	Std. Deviation	Minimum	Maximum
1-10	0	73.72	0.0937	31.89	91.22
10-20	0	-	-	-	-
21-30	0	-	-	-	-
31-40	7	-	-	-	-
41-50	0	-	-	-	-
51-60	18	-	-	-	-
61-70	94	-	-	-	-
71-80	168	-	-	-	-
81-90	72	-	-	-	-
91-100	1	-	-	-	-

Source: model output (2021)

Table 6 Estimates from the Tobit model

	Technical efficiency		
Variables	Coef.	Std. Err.	ME $[\partial(\varphi(Z_U) - \varphi(Z_L)$
SEX	-0.032 **	0.0134	0.0256
AGE	0.002 ***	0.0004	0.0012
Education	0.002	0.002	0.0012
NOFIC	0.010	0.030	0.0001
Household Size	0.003 ***	0.001	0.0016
No. plots	-0.011 ***	0.003	-0.0068
Extension	-0.003	0.011	- 0.0017
Livestock	0.005	0.010	0.0034
Ln credit	0.001	0.001	0.0005
MKT info	0.060 ***	0.014	0.0237

The symbols ***, **, and * represent the significance levels of 1%, 5%, and 10%, respectively.

Thus, the average technical efficiency for male- and female-headed people was 83% and 67%, respectively.

Age of HH: According to Table 6, the calculated age-technical efficiency correlation was positive and significant at the 1% level of significance. This conclusion implies that HH's technical efficiency grows with age and is correlated with its level of agricultural expertise. Additionally, the marginal influence of age on technical effectiveness (TE) shows that, for the sample period, a one-year increase in age results in a 0.12% increase in the likelihood of being technically efficient. This result is in agreement with those of Begum, (2019) and Baloyi's (2011) findings, who described that the coefficients of age were positively significant at 1 and 5 % significant levels, respectively. This is opposed to the result of Zinabu and Bosena's 2021 finding, who investigated age has a statistically significant and negative association with teff production technical efficiency at a 5% level of significance [9,32,33].

Family size: The number of family members living in the home has a favorable and significant impact on technical efficiency at the 1% level of significance. The results show that involvement in the labor force has a greater impact on turmeric output than on consumption. This result may be explained by the fact that having a bigger household size ensures that there will be enough family labor to complete farm tasks on schedule. Because turmeric is a large commodity, production during busy times requires a lot of labor. Due to the labor scarcity, homes with big family sizes would need more labor than their counterparts to complete necessary farming tasks like plowing, cutting finger rhizomes, gathering by digging, boiling, drying, and up to uploading activities on schedule. Tenaya, 2020 discovered that the technical efficiency coefficient of family size was positive and statistically significant at 5%, which is consistent with the findings. They reasoned that family labor is the key input in crop production, farmers with large family sizes are more productive than those with small families because they can manage their crop plots more effectively and apply the correct input combination [36]. This result also contradicted the findings of Zewdie *et al*.,2021, who discovered that TE was positive and significant at a 1% significance level. According to him, smallholder farmers in the research area grow crops on plots of land that are typically less than half a hectare in size, making it difficult to employ many workers in the crop production process. The number of workers (household members who are actively employed) increases with family size and decreases with the dependence ratio. As a result, a small farm plot size results in poor TE when the workforce for agricultural production is increased [37].

Land Fragmentation (LFRG): The coefficient for the plot number showed a significant negative impact on the technical efficacy of turmeric production, contrary to the predicted outcome. The marginal effect finding also indicated that increasing the number of plots by one results in a 0.68 drop in the chance of being technically efficient. It might be because fragmented land makes families less productive, wastes time, and diverts resources that ought to be available simultaneously. This outcome was consistent with Bati's 2017 conclusion, according to which land fragmentation had a detrimental and statistically significant effect on TE. Technical efficiency fell by 0.31% for every unit increase in the number of plots. Additionally, if the farmer operates more plots, it can become more challenging to manage them all. Farmers that have a lot of plots, in his opinion, can squander time traveling between them[38]. This outcome did not coincide with Tolesa's 2022 and Alemu, Angasu, and Sime's 2022 analysis results showing a positive association between farm size and production efficiency. He discovered that this variable was significant at a 1% level of significance. According to the coefficient of the size of the farm utilized for crop production, a 1% increase in the amount of land used for growing different crops results in a 0.97% rise in the farmer's productivity[8], [17].

Market information (MKT): This was the last but certainly not least explanatory factor that contributed to the technical efficacy of turmeric production. This finding reveals that the availability of market knowledge has a significant and advantageous effect on TE at the 5% level of significance. The marginal effect results also show that for every unit increase in the dummy variable indicating access to and lack of availability of market data, categorized from 1 to 0, the likelihood of farmers being technically efficient rises by 2.37. It was comparable to the findings of Mebratu and Belet 2019, which showed that having access to market knowledge had a good and significant impact on how efficient a company was [39,40].

CONCLUSION

The following important conclusions were drawn from smallholder farmers' technical proficiency in producing turmeric. This study shows that smallholder turmeric growers have a great deal of space for technical efficiency improvement. The Cobb-Douglas production function had a positive sign, which meant that land, labor, and oxen power were the main constraints. Positive coefficients for these variables imply that output was elevated to a higher level by using more of these inputs. The typical technical efficiency of the study households was 73. Technically proficient farmers might increase turmeric production by an average of 26.28 percent without increasing input costs.

The important elements influencing the degree of efficiencies were identified to assist various stakeholders in increasing the current efficiency level in turmeric manufacturing. As predicted, gender, age, household size, number of plots, and market knowledge all positively and substantially influenced technical efficiency. This means that older male farmers had a larger family size (man-equivalent), had access to more market knowledge were more technically efficient than their peers. The number of plots, on the other hand, hurt technical efficiency. As a result, farm households with more plots were technically less efficient than others.

The favorable impact of family size on farm producers' technical efficiency necessitates governmental attention to engage and mobilize the rural population, particularly the young, in agricultural activities through incentives.

Market information was discovered to impact smallholder turmeric growers' technical efficiency positively. As a result, policymakers must provide appropriate marketing information to smallholder turmeric growers to support market participation and integration.

Finally, there is significant room to improve the technical efficiency of turmeric production by introducing technology that reduces the labor force and the cost of wood and water. This study served as a benchmark for policymakers and researchers looking to improve the efficiency of turmeric producer farmers.

ACKNOWLEDGMENT

The author/s would like to say thanks to Mizan Tepi University and the Sampled farmer for their cooperation.

Authors' Contribution

Both authors equally contribute to accomplishing this study. Like, starting from idea creation, questionnaire development, data collection, Data coding, data entering, data analysis, Report writing, and article preparation.

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