DMU

Advanced Journal of Interdisciplinary Studies 9(2025) 1583-1594

AJIDS

Journal homepage: www.ajids.dmu.edu.et

Volume 9(1), June 2025

Technical Efficiency of Small Holder Maize Producers' and its Determinants: The Case of Ayehu Guagusa District, Awi Zone, Amhara Region, Ethiopia

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Abstract

Farmers can enhance their productivity by utilizing modern technologies, increasing efficiency, or a mix of both approaches. This study was carried out to analyze the technical efficiency of maize production and its determinants among smallholder farmers in Ayehu Guagusa District during the 2020/2021 production season. A Stochastic Frontier Production Function that includes inefficiency variables was used through a Maximum Likelihood method to assess technical efficiency and its factors, using data gathered from 120 smallholder maize farmers in the region. The results show that DAP, labor, oxen power, and the size of maize fields greatly affect maize production. The mean technical efficiency was determined to be 84 percent, indicating that there is potential for a further 16 percent improvement in technical efficiency. The gamma parameter (discrepancy ratio) was approximately 57 percent, indicating the percentage change in production from the frontier level due to inefficiency. This suggests that the other 43 percent is attributed to the effect of random noise. Moreover, the findings indicate that the educational attainment of farmers, the accessibility of enhanced maize seeds, and the availability of credit have a significant and adverse effect on the technical inefficiency of farmers. Hence, policy makers should focus on improving the education level of smallholder farmers, enabling better access to formal credit, and encouraging the adoption of higher-quality maize seeds.

Keywords: *Maize, Stochastic Frontier, Technical Efficiency.*

1. Introduction

Maize is originated in Central America and is the third-largest food crop globally, following rice and wheat (Kumar *et al.*, 2020). It possibly reached Ethiopia in the late 16th or early 17th century (Abate *et al.*, 2015). Since its launch, it has increased in significance, currently standing first in overall yearly grain output and second in area coverage among Ethiopian cereals (FAO, 2014). It ranks as Africa's second most important food crop after cassava, and it is cultivated in diverse environments. Africa exhibits the highest maize consumption per capita, especially in the eastern and southern regions. Maize is transformed into multiple products, such as whole maize meal flour, refined maize meal, cooking oil, bakery flour, dough, cornflakes, snacks, crackers, and starch converted into sugars like glucose syrup and dextrose (Gwirtz and Garcia-Casal, 2014).

Maize is Ethiopia's primary crop, grown widely by smallholder farmers. In 2012/13, maize production reached 42 million qt, exceeding teff by 40% and wheat by 75%. From 2010 to 2013, maize was the leading cereal crop in Ethiopia regarding yield and output, averaging 17.4 qt/ha (Rashid *et al*., 2010). Cereals made up 84.69% (144.96 million qt) of Ethiopia's grain output during the 2013/14 meher seasons. The overall grain production percentages were 22.97% for maize, 14.83% for wheat, 17.69% for teff, and 16.38% for sorghum. Maize, wheat, and teff produced average yields of 22.24, 17.46, and 12.22 qt/ha, correspondingly (Tesfaye *et al*., 2014).

Ethiopia's maize sector has grown through policy, technology, and infrastructure improvements. Maize production has increased more than twofold in recent years, rising from about 16 qt/ha in 1990 to over 37 qt/ha in more recent times, ranking it the highest in Sub-Saharan Africa after South Africa (FAO, 2019). The rise in production is driven by greater accessibility and use of modern inputs (such as improved varieties and fertilizers), enhanced extension services, and a growing demand (Abate *et al.,* 2015).

In Ethiopia, maize is crucial for food stability. Over 9 million small farmers cultivate maize on approximately 2 million hectares (14% of Ethiopia's overall land area), with 88 percent of their yield directed towards food consumption (Abate *et al.,* 2015). When it comes to carbohydrate consumption, maize is the key staple crop in rural areas of Ethiopia (Berhane *et al.,* 2011).

The need to examine and understand the dynamics that generate maize technical efficiencies is the driving reason behind efficiency studies. Whether the future prospects of any conceivable agricultural policies concern a sustainable or more intensive agricultural output, a study of individual farm efficiency is necessary to optimize the expected benefits of such a policy. The majority of Ethiopian farmers are smallholders, and land, along with many other precious resources, is a limiting factor in productivity (Wondimu and Hassen, 2014).

The demand for land in Ethiopia's highlands has risen considerably in the previous three decades, according to Endalkachew (2012). The total land holding per household has been diminishing over time, according to available evidence. Inefficiency not only limits the gains from existing resources, but it also precludes the benefits from using more modern technology inputs. One of the most difficult difficulties in the struggle to feed the world's growing population is increasing agricultural output and efficiency (FAO, 2014).

Gains in agricultural productivity through increased efficiency are becoming increasingly essential these days. Farm productivity can be increased by bringing more forest area into cultivation or increasing the use of physical resources, but these chances are dwindling. Furthermore, as a means of enhancing agricultural productivity and smallholder farmer income, eliminating existing inefficiency among smallholder farmers may prove to be more cost effective than adopting new technologies (Gemeda, 2011).

The national average of 21 qt/ha is lower than the farmers' field yield, which ranges from 50 to 60 qt/ha, and the research field yield, which ranges from 80 to 110 qt/ha (Dawit *et al*., 2010). In this regard, Endrias *et al*. (2013) indicated that technical efficiency based on research is not resulting in greater efficiency and productivity of resources.

Maize is the primary cereal crop in the study area. In the study year (2020/21 production year), it took up approximately 46.37% of the overall planted area in the research district (AGDAO, 2020/2021). Although extensive attempts have been made to boost maize production, low yields continue to be a significant issue in the agricultural industry.

As a result, the purpose of this research is to discover the technical efficiency of maize producer smallholder farmers in Ayehu Guagusa district, and the factors that influence it. Thus, the objectives of the research are:

- To measure the technical efficiency of maize production among smallholder farmers
- To identify the factors that influence maize productivity and technical efficiency among smallholder farmers in the research area.

The research has identified production inefficiencies and their root causes, offering valuable insights. It may be advantageous in emphasizing the potential to increase output through enhanced efficiency while using the current resources and technologies. Scholars and researchers focusing on this field can utilize the results of this study as a resource for additional investigations.

2. Research Methodology

2.1. Description of the Study Area

The research was conducted in Ayehu Guagusa District, Awi Zone, Amhara Region, Ethiopia; its position is at 10.76 degrees North latitude and 36.86 degrees East longitude. The district capital, Azena, is roughly 458 kilometers away from Addis Ababa and around 120 kilometers from Bahir Dar, the regional capital. Ankesha District is adjacent to the study district to the north, the Oromia region to the south, Zigem district to the west, and Wemberma district to the east. The district has 17 rural Keble Administrations and three urban Kebeles (AGDAO, 2020/21).

The entire land area of the district is 60,151 hectares and about 65% is allocated for agriculture, 31.23% for grazing, 0.34% for water bodies, and the remainder is designated for other uses. The total population of the district is 135,209, with 65,518 (48.46%) being male and 69,691 (51.54%) female. The rural demography is projected to be 124,266 individuals, including 60,743 (48.89%) males and 63,523 (51.11%) females.

The yearly precipitation varies between 900 and 1500 millimeters. Average temperatures vary between 12.5 and 25 degrees Celsius. Its altitude varies between 1024 and 2856 meters above sea level, which is perfect for a broader spectrum of crop cultivation and enhanced livestock handling. The major crops grown in the district include maize, pepper corn, wheat, teff, Dagussa, barley, and bean through practice of traditional agricultural system (AGDAO, 2020/21).

2.2. Sampling Technique and Sample Size Determination

The sample size was determined by using a formula developed by Yamane (1967). A three-stage random sampling method was used to select 120 smallholder farmers from 17 rural Kebele Administrations (KAs). In the first stage, 7 KAs known for maize production in the 2020/21 season were purposely chosen. In the second stage, 3 kebeles (Dikunaderb, Chibachibasa, and Kupar) were chosen using simple random sampling technique. In the third stage, farmers were categorized as maize growers and non-growers during the 2020/21 planting season. At this stage, 120 sample participants were chosen using systematic random sampling technique. Consequently, 42, 41, and 37 participants were proportionately chosen from Dikuna derb, Chibachibansa, and Kupar Kebele Administrations, respectively.

2.3. Data Collection Methods

This study used both primary data from structured questionnaires and secondary data from existing sources. Secondary data were collected from multiple sources, including AGDAO reports and other relevant published and unpublished materials for the study.

2.4. Methods of Data Analysis

Descriptive and econometric analyses were used to examine factors influencing smallholder maize farmers' productivity and efficiency. Means, standard deviations, percentages, and frequencies were utilized to analyze the socio-economic traits of farmers. As stochastic frontier method requires a prior specification of the functional form a log likelihood ratio test indicated that Cobb-Douglas production function is the best functional form for this study. The one-stage estimation procedure of the inefficiency effects model together with the production frontier function was used in the study. The two-stage procedure produces inconsistency in the assumption (Coelli and Battese, 2006). Moreover one-stage procedure is the most commonly used method in the analysis of technical efficiency. Thus one-stage procedure was selected for this study. The stochastic frontier approach splits the deviation (error term) into two parts to accommodate factors which are purely random and are out of the control of the farmers. One component is the technical inefficiency of a firm and the other component is random shocks (white noise) such as bad weather, measurement error, and omission of variables and so on.

The Cobb-Douglas production functional form which specifies the production technology of the farmers is expressed as follows:

$$Y_i = f(X_i;\beta_i)\exp V_i - U_i$$

Where,

Y_i = Output of maize in the i^{th} farm

X_i = Quantity of inputs used by the i^{th} farm

β_i = Vector of parameters to be estimated

V_i = Random errors assumed to be independently and identically distributed, having normal N ~ (0, σ^2_v) distribution and are independent of the U_i.

U_i = Random variables that account for technical inefficiency and assumed to be non-negative truncation of the half-normal distribution with mean μ and variance σ^2 ; U_i = N ~ (μ, σ^2_u)

$V_i - U_i$ = Composite error term

Technical efficiency measures a farmer's output relative to the best possible output (frontier) for a given input, indicating how efficiently resources are used. Thus, the technical efficiency of a farmer is represented as:

$$TE_i = \frac{Y_i}{Y_i^*} = \frac{f(X_i;B_i)\exp\,(V_i - U_i)}{f(X_i;B_i)\exp(V_i)} = \exp(-U_i)$$

Where: Y_i is the observed output and Y_i^* is the frontiers output. The TE ranges between 0 and 1.

The variances of the random errors, σ^2_v and that of the technical inefficiency effects σ^2_u and overall variance of the model σ^2 are related thus: $\sigma^2 = \sigma^2_v + \sigma^2_u$. And

$$\gamma = \frac{\sigma_u^{\;2}}{\sigma^2}$$

And the above ratio measures the total variation of output from the frontier which can be attributed to technical or allocative inefficiency (Battese and Cora, 1977). And **γ** has a value between zero and one

2.5. Hypotheses, Measurement Units, and Variable Selection

The study analyzes technical efficiency and inefficiency in maize production using a stochastic frontier model. Key variables for estimating efficiency were chosen based on regional maize characteristics and insights from previous research on efficiency. The variables defined in this study along with their units of measurement are presented below (Table 1).

Table 1. Variable definitions and measurement

Variable	**Variable definition**	**Type of variable**	**Measurement**
Outcome variable	Volume of maize produced	Continuous	Quintal
TE	Technical efficiency	Continuous	It takes values between 0 & 1
Input variables			
Land	The size of maize plot	Continuous	Hectare
Labor	The amount of labor used in maize production	Continuous	Man days equivalent
Seed	The amount of maize seed	Continuous	Kilogram
Urea	The amount of urea fertilizer used in maize production	Continuous	Kilogram
DAP	The amount of dap fertilizer used in maize production	Continuous	Kilogram
Oxen	Oxen used for maize production	Continuous	Oxen days
Inefficiency variables			
Education	Household head's education level	Dummy	1 if literate. and 0,
Age	Household head's age	Continuous	Years

Family size	Household members	Continuous	Number
Farm size	The entire land owned by the farmer	Continuous	Hectare
Slope	Dummy, slope of the maize plot	Dummy	1 if it is flat, and 0
TLU	The amount of livestock owned	Continuous	Tropical livestock unit
Off-farm income	Dummy, off-farm income	Dummy	1 if yes, and 0 otherwise
Improved seed	Dummy, improved maize seed variety	Dummy	1 if yes, and 0 otherwise
Credit	Dummy, credit use	Dummy	1 if yes, and 0 otherwise
Fragmentation	Dummy, fragmentation of maize	Dummy	1 if one plot, and 0

3. Results and Discussion

3.1. Socio Demographic and Economic Characteristics

The average age of farmers in the study area is 52.83 years, with a standard deviation of 8.09 years. Family size averages 5.43 individuals, higher than the national rural average of 3.8. Livestock ownership averages 10.45 TLU, with a standard deviation of 4.34 TLU, indicating variation. The survey found that 45% of smallholder farmers were illiterate, while 55% were literate. Among the 120 respondents surveyed, 70 (58.33%) were engaged in off-farm activities, while 50 (41.67%) focused solely on agricultural operations. This highlights the presence of varying literacy levels and economic diversification among the farmers. The socio-economic and institutional characteristics of the respondents are presented in Table 2 and Table 3.

Table 2. Socio-economic characteristics of sample smallholder farmers.

Variable	**Mean**	**Standard deviation**
Continuous variables		
Age	52.83	8.09
Family size	5.43	1.72
Farm size	1.46	0.76
TLU	10.45	4.34
Dummy variables	Frequency	Percent
Education		
Literate	66	55
Illiterate	54	45
Slope		
Steep	29	24.17
Flat	91	75.83`
Off-farm income		
Yes	70	58.33

No	50	41.67
Improved seed		
Yes	100	83.33
No	20	16.67
Credit use		
Yes	72	60
No	48	40
Fragmentation		
Yes	6	5
No	114	95

The survey indicates that the average maize yield is 64 quintals per hectare. Labor input is 12.75 man days, and seed usage is 23.2 kg/ha. On average, 0.41 hectares of land are cultivated. Fertilizer usage includes 198.2 kg of urea and 189 kg of DAP per hectare.

Table 3. Summary statistics of output and input variables in maize production in the study area.

Variable	Mean	Standard deviation
Output	64	13.71
Land	0.41	0.14
Labor	12.75	4.1
Seed	23.2	3.60
Urea	198.2	28.11
DAP	189	28.39
Oxen	1.48	0.7

3.2. Econometric Analysis

3.2.1. Maximum likelihood estimates of stochastic frontier production function

The stochastic frontier production function estimates maize producers' efficiency in the study area, as shown in Table 4. The variance values for δ^2 (0.2) and γ (0.57) suggest that 57% of the variation in maize output is due to technical inefficiency. δ^2 reflects the combined error's quality and fit, while γ confirms the presence of inefficiency in the model. This makes OLS unsuitable, as it cannot account for the one-sided error term, leading to biased results. Stochastic Frontier Analysis (SFA) is more appropriate. The stochastic frontier production model was employed to measure and analyze technical efficiency by estimating a Cobb-Douglas production function by Wondimu and Hassen (2014), and Yimenu (2017) and the estimated gamma (γ) parameters were 0.73 and 0.84, respectively indicating that 73% and 84% of the total variations in maize outputs were due to technical inefficiencies.

The land coefficient is significant at the 1% level, indicating a strong impact on maize production. DAP fertilizer and oxen are significant at the 5% level. Oxen have an elasticity of 0.203, meaning a 10% increase in oxen power leads to a 2.03% rise in maize output.

The 0.42 returns-to-scale coefficient indicates diminishing returns to scale implying that a one percent increase in all the inputs will bring about 0.42 percent increase on maize output of smallholder farmers. This suggests that farmers are not using their resources efficiently, as additional inputs yield decreasing productivity. However, this also implies there's potential for increased output with better resource utilization, improved management, or technology adoption, which could help overcome diminishing returns and boost overall productivity. In this regard, Abdi *et al*. (2024) investigated technical efficiency of maize production and their determinants among smallholder farmers in Sidama region and reported returns to scale value of 0.634 implying that farmers were operating at decreasing returns to scale. Similarly, Yimenu (2017) and Wondimu and Hassen (2014) reported returns to scale values of 0.94 and 0.956, respectively meaning that maize production in their study areas was operating at decreasing returns to scale.

Table 4. Maximum likelihood estimate of the Cobb-Douglas stochastic frontier production function and technical inefficiency models for maize production

Variable	Coefficient	Standard error	t-ratio
Frontier production function			
Constant	3.93	0.599	6.56***
Ln Land	0.15	0.014	10.09***
Ln Labor	0.017	0.019	0.89
Ln Seed	-0.02	0.113	-0.18
Ln Urea	-0.05	0.107	-0.47
Ln DAP	0.12	0.05	2.4**
Ln Oxen	.203	0.055	2.18**
Inefficiency model			
Constant	-1.67	0.93	-1.8*
Education	-0.344	0.135	-2.55**
Age	1.21	0.25	4.84***
Family size	-0.12	0.11	-1.1
Farm size	0.28	0.05	5.6***
Slope	-0.34	0.01	-34***
TLU	0.26	0.05	5.2***
Off farm income	0.14	0.08	1.75*
Improved seed	-0.621	0.255	-2.44**
Credit use	-0.02	0.01	-2**
Fragmentation	0.49	0.10	4.9***
Variance parameters			

Sigma-squared (σ^2)	0.2	0.04	5**
Gamma (γ)	0.57	0.20	2.85***
Log likelihood function	-243		
LR test (one-sided test)	53.28		

Note: ***, ** and * indicate level of significance at 1%, 5% and 10%, respectively

3.2.2. Technical efficiency levels and determinants

The predicted farm-specific technical efficiency ranges from 70% to 98%, with an average of 84%, indicating varying performance across farms (Table 5).

Table 5. Technical efficiency distribution of farmers in the study area

Efficiency category	Frequency	Percentage
0.70-0.80	42	35
0.81-0.90	50	41.67
0.91-1.0	28	23.33
Total	120	100
Mean	0.84	
Standard deviation	0.07	
Minimum	0.70	
Maximum	0.98	

If the average smallholder farmer increased their technical efficiency (TE) to match the most efficient peer's TE (98), they could boost output by approximately 14%. Similarly, the least efficient farmer (TE of 75) could increase productivity by 23% by matching the most efficient farmer's TE. These improvements highlight significant potential for productivity gains.

Analysis of the inefficiency model

The inefficiency model analysis reveals that age, farm size, TLU, off-farm activities, and farm fragmentation are positively correlated with technical inefficiency (TE). Table 5 shows that as these factors increase, technical inefficiency also rises among farmers in the study area, suggesting that they contribute to reduced farm productivity and efficiency. Conversely, the coefficients for educational level, slope, improved seed, and credit utilization were negative, implying that these factors enhance TE for maize producers in the region (Table 5).

Education significantly reduces technical inefficiency in maize production, with a notable effect at the 5% significance level. This finding aligns with the studies of Yimenu (2017), Getachew and Bamlak (2014), Wondimu and Hassen (2014) and Ogundari Kolawole and Ojo (2007). Enhanced seed has adversely and notably affected technical inefficiency at the 5% significance level. This aligns with the results of Solomon (2014), Rudra *et al.* (2014), and Endrias *et al.* (2013). Credit has notably impacted the farmers' technical inefficiency adversely at a 5% level of significance. This aligns with the research conducted by Musa *et al.* (2015), Kwabena *et al.* (2014), and Bekele (2013). Likewise, the coefficient for enhanced seeds was notable at the 5% significance level. The outcome aligns with the results of Solomon (2014), Rudra *et al.* (2014), and Endrias *et al.* (2013).

4. Conclusions and Recommendations

This study revealed that inefficiency was present among smallholder maize producers indicating that there is an allowance of efficiency improvement by addressing some important policy variables that had influenced farmers' levels of technical efficiency in the study area. It was shown that education (years of schooling) had a negative relationship with technical inefficiency and therefore farmers should be encouraged to improve their levels of education through adult/continuing education programs. The negative relationship between credit use and inefficiency of the farmers implies that policies should increase the number of rural financial institutions and improve the borrowing conditions so that farmers can avail themselves of loans to assist in their production operations. Policy interventions should also focus on timely and adequate supply of improved seed to improve farmers' efficiency in maize production.

5. References

Abate, T., Shiferaw, B., Menkir, A., Wegary, D., Kebede, Y., Tesfaye, K., Kassie, M., Bogale, G., Tadesse, B. & Keno, T. 2015. Factors that transformed maize productivity in Ethiopia. *Food security,* 7**,** 965-981.

Abdi Tumuri, Debela Geleta and Getachew Sime. 2024. Technical efficiency of maize production and their determinants among smallholder farmers in Ethiopia: A case study in Sidama region. Cogent Food & Agriculture, 10:1, 2392045, DOI: 10.1080/23311932.2024.2392045

AGDAO (Ayehu Guagusa District of Agricultural Office), 2021. Progress report and information posted on office (Unpublished).

Battese, G.E. and G.S. Corra. 1977. Estimation of a production function model with applied to the pastoral zone of Eastern Australia. Australian Journal of Agricultural Economics, 21: 169-179.

Bekele, A. R. 2013. Technical efficiency variation for smallholder irrigated maize producers: a case study of Tibila surface water irrigation scheme. The Institute of Development Studies and Partner Organisations.

Berhane, G., Paulos, Z., Tafere, K. & Tamru, S. 2011. Foodgrain consumption and calorie intake patterns in Ethiopia. IFPRI Ethiopia Strategy Support Program II (ESSP II) Working Paper, 23, 1-17.

Coelli T., and G. E. Battese, 2006. An Introduction to Efficiency and Productivity Analysis, Kluwer Academic Publishers, Norwel, Massachusetts, U.S.A.

Endalkachew Yehun, 2002. Technical efficiency analysis of malt barley production: The case of smallholder farmers in Debark Woreda, North Gondar Zone of the Amhara National Regional State. An M.Sc. Thesis Presented to the School of Graduate Studies of Haramaya University. 123p.

Endrias Geta, Bealu Tukela, and Tadesse Ababu, 2013, Factors affecting economic efficiency in maize production: the case of Boricha Woreda in the Sidama zone, Ethiopia.

FAO, 2014. Analysis of price incentives for maize in Ethiopia for the time period 2005-2013.

FAO STAT, 2019. Google Scholar

Gemeda Olani, 2011. Analysis of wheat production efficiency: The case of small-scale farmers in Gebe-Hasasa, West Arsi Zone of Oromia Reional State. An M.Sc. Thesis Presented to the School of Graduate Studies of Haramaya University.

Getachew Magnar and Bamlak Alemayehu, 2014. Analysis of technical efficiency of smallholder maize growing farmers of Horo Guduru Wollega Zone, Ethiopia: Science Technology and Arts Research Journal, Vol. 3, No. 3, PP. 204-212.

Gwirtz, J. A. & Garcia-CasaL, M. N. 2014. Processing maize flour and corn meal food products. *Annals of the New York Academy of Sciences,* 1312**,** 66-75.

Kolawole, O. & Ojo, S. 2007. Economic efficiency of small scale food crop production in Nigeria: A stochastic frontier approach. *Journal of Social Sciences,* 14**,** 128-130.

Kumar, S., Kumar, S., & Mrs, S. 2022. *Recent Advancement in Maize Production Technology*.

Kwabena Nyarko Addai, and Gideon Danso-Abbeam. 2014. Effects of farmer based-organization on the technical efficiency of maize farmers across Varios agro-ecological zones of Ghana.

Musa, H. A., Lemma, Z. & Endrias, G. 2015. Measuring technical, economic and allocative efficiency of maize production in subsistence farming: Evidence from the Central Rift Valley of Ethiopia. *Applied Studies in Agribusiness and Commerce,* 9**,** 63-73.

Rashid.S, Kindie Getnet and Solomon Lemma. 2010. Maize value chain potential in Ethiopia, constraints, and opportunities for enhancing the system. IFPRI (International Food Policy Research Institute), USA.

Rudra Bahadur Shrestha, Wen-Chi Huang and Raju Ghimire, 2014. Production efficiency of smallholder vegetable farms in Ilam District, Eastern Hill, Nepal. American-Eurasian J. Agric. & Environ. Sci., 14 (2): 150-154.

Solomon Bizuayehu, 2014. Technical efficiency of major crops in Ethiopia; Stochastic Frontier model: university of Oslo.

Tesfaye, W., Beshir, H. & Chaurasia, S. 2014. Determinants of technical efficiency in maize production: the case of smallholder farmers in

Dhidhessa district of Illuababora zone, Ethiopia. *Journal of economics and sustainable development,* 5**,** 274-284.

Wondimu Tesfaye and Hassen Beshir, 2014. Determinants of Technical Efficiency in Maize Production: The Case of Smallholder Farmers in Dhidhessa District of Illuababora Zone, Ethiopia. Journal of Economics and Sustainable Development

Yamane, T. 1967. Statistics, an Introductory Analysis, 2nd Edition. New York: Harper and Row.

Yimenu Kassa, 2017. Determinants of technical efficiency in maize production of smallholder farmers; the case of Fogera district, south Gondar zone, Ethiopia. An M.Sc. Thesis presented to the School of Graduate Studies of University of Gondar.