

ESTIMATION OF TECHNICAL INEFFICIENCY OF WHEAT PRODUCTION, IN CASE OF JIDA WEREDA NORTH SHEWA ZONE OROMIYA REGION ETHIOPIA



**SALALE UNIVERSITY
COLLEGE OF BUSINESS AND ECONOMICS
DEPARTMENT OF ECONOMICS**

Master thesis Submitted to Department of Economics, College of Business and Economics Salale University for the partial fulfillment of the Requirements for the Award of Masters of Science in Development Economics

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CERTIFICATE

This is to certify that the thesis entitled “Estimation of technical inefficiency of wheat production in case of Jida woreda” submitted to Department of Economics, College of Business and Economics, Salale University by Abraham Hailemariam Dadi for the degree of Masters of Science in Development Economics, is original work done by the candidate under my supervision. I further certify that the entire thesis represents the independent work of Abraham Hailemariam Dadi and all the research works are undertaken by the candidate under my supervision and guidance. This research has been submitted for examination with my approval

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THESIS APPROVAL SHEET

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LIST OF ABBREVIATIONS

AE	Allocative Efficiency
CSA	Central statical agency
DA	Development Agent
DAP	Di-Ammonia Phosphate
DAs	Data analysis
DEA	Data Envelopment Analysis
EE	Economic Efficiency
GDP	Gross domestic product
HH	House hold
IE	In efficiency
Ln	Natural logarithm
MLT	Maximum Likelihood Estimation
NTDs	Neglected tropical diseases
RAAE	Review of Agricultural and Applied Economics
SFA	Stochastic Frontier analysis
SFM	Stochastic frontier model
SPF	Stochastic production frontier

SSA	Sub-Saharan Africa
TE	Technical Efficiency
TIE	Technical Inefficiency
UA	Urban agriculture
WFP	World Food Program

LIST OF TABLES

Table 3.1. Sample of farmers and sample size selection from each Kebele.....	32
Table 3.2. Variables incorporated in the production function	41
Table 3.3. Variables Incorporated in the determinant of technical inefficiency level in wheat production.....	42
Table 4. Age and marital status	44
Table 4.2: Input-output variable used in production function.....	46
Table 4.3: land fragmentation, distance from market center and land size	47
Table 4.4: Labor source for wheat production by sample household.....	48
Table 4.5: Livestock (Oxen) ownership of sampled household by timad.....	49
Table 4.6: extension services and credit access of households	49
Table. 4.7: Training and farmer cooperatives.....	50
Table. 4.8: High price of fertilizers and price incentives	50
Table 4.9. Maximum estimate for SFM with CD production function.....	51
Table 4.10. Determinants of technical inefficiency	53
Table 4.11 VIF for TIE variables	55
Table 4.12 CD stochastic frontier normal/half-normal model	57
Table 4.13 Stochastic frontier normal/exponential model	59
Table 4.14 Stochastic frontier normal/exponential model	59

LIST OF FIGURES

Figure 1: Conceptual of framework	28
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Table of Contents	Pages
CERTIFICATE.....	ii
ACKNOWLEDGEMENT	iii
THESIS APPROVAL SHEET	iv
LIST OF ABBREVIATIONS.....	v
LIST OF TABLES	vi
LIST OF FIGURES	vii
ABSTRACT.....	xi
CHAPTER ONE	1
1. INTRODUCTION	1
1.1. Background of the study	1
1.2. Statement of Problem.....	3
1.3. Objective of the Study.....	5
1.3.1. General Objective	5
1.3.2. Specific Objective	5
1.4. Research Hypothesis	5
1.5. Significance of the Study	6
1.6. Scope and Limitations of the Study	6
1.7. Organization of the study	6
CHAPTER TWO	7
2. LITERATURE REVIEW	7
2.1. Introduction.....	7
2.2. Theoretical Literature Review	7
2.2.1. Concept and Definition of wheat production	7
2.2.2. Concepts of Technical Efficiency	8
2.2.3. Approaches of technical efficiency measurement.....	9
2.2.3.1. Input-oriented approach	9
2.2.3.2. Output-oriented approach	10

2.3.	Models of Efficiency Measurement	10
2.3.1.	Non-Parametric Frontier Model	10
2.3.2.	Parametric Frontier Models	10
2.4.	Stochastic frontier model	11
2.5.	Description of factors affecting technical inefficiency of wheat production	12
2.5.1.	Socio-demographic factors	12
2.5.2.	Institutional factors	14
2.5.3.	Production factors	15
2.5.4.	Environmental factors	17
2.6.	Empirical Literature Review	19
2.6.1.	Review of Empirical Studies on Technical Efficiency Abroad	19
2.6.2.	Empirical Studies on Technical Efficiency in Ethiopia.....	21
2.7.	Summary of literature review and research gap.....	26
2.8.	Conceptual frame work of the study	26
	CHAPTER THREE.....	29
3.	RESEARCH METHODOLOGY	29
3.1.	Description of the Study Area.....	29
3.2.	Research design	30
3.3.	Sampling Techniques and Sample Size.....	31
3.4.	Method of data collection	33
3.4.1.	Method of Data Analysis.....	33
3.5.	Stochastic frontier model	33
3.6.	Selection of the Functional Form.....	35
3.7.	Variables in Technical Inefficiency Measurement and Expected sign	36
3.7.1.	Production function variables	36
3.8.	Determinants of technical inefficiency in wheat production.....	38
3.9.	Summary of the Variables Include This Study.....	41
	CHAPTER FOUR.....	44
4.	RESULT AND DISCUSSION	44
4.1.	Descriptive Statics Result	44
4.1.1.	Demographic and Socioeconomic characteristics of sample household.....	44
4.2.	Farm characteristics of sample households.....	47
4.2.1.	Land size	47
4.2.2.	Labor	48
4.2.3.	Livestock.....	48
4.3.	Institutional and Other Characteristics of Sample Households	49

4.3.3.	Training and farmer cooperatives	50
4.3.4.	Price incentives and high price of fertilizers.....	50
4.4.	Econometric Result.....	51
4.4.3.	Parameter estimates of the SFM	51
4.5.	Determinants of technical inefficiency	53
4.6.	Cobb-Douglas function by logarithms	57
CHAPTER FIVE		60
5.	CONCLUSION AND RECOMMENDATION	60
5.1.	Conclusion	60
5.2.	Recommendation	61
REFERENCES		62
Appendix I		68
Appendix II		71

ABSTRACT

The main goal of this study was to identify the determinants of technical inefficiency of wheat production in Jida woreda. The study utilized cross-sectional data obtained from 338 farmers who produce wheat using the two stage sampling techniques during the production season of the 2022/2023-2023/2024. The data was collected from farmers who produce wheat in Jida woreda through questionnaires. Descriptive, inferential statistics and econometrics method were used. Stochastic production frontier model with Cobb Douglass production functional form was used to estimate the level of technical inefficiencies. Inferential statistics like the likelihood ratio and chi-square (χ^2) test were also used to infer the population from a sample. The researcher investigated the factors affecting technical inefficiency and production factors of wheat production in Jida woreda. As study result soil fertility, age, gender, education, land fragmentation, water availability, training and high price of fertilizers influence the level of technical inefficiency of wheat production and statically significant at 1 and 5 percent in Jida woreda. High price of fertilizers, land fragmentation, age, and credit access were statically significant at 1 and 5 percent and increase the technical inefficiency by 3.21%, 1.2%, 0.72% and 1.07% respectively. However, soil fertility, gender, education, water availability, and training were statically significant at 1 and 5 percent and decreases the technical inefficiency of wheat production by 1.08%, 2.2%, 0.38%, 2.8% and 1.1% in the study area respectively. Dap, Urea and preferred seed were statically significant at 5 and 1 percent and positively affects the output wheat in Jida woreda. Dap, Urea and preferred seed increase the wheat production of Jida woreda by 0.09%, 0.03% and 0.37% respectively.

Keywords: Wheat Production, Technical Efficiency, Stochastic Frontier

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the study

Wheat is among the best important stable food crops and a major diet that is consumed by more than 2.5 billion people in the world. It is a stable food in all nation of the world and supplies 35% of food and provides 20% of the calories. Wheat is cultivated on an estimated 216 million hectares making it the most widely grown crop in the world, and in terms of production it accounts for 752 million tone(Senbeta & Worku, 2023). One of the top cereal crops, wheat has a high protein content and is grown in a variety of conditions all over the world. It is also a staple food for humans. China is the world's largest producer of wheat, with Russia, India, the United States, France, Canada, Germany, and Pakistan following in order. According to observations, emerging nations use 75% of the world's wheat production (Khan et al., 2021).

But, changes in temperature, rainfall patterns, and extreme weather events, such as droughts or floods, can have a substantial impact on wheat production in the world. Higher temperatures and increased frequency of heatwaves can lead to reduced yields and affect the quality of the crop. Changes in precipitation patterns can also impact water availability for irrigation, which is crucial for wheat production(Lobell & Gourджи, 2012). Wheat production is influenced by various market and economic factors, such as prices, demand, competition, and policies. These factors can impact the incentives for farmers to grow wheat and invest in its production. Changes in market conditions can influence the availability and affordability of inputs, machinery, and technology, ultimately affecting wheat production(Kibirige et al., 2017).

In the trading year 2020/2021, Africa produced about 25.6 million metric tons of wheat. Based on the source's projections, the production might reach 30.4 million metric tons in 2021/2022. More than 60% of the wheat produced in Africa came from North Africa. Approximately 54.8 million metric tons of wheat were imported into the continent in 2020–2021, according to Guwela (2023).

The majority of people in Ethiopia make their living from agriculture. Nonetheless, the nation's agricultural system is mainly rain-fed, and the industry is nevertheless susceptible to

floods and droughts. After South Africa, Ethiopia is the second-largest wheat-producing nation in sub-Saharan Africa. In the crop year 2015–2016, wheat occupies 13.3% of the total land allotted for cereal crops, placing it fourth in terms of area, ahead of sorghum, maize, and teff. Over the past twelve years, there has been a 61.4% increase in wheat productivity and an 84% increase in total production area. With a 51.6% growth in output volume, the production rose from 2,176,603 tons in 2005 to 4,219,257 tons in 2016 (Hailu, 2020).

Ethiopia is expected to produce a record 5.7 million MT of wheat and 10.2 million MT of corn in 2022–2023. The construction of small- and large-scale irrigation systems, the financing of agricultural inputs, the promotion of cluster farming, and the reduction of post-harvest loss are the top priorities that the Ethiopian government has identified as having the potential to boost grain production and productivity. Farming has become extremely difficult due to the ethnic violence and security crisis that has spread from Tigray to Amhara and Afar. Ethiopia's wheat supply, which are dependent on those two countries for commercial wheat purchases, may be impacted by Russia's conflict in Ukraine (Tefera et al., 2023).

Ethiopian wheat is mostly grown in Oromia, Southern Nations Nationalities and Peoples Region (SNNPR), Amhara, Benishangul-Gumuz, and Tigray. The yields of these regions' wheat crops are, in order, 29.71 Qt/ha, 26.66 Qt/ha, 25.33 Qt/ha, 24.06 Qt/ha, and 19.83 Qt/ha. About 4.2 million farm households in Ethiopia are directly dependent on wheat production. Wheat is the fourth most important cereal crop produced during the country's major growing season (meher), after sorghum and maize. Between the production years of 2016–17 and 2017–18, there was a minor shift in Ethiopia's wheat yield (in quintals/hectare), going from 26.75 Qt/ha to 27.36 Qt/ha (CSA, 2017–18).

North Shewa zone is known for its cereal production such as wheat, teff, and barley. Among pulses, horse beans and field peas are grown widely. Other crops include vegetables, fruits, root crops, and stimulants are also grown. According to (North Shewa zone agricultural report, 2024) the productivity of wheat production of North Shewa Zone and Jida woreda is 38.3Qt/ha maximum and 26.5Qt/ha (2023/2024), 35Qt/ha maximum and 30.6Qt/ha minimum (2022/2023), and 27.5Qt/ha maximum and 18.5Qt/ha minimum (2023/2024), 27Qt/ha maximum and 22Qt/ha minimum (2022/2023) respectively.

Jida district is one of the potentials wheat-producing districts in North Shewa Zone. But the district's wheat producer farmer didn't achieve the wheat production potential of productivity as zone, region and country in seasonal average. There are several reasons against to produce high potential productivity of wheat production in case of environmental factors, production factors and institutional factors (North Shewa zone agricultural, 2024).

1.2. Statement of Problem

In Ethiopia, wheat is a significant stable cash crop that contributes to rising national GDP, job growth, food security, and household income. However, issues such a lack of agricultural inputs, pests and diseases, a lack of infrastructure, a lack of institutional services, a lack of storage materials, bad product quality, low selling prices, and price-fixing pose challenges to its production and marketing (Dagninet Asirat, Adugnaw Anteneh, 2020).

According to Waqas et al. (2014), there are several elements that affect wheat productivity, such as the area planted to wheat, farm size, varieties, insecticides, fertilizers, and sowing time. Sustainable wheat production and increased profitability depend on the effective use of resources. Furthermore, a variety of factors like seed variety, fertilizer, pesticides, weedicides, seed bed preparation, and irrigation water quality and quantity all affect crop yield.

According to (Tenaye, 2020), intelligent irrigation systems have a higher water use efficiency than traditional irrigation systems. According to some earlier research, there may be three ways to increase farm productivity and production: (1) by designating more land for production; (2) by creating and implementing new wheat technologies; and/or (3) by making better use of the resources already in place (Beyan Ahmed & Geta, 2013). Selecting the first approach would entail attempting to increase productivity at the expense of cultivating marginal areas.

According to some other writers, yield upgrading is necessary to boost cereal production and productivity because there isn't enough suitable land available, particularly in the highlands, for the extension of farmed areas (Ochola et al., 2021). On the other hand, creation and introduction of new technologies is a long-term option and requires a lot of capital for research and extension. Rather, efficient utilization of available resources is the best way of increasing production especially in the short run (Tiruneh & Geta, 2016)

Factors like sex, age, distance to all weather roads, livestock holding, group membership, farm size, farm fragmentation, tenure status and investment on fertilizers are identified as the

key determinants of the technical inefficiency of wheat production in Ethiopia. The frequency distribution of technical efficiency levels was not fairly distributed. The wheat farms were being operated below level of technical efficiency. This implies that a large number of wheat farms in the Ethiopia faced inefficiency problems.

According to previous researchers studied, in Ethiopia there are several factors influencing the technical inefficiency of wheat production. For example (Hunachew Asfaw,2020, Asefe Ayele, 2016, Tadesse Getachew, 2021, James Njeru, 2010, Charie Kassa, 2019, Aderajew Gabrie, 2018). Article reviewers are studied on factors affecting wheat production. For instances, (Daniel Hailu, 2020, chimdessa uma, 2017, Moges Dessale, 2018, Hika Wana, 2019, Gemechu Mulatu, 2020, Kaleb Kelemu,2016). According to these researchers and article reviewers, they are studied only on the factors influencing technical efficiency of wheat production. That means some of them take the factors affecting wheat production in case of only environmental factors. Some of them take only socio-demographic factors, economic factors, institutional factors, and etc.

But the researcher would be studied that which unique from those, estimate the difference between maximum wheat productivity and minimum wheat productivity quintals per hectare in Jida woreda and compare with the wheat productivity of Ethiopia, Oromia, and North Shewa zone quintals per hectares in average and estimate the core variables which more influencing the technical inefficiency of wheat production in study area as a research gap.

Jida woreda has a wide farm land and comfort water to produce high quality of wheat production. But the amount of wheat productivity potential quintals per hectare in Jida woreda is maximum 27Qt/ha and minimum 22Qt/ha in 2022/2023, and maximum 27.5Qt/ha and minimum 18.5Qt/ha in 2023/2024, which different from region, country, and zone wheat productivity. There is a time and geographical area gap on this study. Because there is no studied on technical inefficiency of wheat production between 2022/2023 and 2023/2024 years in Jida woreda. Maximum 35 Qt/ha and minimum 30.6 in 2022/2023years, 38.3 maximum Qt/ha and minimum 26.5Qt/ha in 2023/2024 years, maximum 39.4Qt/ha and minimum 28.3 Qt/ha in 2022/2023 years, maximum 37.9Qt/ha and minimum 29.4Qt/ha in 2023/2024 years, maximum 42.6 Qt/ha and minimum 34.1Qt/ha in 2022/2023 years, maximum 43.8Qt/ha and minimum 35.6Qt/ha in 2023/2024 years, in North Shewa zone,

Oromia region and Ethiopia in average respectively (North Shewa zone agricultural office report, et.1, 2024,).

The researcher would be studied that the factors affecting technical inefficiency of wheat production in case of production factors, environmental factors, institutional factors and socio-demographic factors. Environmental factors, water availability and management, soil fertility, land fragmentation. Institutional factors access to credit, extension contact, distance to market center, farmers cooperatives, training and high fertilizer prices. Production factors labor, seed, land size, organic fertilizers, livestock, inorganic fertilizers, tractor, combiner, chemicals, and price incentives. Socio-demographic factors educational status, age, gender, farmer experience and family size. The researcher took these factors that affecting technical inefficiency of wheat production at study area as a research gap.

1.3. Objective of the Study

1.3.1. General Objective

The general objective of the study is to estimate technical inefficiency and find out the determinants of technical inefficiency of wheat production in case of Jida woreda

1.3.2. Specific Objective

The specific objectives of the study are:

- To estimate the level of technical inefficiency in wheat production in the study area,
- To identify factors affecting the technical inefficiency in wheat production among farmers in the study area.

1.4. Research Hypothesis

- ❖ The study hypothesizes that each farmer in study area is not technically efficient.
- ❖ Seed quality negatively influences wheat productivity
- ❖ Labor force positively influence wheat productivity
- ❖ Soil fertility has significant relationship to technical inefficiency
- ❖ Land fragmentation has insignificant effect on the technical inefficiency

1.5. Significance of the Study

The study would focus on the issue of estimation of technical inefficiency of wheat production and identifies factors associated with technical inefficiency among farmers in Jida woreda North Shewa Zone. Hence, the outcome of this piece of work can have important implications for the professionals and purposes for the policy formulation. Therefore, in the view of the narrated importance of knowing the factors affecting wheat production, the study would have significant important as follows; first, the result would provide useful information for the government and policy makers regarding the factors affecting production.

Thus, it would contribute to designing appropriate policies and strategies to increase wheat production. Secondly, the study would also contribute to useful information for other grain crops that usually have similar production processes for farm households and helps in designing wheat extension package in the context of the zone and region as well as the national level. Finally, it would serve as source for future empirical literature for scholars and students interested in the area of efficiency and in the field of development economics and related fields

1.6. Scope and Limitations of the Study

The study is limit to only the estimation of technical inefficiency of wheat production and determine factors affecting wheat production in Jida woreda North Shewa Zone. Technical efficiency and market participation of farmers would be studied from the perspective of the wheat crop; other crops are not included in this study. Due to time and budget constraints this study focused only on four kebeles, Daga Golba, Ariya Kalate, Gango and Wagna Daga Nasiri. Shortage of time is the main challenge to do the best thesis. The shortage of adequate reference materials is another limitation of the study.

1.7. Organization of the study

The study is organized into five chapters. From those chapters the first chapter covers the background, statement of the problem and research hypothesis and, objectives of the study, significance, scope and limitation of the study. Chapter two include literature review both theoretical and empirical literature on efficiency and its measurement method. Chapter three presents the methodologies adopted for this study together with brief description of the study

area related issues, sampling procedure and sample size drawn for the study and methods of data collection. In chapter four, analysis all data are presented and discussed in detail. Chapter five included that the conclusion and recommendations of the thesis.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Introduction

In this chapter, concept and definition of wheat production, and technical inefficiency, approaches of technical inefficiency measurement, models for efficiency analysis, empirical studies on technical efficiency, identify factors affecting technical inefficiency of wheat production and conceptual framework would be discussed briefly.

2.2. Theoretical Literature Review

2.2.1. Concept and Definition of wheat production

In Africa wheat is one of the major cereals and a staple crop. Demand for wheat is increasing in Sub-Saharan Africa because of income growth, urbanization and dietary diversification. However, Sub-Saharan countries, and Africa as a whole, produce only about 30% and 40% of their domestic requirements respectively causing heavy dependence on imports and making the region highly vulnerable to global market and supply shock(Worku & Abebe, n.d.).

Ethiopia is the second largest wheat producing in Sub-Saharan Africa country after South Africa. Wheat is one of the most important cereal crops in Ethiopia in terms of both consumption and production and also in terms of caloric intake it is the second most important cereal crop in the country after maize. It is providing an estimated 12percent to the daily per capita caloric intake for the country's more than 90 million population(McGuire, 2015). In Ethiopia agricultural production and productivity is very low and the growth in agricultural output has barely kept pace with the growth in population. The high potential areas of Ethiopia can produce enough grains meet the needs of the people in the deficit areas. However, the inefficient agricultural systems and differences in efficiency of production discourage farmers to produce more(A. Alemu et al., 2018)

2.2.2. Concepts of Technical Efficiency

Efficiency: It is the act of achieving good result with little exertion of efforts. It is the act of harnessing material and human resources and coordinating these resources to achieve better management goal(Lin et al., 2019). (Sharma & Sekhon, 2022)distinguished between types of efficiency such as Technical Efficiency (TE), Allocative Efficiency (AE) and Economic Efficiency (EE), by which it can be measured in terms of all these types of efficiency. The appropriate measure of technical efficiency is input saving which gives the maximum rate at which the use of all the inputs can be reduced without reducing output.

Technical efficiency: it reflects the ability of a firm, country or university to obtain maximal output from a given set of inputs and technology. It is measured by the output of the firm relative to that which it could attain if it were 100% efficient, i.e. if it lay on the frontier itself, and is therefore bound between zero and one(Ambetsa, 2020).

Technical efficiency is concerned with the efficiency of the transformation of inputs to physical output. That is, for efficient production, farm output should lie on the envelope curve, or production function, which traces out the maximum quantities of output from varying quantities of inputs under a given technology. When technical efficiency is defined in terms of maximum output from a given bundle of measured inputs, only those farmers who are technically efficient is operate on the production frontier. A farmer whose input- output performance falls below the production function is technically inefficient(Dessale, 2019).

According to the neoclassical definition of technical efficiency, firms are efficient and whatever inefficiency comes in the process of production is due to external shocks or statistical noise which is entirely beyond their control. Furthermore, a production process is technically efficient if and only if it yields the maximum possible output for a specified technology and input set. The concept of efficiency can be explained more easily using input or output-oriented approaches. The input-oriented measure of efficiency addresses the question “by how much can input quantities be proportionally reduced without changing the output quantities produced?”(Saiyut et al., 2019). A farm can be on or above the unit iso-quant on the input per unit of output space and cannot be below or to the left to it. A departure from the unit iso-quant indicates technical inefficiency and the more a farm were far from the unit iso-quant, the more it is inefficient.

Allocative efficiency deals with the extent to which farmers make efficiency decisions by using inputs up to the level at which their marginal contribution to production value is equal to the factor cost. Technical and allocative efficiencies were components of economic efficiency (Simar & Wilson, 2020). Economic efficiency is concerned with the realization of maximum output in monetary term with the minimum available resources.

Technical and allocative efficiency (price efficiency) in production, which together comprises the economic efficiency are through the use of frontier production function. While technical efficiency relates the physical input with the optimum level of output that can be produced at a given level of technology, Allocative efficiency reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices and the production technology. Economic efficiency is the multiplicative product of technical and allocative efficiencies. The simple and straight forward way of measuring efficiency of a farm could be yield per hectare. However, given output is a function of multiple inputs in the reality, this is very simplistic way of measurement in that it only considers a single input of production, land. The other technique is to use the conventional econometric analysis, which generally assumes that all producers always manage to optimize their production process. However, there are discrepancies between production amount and production values even if the enterprises have identical technological constraints. This depends upon different productive capabilities and less favorable utilization resources by some enterprise (Dube et al., 2018)

2.2.3. Approaches of technical efficiency measurement

Basically, there are two approaches in measuring efficiency: input-oriented and output-oriented. Both measures coincide when the technology exhibits constant returns to scale, but are likely to vary otherwise (Gong et al., 2019) and the details on both approaches have been given in the following sections.

2.2.3.1. Input-oriented approach

The original idea of representing the technology in a convex iso-quant is an input-oriented measure of efficiency (Seddighi et al., 2020) illustrated the idea of input-oriented efficiency using a simple example of a given firm, which uses two factors of production, capital (K) and labour (L), to produce a single output (Y), and face a production function,

$$Y = F(K, L)$$

Under the assumption of constant returns to scale, where the assumption of constant return to scale helped us to present all necessary information on a simple iso-quant. The input-oriented

approach addresses the question "by how much a production unit can proportionally reduce the quantities of input used to produce a given amount of output?" The two factors per-unit output that firm uses can be presented on the two-dimensional input/input space(Galluzzo, 2022).

2.2.3.2. Output-oriented approach

While the input-oriented approach answers the question by how much the input use can be reduced without affecting the level of output, in the output-oriented approach one can alternatively answer the question by how much can the output be increased without increasing the number of inputs used(Qu et al., 2022).

2.3. Models of Efficiency Measurement

2.3.1. Non-Parametric Frontier Model

The non-parametric approach has historically been incorporated into Data Envelopment Analysis (DEA), a mathematical programming model used to analyze observed data and provide a method for the construction of production frontiers as well as the calculation of efficiency scores related to those constructed frontiers. Non-parametric Data Envelopment Analysis (DEA) can handle many inputs and outputs with ease. A priori trade-offs or input and output pricing are not necessary for DEA application inputs and outputs to have widely diverse units of measurement(Galluzzo, 2020).

2.3.2. Parametric Frontier Models

Deterministic and stochastic models can be separated under the umbrella of parametric techniques. The first is additionally known as a "full frontier" model. They encompass all observations, defining technical inefficiency as the difference between observed production and the maximal production, determined by the frontier and the available technology. In contrast to the stochastic method, the deterministic model assumes that any divergence from the frontier results from inefficiency. Frontier models can also be divided into two groups based on the methods employed to solve them, namely econometric and mathematical programming methods. The deterministic frontier functions can be solved either by using mathematical programming or by means of econometric techniques. The stochastic specifications are estimated by means of econometric techniques only. (Galluzzo, 2020) recommended that stochastic frontier analysis is more appropriate than Data Envelopment Analysis and deterministic models in agricultural applications, especially in developing

countries, where the data are heavily influenced by measurement errors, and the effect of weather, disease, and the like plays a significant role.

The parametric approach is naturally subdivided into deterministic and stochastic models. Deterministic models envelope all the observations, identifying the distance between the observed production and the maximum production, defined by the frontier and the available technology, as technical inefficiency. On the other hand, stochastic approaches permit one to distinguish between technical efficiency and statistical noise.

2.4. Stochastic frontier model

The stochastic frontier approach which was introduced by reversed the conventional belief that deviations from the production frontier is due to inefficiency of the producing units (that is, factors under the control of the producers, which may not be true). Hence, stochastic estimations of technical efficiency incorporate a measure of random error, which is one component of the composed error term of a stochastic production frontier. This model accepts the possibility that circumstances beyond the control of the farmers may potentially have an impact on the volume of output. Finding out whether production is deviating from the frontier output as a result of firm-specific characteristics or random external influences is now possible. The stochastic frontier production function's main benefit is that it makes it possible to calculate farm-specific technological efficiencies.

Food availability in rural Ethiopia is to a great extent determined by domestic staple food production by subsistence agriculture. Even though there is a marked variation among various areas, cereals including sorghum, wheat, maize, and barley are predominantly produced and consumed in most areas. Output and productivity are low and only the simplest traditional methods and tools are using. Capital investment is minimal. Land and labor are the principal factors of production (Smith, 2003).

Typically, a small holding gives its owner a way to meet his or her family's needs independently, which he or she may be able to supplement by selling excess produce at a farmers' market. Temporary booths or more permanent shop facilities are frequently included in small holdings, and the majority of small holder farmers cultivate their crops on less than 2 hectares of land. In areas with extensive plant life and where cultivation is reliant on unpredictable rainfall, subsistence agriculture is very dangerous and uncertain. The average

yield will be poor, putting the peasants in grave danger of hunger. Accordingly, small farmers may be highly hesitant to switch from old crop patterns and technology to a new one that offers higher yields but also carries a chance of crop failure when risk and uncertainty are high (Smith, 2003)

2.5. Description of factors affecting technical inefficiency of wheat production

2.5.1. Socio-demographic factors

Educational status: is expected to enhance managerial and technical skills of wheat producer farmers in study area and it is one of the basic determinants of technical progress for wheat production activity. The variable is used for making decision regarding input choice, allocation of input and he/she become active to manage other farm tools. Literate farmers may have a relatively adequate knowledge to apply improved methods to agricultural activities and thus the farmers may be able to far away themselves from being technically inefficient than illiterate one.

The coefficient of the variable entered into the technical inefficiency effect model also indicated that the variable is significant at 1 percent level of significant and positively affects level of technical efficiency in wheat production. This result indicates that literate farmers are technically more efficient than illiterate ones. Educated the farmer he/she may be better in communicating with other leader farmers and also, they can access information from different sources which help to improve their efficiency level. Therefore, by increasing the education status of farmers through education and training, the government can increase the efficiency level of farmers in wheat production. The finding was consistent with the findings of (Gebrie & Mada, 2018).

Age: The age of the household is the proxy for the experience of the household head in farming. The result indicated that age of the household heads influenced inefficiency negatively at 5% level of significance. This suggested that older farmers were more efficient than their young counterparts. The reason for this may probably be that the farmers become more skill full as they grow older due to cumulative farming experiences (Miche et al., 2019). Moreover, increase in farming experiences leads to a better assessment of the important and

complexities of good farming decision-making including efficient use of input. This result was consistent with the arguments by (Atkinson & Messy, 2013) they indicated that, since farming as any other professions needs accumulated knowledge, skill and physical capability, it is decisive in determining efficiency. The knowledge, the skills as well as the physical capability of farmers is likely to increase as their age increases. A study conducted by (Abate et al., 2019), found that as the age of producers increases, the level of red pepper technical efficiency increases. A study done by (Belete, 2020), also found that as the age of producers increases, the technical efficiency of maize production increases.

Gender: It is a dummy variable that takes the value 1 for male and 0 for female. Male headed households have better opportunity to engage in farming activities than female headed households. The probable reason is that female's major activities are mostly at home not denying their active labour contribution to agriculture, due to cultural influence. Crop productivity was better for male headed household (Akintayo et al., 2020). The study suggested by (Abebe, 2014) also confirmed that male headed households were better in efficiency for productivity. Therefore, positive relation was expected between male household head and productivity and also better in technical efficiency.

Family size: It refers to the number of person (family member) in the household. It is the sum of labor force and non-labor force in the household. It is the dominant source of labor force. The study conducted by (Tenaye, 2020) confirmed that family size has negative influence on technical efficiency of farmers. The result is similar to the previous expectation that farmers those having large family size are more efficient than farmers having small family size, because; family labor is the main input in crop production as the farmer has large family size, he would manage crop plots on time and may able to use appropriate input combinations. This is in line with the findings of (Wana & Dhugasa, 2019)

Farmer experiences: farmers with experience in wheat production are likely to have a deep understanding of the best agronomic practices for growing wheat. This includes knowledge of optimal planting times, seed varieties, soil preparation, fertilization, irrigation, pest and disease management, and harvesting techniques. This knowledge can lead to more efficient and successful wheat production.

2.5.2. Institutional factors

Access to credit: It is an important element in agricultural production systems. It allows producer to satisfy their cash needs induced by the production cycle. Amount of credit increases farmers' efficiency because it temporarily solves shortage of liquidity/working capital. The empirical studies conducted by (M. D. Alemu et al., 2018) found positive and significant relationship between credit and farmers' technical efficiency which was in line with this study.

Distance to nearest market (Distance): Distance to market refers to the distance measured in hours to walk from the farmers' homestead to market. Proximity to market encourages market participation and intensity of participation because of its effect on reducing transaction costs. Closeness to market creates access to market information; so that, households near to market have better opportunity to participate in the market (Elamer et al., 2021).

Farmers cooperatives: A farmer usually belongs to various types of social association/groups

and also forms part of various networks. Membership in social association implies that farmers meet regularly and allow discussions on farm issues and farmers within a group learn from each other how to grow and market new crop varieties. As discussed, the evidence suggests that network effects are important for individual decisions, and that, in the particular context of agricultural innovations, farmers share information and learn from each other (Brandano et al., 2019). Therefore, membership in social association/group may lead to sharing of information on new agricultural technologies and how to use them on their farm plots

Extension contacts: In order to give effective extension service to the farmers, the region assigned three DAs in each kebele. This can help the farmers to know modern agricultural technologies. The concept of agricultural growth suggests two channels of impacts of extension in agriculture. The first channel is to assist the destination of new technologies to farmers as a way of increasing agricultural productivity thus speeding up adoption or the use of new technologies and practices. The second channel is the role of extension in improving human capital and management skills of farmers to improve their level of technical efficiency. Different extension programs have been implemented to support farmers and it is well known that there is a change in the use of agricultural technologies such as fertilizer and

improved seeds over the past 15 years. This would not assure improvement in efficiency(Wana & Dhugasa, 2019).

Training: this variable is obtained as expected on the technical efficiency of farmers. It was significant at 5% significance level and had a positive effect on technical efficiency. This could be due to the fact that training improves the managerial as well as the technical ability of farmers. The technical efficiency of the trained farmers exceeded the technical efficiency of the untrained farmers by 0.8%. The result was similar to the result of (Getahun, 2014) and (Beyan et al., 2013)

High fertilizer prices: Nitrogen (N), phosphorus (P), and potassium (K) are essential elements needed for crop growth, and fertilizers containing these elements are widely used in agriculture production. While synthetic fertilizer use has been one of the main contributors to crop yield increases over the last century, the unabsorbed fertilizer pollutes aquatic ecosystems through leaching and surface runoff (Wang, T., Jin, H., & Sieverding, H. L. (2023).

2.5.3. Production factors

Price incentives: Farmers have a choice of crops to plant, if farmers expect high prices of wheat, this will encourage more planting now and greater supply next year. If farmers expect low prices, they will cut back production and in the next year, supply could be less. Therefore, farmers can respond to market signals, but there is a delay of one growing season. This explains why supply can be relatively inelastic in the very short term (though some wheat can be stored to act as a buffer) The cobweb theory suggests the price of commodities can be unstable because of delay in reacting to market signals(Ayub & Pusparini, 2022)

Labor: labor can significantly affect wheat production. Labor is essential for tasks such as planting, harvesting, and maintaining the crop. The availability and cost of labor can influence the overall production and profitability of wheat farming. Total person-days engaged per season and includes all the economically active persons involved in wheat farming, i.e., family and hired labor. Labor is expressed as person-days and is the summation of family labor and hired labor. No distinction was made between either male and female or skilled and unskilled labor. It is expected that labor will positively influence the level of output(Njeru, 2010).

Land size: Land is perhaps the single most important and scarce resources in agricultural production as it is a base for any economic activity especially in agricultural sector. is one of

the most important and scarce resources in agricultural production. The size of landholding is hypothesized to have a positive impact on the technical inefficiencies of wheat production. Small land size is expected to be more efficient than large farms because of its simplicity in management and transaction costs. A study conducted by (Sisay et al., 2021), found that land size was negatively affecting the technical efficiency of maize production. Hence, a household with a large land size was hypothesized to be more technically inefficient than a household with less land size.

Off-farm income: Off/non-farm income activities refer to activities out of their farm and other than farm, respectively. Being involved in off/non-farm activities might have a systematic effect on the production efficiency of producers. This is because producers may allocate more of their time to off/non-farm activities and thus may lag in agricultural activities. The effect on the production of a farmer being involved in off/non-farm activities may be twofold. First, if farmer spends more time on off/non-farm activities relative to farm activities, this may negatively affect agricultural activities. Second, financial gain generated from off/non-farm activities might be used to acquire purchased inputs and hence positively complement farm activities and will be used as additional money to buy agricultural inputs and also be a supplement for home use (Teklemariam, 2014). Hence, it was hypothesized that a farmer engaged in off/non-farm activities to be less technically inefficient than his counterpart.

Fertilizers: Farmers commonly apply Di-Ammonia Phosphate (DAP) and UREA for production in the study area. Farmers used it in equal amount. The rate of application of this productivity enhancing input clearly matters to maximize yield. Its unit of measurement is in kg.

Livestock (Oxen): it is a proxy variable for the wealth status of a household and measures the number of livestock holding of household heads in tropical livestock units. Crop production is highly supplemented and complemented by animal husbandry. The income obtained from livestock serves for investment in crop production (purchase of inputs) that would improve the productivity of the households. A study done by (Abate et al., 2022) found that farmer who owning more livestock were more efficient than those who own less livestock. Hence, livestock holding was hypothesized to influence technical inefficiency negatively.

Seed: a variable which refers total quantity of wheat seed used by the farmer per hectare of land measured in Quintal. The seed has a positive effect on the output (Ermias, 2013).

Chemicals: the amount of chemicals such as herbicides, insecticides, and pesticides applied by the sample households for protection of weed, insects, and pests in wheat production, respectively.

Combiner and Tractor: The use of cost-effective technology is one of the factors that increase the performance of output by directly raising the level of production. The currently available wheat production technology in the study area was not more tractor and combiner. Both technologies hindered by various linked constraints on the application of land preparation. Technology had significant productive effect on production. Using harvester machine than human labour force is more appropriate to take production output on peak harvesting time that save storage, loading and unloading cost of farmers. The study by (Kussey et al. 2018) found that the harvester machine had significant positive effect on the level of economic efficiency.

Pesticides: Pesticides help to control pests and diseases or their vectors, as well as reduce spoilage during storage. Weeds, diseases, insects, and other pests can reduce wheat crop yields, and the use of pesticides helps to minimize these losses.

2.5.4. Environmental factors

Land fragmentation: This refers to total number of plots that the farmer has managed. Plots in the area are highly fragmented and scattered over many places that would make difficult to perform farming activities on time and effectively. Increased land fragmentation leads to inefficiency by creating shortage of family labour, costing time and other resources that should have been available at the same time (Kenea, 2010)

Farm land slop: Slope of the land may affect level of production. For instance, steep plots are usually subject to water erosion. As a result, they are likely to be of lower productivity. Since steep plots are vulnerable to erosion damage and they are likely infertile compared to gentle plots, slopes of plot were found to be related negatively to technical efficiency (Tayea, 2011)

Temperature: wheat is grown over a wide range of environments; it is common in the major wheat-producing countries for grain filling to occur when soil moisture is declining and temperature is increasing. Average global temperatures have increased over the last decades and are predicted to continue rising, along with a greater frequency of extremely hot days. Such events have already been reported for major wheat growing regions in the world.

However, the direct impact of past temperature variability and changes in averages and extremes on wheat production has not been quantified. Attributing changes in observed yields over recent decades to a single factor such as temperature is not possible due to the confounding effects of other factors. By using simulation modelling, we were able to separate the impact of temperature from other factors and show that the effect of temperature on wheat production has been underestimated(Asseng et al., 2011).

Water availability and management: A major factor influencing the yield and quality of wheat is the availability of water. The effect of limited water is to subject the crop to moisture stress. As population growth continues around the world, there are many concerns about water scarcity. This trend shows the current need for saving water resources to prevent significant water shortages in the future.

In many countries, the scarcity of water resources places many constraints on the economic development of arid and semi-arid regions(Shokati Amghani et al., 2022). Breeding high varieties and adoption of optimal water management practices are two of the most important factors for achieving high wheat production, particularly in water-limiting environments(Li et al., 2020).

Climate change: Climate change is one of the major challenges facing humanity in the future and effect of climate change has been detrimental to agricultural industry. Climate change, due to greenhouse gases increasing the earth's overall temperature, is an emerging issue of agricultural production. The higher temperatures may negatively affect the growth process of wheat and decrease the production of wheat(Janjua et al., 2010).

Soil fertility: Soil fertility decline and soil management for crop production are important economic issues for grain growers. There is evidence of soil fertility decline which is attributed to past crop management practices. The questions addressed in this article are first,

whether components of soil fertility can be improved by better management and second, by how much soil fertility would change. Soil fertility for crop production is considered in terms of soil organic carbon and nitrogen. A stochastic dynamic economic analysis of soil fertility management for wheat production is presented (Farquharson et al., 2008).

2.6. Empirical Literature Review

2.6.1. Review of Empirical Studies on Technical Efficiency Abroad

A number of efficiency analyses have been conducted by different researchers with the aim of identifying the sources of inefficiencies and policy implications so as to improve the future development endeavors through enhancing the prevailing technical efficiencies. Most of the studies have specified the Cobb-Douglas and Tran slog type of production function and commonly estimated parameters by using the MLE procedure and also used the SPF and DEA methodology.

In analysis of technical efficiency in Northern Ghana by (Luke et al., 2019) using bootstrap DEA, the average TE of crop production was found to be 77.26 percent. They indicated as nearly 23 percent production loss being due to technical inefficiency. The estimated scale efficiency was 94.21 percent. They used a two-stage estimation method, which they found hired labor, geographical location of farms, gender and age of head of household significantly and positively affect (Ali et al., 2018) used the stochastic frontier Cobb-Douglas production function to analyses the technical efficacy of wheat production in the Khyber Pakhtunkhwa province of Pakistan's district Peshawar. Additionally, their findings demonstrated that a 1% increase in the cost of labor, a 1% increase in the cost of chemical fertilizer, and a 1% increase in the cost of a tractor plough would, respectively, increase the wheat yield by 0.052, 0.566, 0.130, and 0.438 percent.

These findings were all statistically significant. Education of farmers was discovered to be a significant factor in determining technical efficiency or inefficiency. The computed coefficient of farmer education was statistically significant and negative, suggesting that technical inefficiency diminishes as farmer education increases. Their findings also suggested that the nation's wheat production would rise if more people worked and tractor ploughing hours were added. The average technical efficiency of maize production in Masaiti district,

Zambia, was found to be approximately 0.796 by (Nguyen-Thi-Lan et al., 2023) using the SPF model. This showed that smallholder farmers in the study area had the potential to enhance maize production at the farm level by 20.4% with effective use of a particular input and technology. Age, cooperative membership, which implies access to fertilizer, and farm size were important and favorable influences on technical efficiency, according to their results of the inefficiency model. The types of seeds utilized, rotation techniques, and the farmer's educational background all had a significant and detrimental impact on technical efficiency.

(Ogada et al., 2014) estimated smallholder efficiency levels and determined the causes of variation among Kenya's smallholder food crop producers using a two-stage nonparametric technique on household panel data. According to his findings, technical inefficiency in the study area is positively influenced by wage rates for farm workers and negatively influenced by age, gender, education, household size, credit, social capital, and family labor, intensity of manure use, distance to the nearest road, and distance to the nearest market. Plot size for crops, land for other uses, annual rainfall total, and technical inefficiency are all factors that negatively and significantly affect technical inefficiency in the study area.

(Mburu et al., 2014) used SPF model to analysis of economic efficiency and farm size: A case study of wheat farmers in Nakuru District, Kenya. The study attempts to estimate the levels of technical, allocative, and economic efficiencies among the sampled 130 large- and small-scale wheat producers in Nakuru District. Their result indicated that the mean technical, allocative, and economic efficiency indices of small-scale wheat farmers are 85%, 96%, and 84%, respectively. For the large-scale farmers, the equivalent numbers are 91%, 94%, and 88%, respectively. Education, accessibility to extension counsel, and household size all had a considerable favorable impact on efficiency levels. The idea that only large-scale farmers are capable of producing wheat efficiently is refuted by the comparatively high levels of technical efficiency among small-scale farmers. Urban agriculture (UA) farmers in Tanzania's urban wards of the towns of Arusha, Dares Salaam, and Dodoma were the subject of an analysis using SPF by (Mwajombe & Mlozi, 2015)

According to their study's findings, a mean technical efficiency index of 0.72 was attained, which indicates that the output of urban agriculture production might be enhanced by 28% by applying current technologies. Urban farmers confronted a number of resource allocation difficulties despite their business skills. TEI was adversely affected by the size of the land,

total variable costs, and extension service fees. The Kou valley, located in the area of the high basins in the western portion of Burkina Faso, was the subject of (Ouedraogo, 2015) research, which focused on the technical and financial efficiency of rice growers there. From a Cobb-Douglas stochastic frontier function and its dual, which allow the estimation of the technical, allocative, and economic efficiency, the stochastic frontier approach was utilized to estimate the production function.

According to his findings, the technical efficiency of rice production in the Kou Valley was significantly and favorably impacted by factors such as farm size, fertilizer use, labor availability, years of experience, and educational attainment. Producers' average TE, AE, and EE are 80.15%, 92.7%, and 74.43%, respectively. By increasing their economic efficiency, farmers might increase rice production by 25%. In order to assess the degree of economic efficiency and its causes in small-scale soybean production in the Central Agricultural Zone of Nigeria, (Biam et al., 2016) used the Cobb-Douglas stochastic frontier cost function. Their analysis's findings indicated that the average economic efficiency was 52%. Age, farm size, and household size were discovered in the study to be adversely and significantly associated to economic efficiency. Economic efficiency was strongly and favorably correlated with education, farming experience, loan availability, and fertilizer use. Economic effectiveness, extension contact, and farmers' association membership did not significantly correlate.

2.6.2. Empirical Studies on Technical Efficiency in Ethiopia

In Ethiopia, numerous studies on the effectiveness of farmers in various locations are carried out using various models and variables in attempt to quantify and pinpoint the degree and causes of technical inefficiency. In the highlands of North-East Ethiopia, (Beshir et al., 2012) evaluated the effectiveness of crop-livestock production and identified areas for improvement. They have examined the economic effectiveness of the mixed crop and animal production system and determined its determinant factors using cross sectional data. Economic efficiency was assessed using a parametric stochastic frontier methodology. The majority of farmers in the research area were found to be inefficient, according to their findings, which showed mean technical, allocative, and economic efficiencies of 62%, 51%, and 29%, respectively. Their findings also indicated that home production efficiency has greatly increased as a result of the use of better agricultural technologies.

(WOYIMO, 2019) evaluated the technical efficiency of farm production of smallholder farmers in Girawa district. Cobb-Douglas production function was fitted using stochastic production frontier approach to estimate technical efficiency levels and to identify factors affecting efficiency levels of the sample farmers. His result showed that the mean technical efficiency of 81.5%. The discrepancy ratio (γ), which measures the relative deviation of output from the frontier level due to inefficiency, implied that about 75% of the variation in maize production was attributed to technical inefficiency effects. He also found that education, livestock holding, extension contact, farmer's training, cultivated area and participation to irrigation were found to determine technical efficiencies of farmers positively while social status had negative relationship with technical efficiency.

In (Yami et al., 2013) study's a Translog production function approach was utilized to look at the causes of smallholder wheat farmers' technical inefficiency in a few water-logged areas of Ethiopia. Their findings suggested that wheat fields had an average technical efficiency of 0.55. The integration of enhanced wheat production with the 21 input and output market plays a vital role in improving the technical efficiency of wheat producer farmers. Age, quantity of animals, and access to input and output markets all have a favorable impact on efficient wheat production. Input (better seeds, fertilizer, pesticides, herbicides, and fungicides) and output market facilities are thus provided, which increases farmers' degree of wheat production efficiency.

(Tefaye & Beshir, 2014) used SPF model to analyze technical efficiency in maize production of smallholder farmers in Dhidhessa district. From their result, the estimated gamma parameters indicated that 71% of the total variation in maize output was due to technical inefficiency. The average technical efficiency was 86% while return to scale (RTS) was 0.96 %. Based on the results, the existence of scope for increasing maize output by 14% through efficient use of existing resources was concluded from the study. Their result also indicated that area allocated under maize and chemical fertilizers appeared to be significantly influencing maize production and the marginal effect of inefficiency variables such as age, improved seed, labour availability and training were affect positively and significant. On the other hand, number of livestock, market distance, and interaction of education and off farm income were affected negative and significant.

(ASFAW, 2022) used the Cobb Douglas stochastic production frontier to analyze the technical efficiency in wheat production in the Raya Alamot district. From his result Fertilizer application rate has contributed positively and significantly to wheat production, indicating that there is a possibility to increase wheat production by increasing fertilizer application rate. Education of the household has significant positive contribution to wheat production indicating that there is scope for increasing wheat production by improvement the education level of the farmers. The inefficiency in wheat production was due to sowing of poor-quality seed year after year and large operational farm size.

(Wassie, 2014) used the SPF model together with the inefficiency parameters to identify factors affecting level of technical efficiency of wheat and the study shown that age had a positive and significant effect on TE of wheat production. The inefficiency effect analysis for major crop production shown that education, participation in soil and water conservation activities, poverty status and adoption of improved seed are the major determinants. Off-farm income of the household head was found to affect technical inefficiency in wheat production positively, contrary to this age of household head, slope and numbers of livestock were found to affect negatively.

(Ahmed et al., 2018) used a Cobb-Douglas stochastic frontier production analysis approach with the inefficiency effect model to analyze the technical efficiency in maize production of smallholder farmers in central rift valley of Ethiopia. Their result shows that the mean technical efficiency of the farmers in the production of maize as 88%. The estimated stochastic production frontier (SPF) model indicates that DAP fertilizer, Area, Labor, seed and oxen as significant determinants of maize production level. The estimated SPF model together with the inefficiency parameters shows that frequency of family size, extension contact, access to credit and number of weeding positively and significantly determining the technical efficiency level and farm size and distance to market negatively and significantly determined technical efficiency level of the farmers in maize production in the study area.

(Asfaw et al., 2019) employed SPF to analyze the economic effectiveness of rain-fed wheat producers in Albuko district, north-eastern Ethiopia. His findings showed that the average TE, AE, and EE mean indices varied substantially, at 60%, 42.7%, and 31.65%, respectively. The study discovered that TE had an inverse relationship with farm size and was significantly and positively affected by the sex of the household heads, land fragmentation, fertility quality

of the land, slope, credit use, training gained, and oxen numbers. The sex of the household heads, the frequency of extension uses, the number of oxen and families, the distance of the wheat farm from the residence, the slope, and the level of training all had a positive and significant impact on the allocative and economic efficiency of the farm household. On the contrary, age of the household heads and number of livestock unit have inverse related with allocative and economic efficiency level of the farmers in the area.

(Kitila & Alemu, 2014) used a stochastic frontier approach to analyzed technical efficiency of small holder maize growing farmers of Horo guduru wollega zone. Their result indicated inefficiency in the production of maize in the study area. The relative deviation from the frontier due to inefficiency was 85%. The average estimated technical efficiency for smallholder maize producers ranges from 0.06 to 0.92 with a mean technical efficiency of 0.66(66%). The analysis also reveals that the educational level of the farmer, age of household head, land fragmentation, extension services and engagement in off-farm/non-farm activities were significantly and positively affecting TE and total land holding of the farmer was significantly and negatively affects farmers' technical efficiency of maize production.

In Ethiopia's High-Potential Districts, (Dessale, 2018) conducted a smallholder wheat productivity and efficiency analysis. To assess the relative productivity and efficiency of smallholder wheat producers, they used data envelopment analysis. Their findings showed that age, the number of crops a household cultivated, the average area of plots a household cultivated, the average distance between plots, and household participation had a negative impact on total factor productivity and efficiency. In contrast, they found that sex, education level, household size, area, tropical livestock unit, and production information had a positive influence.

(ASFAW, 2022) used a Cobb-Douglas stochastic frontier production analysis approach with the inefficiency effect model to simultaneously estimate technical efficiency and identify the determinants of efficiency variations among wheat producer farmers in Berehe District. From his result maximum likelihood parameter estimates showed that wheat output was positively and significantly influenced by area, fertilizer, labor and number of oxen. The estimated mean level of technical efficiency of wheat producers was about 72 percent. His result also indicated that Fertility status of the farm, off-farm occupation, education, credit service, and extension contact determining technical efficiency significantly and positively.

However, age of the household head, family size, number of farm plot, and total farm size were found to reduce farmers' technical efficiency. In order to evaluate efficiency and the variables influencing efficiency in the production of wheat, (Lagiso et al., 2020) used the stochastic frontier and Tran slog functional form with a one-step approach. Their findings indicated that the mean technical efficiency was 57%. Efficiency was positively impacted by factors such the sex, age, and education level of the household head, livestock ownership, group participation, farm size, fragmentation, tenure status, and investment in inorganic fertilizers, whereas distance to all-weather roads had a negative impact. According to the results, there is a chance to increase farmers' technical efficiency by 43% through gender-sensitive agricultural intervention, group approach extension, attention to farmers' education, and scaling out best farm practices.

(Beshir, 2016) employed SPF to measure the level of technical efficiency and identify its determinants in wheat crop for smallholder farmers in south Wollo zone, Ethiopia. His result showed that the average technical efficiency of wheat production in the study area was 79 percent indicating a good potential for increasing wheat output by 21 percent with the existing technology and levels of inputs. His econometric results of stochastic 24 production function indicated area, seed, fertilizer, man days and oxen days positively affecting the technical efficiency while off- farm income was negatively affecting technical efficiency. In conclusion, various researches have examined the effectiveness of farmers and the impact of various socioeconomic and agro-climatic factors on that effectiveness.

In order to create and implement an effective policy intervention, policy makers and other development professionals' benefit from conducting studies on farm households' efficiency in various localities. The efficiency level of farmers can be influenced by a variety of factors, but not all of these factors are equally significant or prevalent everywhere at all times. An important factor that was crucial in one location at a particular period might not remain so after some time, even in the same location. As a result, establishing area-specific policies that are compatible with its socio-economic and agro-ecological characteristics may not be possible given the policy implications obtained from some of the aforementioned empirical investigated.

2.7. Summary of literature review and research gap

According to theoretical review, wheat is one of the most important cereal crops in Ethiopia in terms of both consumption and production and also in terms of caloric intake it is the second most important cereal crop in the country after maize. Empirically, wheat production is influenced by several factors, which researchers studied during a period of time. Some of those factors negative impact on technical efficiency of wheat production. For instance, according to (Mufti J., 2019) the result from the Tobit model showed that farming experience, soil fertility, cooperative membership, crop rotation, plot ownership, extension contact, amount of credit, training and combiner had significant positive effect on technical efficiency while family size in adult equivalent, total landholding, plot distance and method of sowing had a significant negative effect. Some of them positive impact on wheat production. For instance, according to (Aderajew G., 2018) the estimated SFM indicated that input variables (land, labor, seed and oxen) were found to be significantly and positively influence wheat production.

Generally, all researcher did not clearly define the factors affecting wheat production completely. But the researcher would study the determinants of technical inefficiency of wheat production with core variables, which more affecting the wheat production in the study area. The gap of this thesis is geographical area and time period in the specific study area. The goal of the study was estimated the amount of wheat produced in quintals per hectare and distinguish the variables affecting technical inefficiency of wheat production in Jida woreda.

2.8. Conceptual frame work of the study

The performance of agricultural production depends on the improvement of efficiency in production, development and use of cost-effective technology which leads to directly by raising production levels and indirectly by reducing poverty through raising incomes of farm households, raising employment, lowering the price of food and there by affecting the food security and wellbeing status of rural households. The efficiency of wheat farm can be affected different factors. These factors can be categorized into four categories.

- ❖ Production factors such as Land holding, Seed, price incentives, Labor, Inorganic fertilizers (DAP and Urea), Chemicals, Oxen, Combiner, Tractor, off-farm income and

Organic fertilizer. These factors are used as inputs in the production of wheat output and they directly affect the performance of the wheat yield.

- ❖ Environmental factors such as nature of soil fertility, land fragmentation, water availability and management, and farmland slop.
- ❖ Institutional factors such as distance from market, extension contact, access to credit and farmers cooperatives, high fertilizer prices and training.
- ❖ Socio-demographic factors like age, gender, farmer experience, family size of farm household and education status.

Figure 1: Conceptual framework



CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

North Shewa zone, located between 9005'N and 10023'N latitude and 37057'E and 39028'E longitude, is one among the 18 zonal administrations of Oromia national regional state. North Shewa zone has an area of 8990 km². The zone capital town is Fiche and it is located 114km far from Addis Ababa, the capital of Ethiopia. North Shewa zone has 13 rural districts with a total of 267 Kebeles and 26 towns with 30 Kebeles administration. The North Shewa zone has a total population of 1,594,720 in 2017/18. Climatically, North Shewa zone is divided into three; Tropical, Sub-tropical, and Temperate. Which accounts for 20.7%, 42.6%, and 36.7% of the total area of the zone, respectively (BOFED, 2008). The average crude farm landholding size, of the North Shewa zone, was 0.637 hectares in 2017/18. In the North Shewa zone, Land cultivated and the crop produced in the zone is privately owned cultivation and there is no state land cultivation and crop production. According to the statistical abstract data of 2017/18, 489,902.93 hectares were cultivated land for crop production. The crops obtained from this cultivated land were 11,366,231.12 quintals. Teff and Wheat are the major crops grown in the zone (Securitiess & Commission, 2017).

Jida woreda district is part of the North Shewa Zone of Oromia state. Jida is bordered on the north Wuchale and Abichu, on the north east by Abichu, on the west Sululta on the east by Kembibit and on the south by Berek and Aleltu. Jida wereda has 13 rural kebele and two urban kebele, totally 15 kebele. Jida woreda located at a distance of 71km from Addis Ababa to the north, along Addis Gojam main road. It is also found at a distance of 74km from Fiche town to the south. Jida has a total area of 654km² (65,400 hectares) (Biri et al., 2023). Altitudinal elevation of the district ranges between 2600m-3500m.

The major rivers of the Jida woreda are Aleltu, Jage, Wasarbi, Kalate and Robi. Mainly, the rivers are used for irrigation, human being and livestock drinking and washing. The district is characterized by temperate and woina-dega ago-climatic zones. Average annual temperature of the district is 14°C, while annual average rainfall ranges between 635 and 1350mm. Major rainy seasons of the district are summer and Belg. There are two major soil types in Jida district, namely clay and sandy soils (Biri et al., 2023). Jida woreda has a best natural resource. Especially water availability for irrigation is the unique resources for wheat

producers. According to collect data from Jida woreda healthy center and agricultural office the total population of Jida woreda is 81531 in 2021. From these total 40766 male and 40765 females. From the total of 35059 Jida woreda farmers, 8376 farmers are wheat producer farmers. From the total kebele of Jida woreda's, 4 kebeles are the most producer of wheat production. Those are Daga Golba, Ariya Kalate, Gango and Wagna Daga Nasiri (Jida woreda healthy center and Agricultural Offices, 2023).

In the woreda, majority of the population is living in rural areas engaged their livelihood by agricultural production. The main economic activity of farmers in the Jida woreda is mixed farming, including crop production and animal husbandry. Cultivation of land is carried out using a pair of oxen and other traditional implementation. Farming is mainly dependent on rain fed, irrigation and traditional farming system. Cereals, such as Wheat, Teff and Barely, are the most commonly cultivated. Wheat and Barley are the most important crops in the study area and the livelihoods of the people. In Jida woreda wheat produced 29.04%, Barley 29.05%, red Teff 16.21% and Beans 7.25%. In the woreda the main economic activity of the urban population is off-farming like selling local beverage, small scale trading, daily laborer, metal welding, house renting and government civil servants (Jida woreda healthy center and Agricultural Offices, 2023).

3.2. Research design

For this study, both quantitative and qualitative data were used. In addition, the researcher used both descriptive and an explanatory research design or approach. The researcher select the explanatory research design since the explanatory research aims to answer the question why some variables have an effect on other variables or it seeks to test a theory which is a set of logically organized and interconnected principles, rules, assumptions, statements and propositions which are employed to explain, describe and predict the phenomenon (Tilahun et al., 2021).

A systematic questionnaire was used to obtain the main data. A structured questionnaire was created and pretested for this investigation. The questionnaire was improved and changed using the pre-test feedback. The Kebele farmer and the enumerator all participate in the primary data gathering process. The enumerators are trainer on data collection procedures. In the study cross-sectional household data of 2022/2023-2023/2024 main harvest cropping season was used. Additionally, primary data was gathered by interviewing the chosen wheat-

producing farmers and agriculture manager body of woreda and other factors like age, education, household size, and extension contact that affect production efficiency. Further socioeconomic information was acquired, including information on institutions, credit availability, livestock ownership, and wealth indices. However, to aid in the analysis and interpretation of primary data, details regarding the trend in wheat production, the accessibility of inputs, and extension services was acquired.

3.3. Sampling Techniques and Sample Size

To get accurate cross-sectional data from sample households in the study area, two-stage sampling approaches was used. Jida woreda was chosen for the first stage because of the huge number of wheat producer households and the area's breadth of production. Despite the fact that the research district consists of 13 rural Kebele, only 4 of them were involved in wheat production. In the second step, the researcher selected Daga Golba, Ariya Kalate, Gango and Wagna Daga Nasiri, from wheat producer farmer by purposive sampling techniques. From farmer list frame for the purpose of providing agricultural input by agricultural extension service officers 2801 smallholder households who produce wheat in 2022/2023 and 2023/2024 production season about 338 total sample households wereselected through systematic sampling techniques after obtained number of total sample size through a basic formula provided by (Kothari, 2004).

The researcher used Kothari sample size formula. Because the target population size is finite or known. Finally, used the probability proportionality size of each Kebele to determine the overall sample size for each sample Kebele. As a result, the necessary sample size at a 95% confidence level and 5% percent level of precision was created a sample size that infers a genuine population.

$$n = \frac{Z^2 \times p \times q}{e^2(N - 1) + Z^2 \times p \times q}$$

$$n = \frac{1.96^2 \times 0.5 \times 0.5 \times 2801}{0.05^2(2801 - 1) + 1.96^2 \times 0.5 \times 0.5}$$

$$n = \frac{2690.0804}{7.960}$$

$$\underline{n \cong 338}$$

Where:

n =sample size required

N =total population

$p=0.5$

$q=0.5$

$e= 0.05$

z = confidence level=1.96 for 95% confidence. 90% confidence 1.64.

The researcher used the method of proportional allocation under which the sizes of the samples from the different strata. Take sample from each kebele farmers randomly with the following sample size proportional allocation formula.

Where: $n_i = N_i/N * n$

N_i = total farmers in each kebele

$i=1, 2, 3 \dots K$

$n = n_1 + n_2 + n_3 \dots n_k$

n =total sample size of the farmers

N =total households of the farmers

Table 3.1. Sample of farmers and sample size selection from each Kebele

No.	Wheat producer kebele	Number of farmers	Sample size selection from each kebele	Sample farmers and sample size
1	Daga Golba	641	$\frac{641}{2801} \times 338 = 77$	
2	Ariya Kalate	652	$\frac{652}{2801} \times 338 = 79$	
3	Gango	796	$\frac{796}{2801} \times 338 = 96$	
4	Wagna Daga Nasiri	712	$\frac{712}{2801} \times 338 = 86$	
Total		2801	338	

Source: Jida Woreda Agricultural office and own computation, 2024

3.4. Method of data collection

In this study, the researcher used primary data. Primary data was collected from sampled households based on the wheat crop season of 2022/2023–2023/2024. To gather primary data, key informant discussions was conducted during scheduled personal interviews using data collection tools or questionnaires. The questionnaire is including questions about a farmer's socio-demographic, environmental factors, production factors and other characteristics, farm characteristics, institutional aspects, input kinds, resource endowment, and input amount were used, as well as the output gained by sample households during the wheat production season.

Informal methods such as focus group discussion and key informants' interviews were made with farmers, development agents, concerned agricultural professionals and administration offices at all levels. Secondary data was gathered from institutional and researcher records and studies in the past. In general, greater effort was put into each sample action to ensure data quality. Enough time was given to properly put up the questionnaire so that the enumerators can readily understand it.

3.4.1. Method of Data Analysis

To achieve the objectives of the study, the researcher used econometric analysis, descriptive statistics, and inferential statistics. The central tendency and measure of dispersion, as well as a summary of some of the most significant characteristics of the sampled households, was determined using descriptive statistics. Inferential statistics like the likelihood ratio and chi-square (χ^2) test was used to infer the population from a sample. The stochastic frontier production and inefficiency model was utilized in econometric analyses with a single stage estimate approach to measure the degree of technical inefficiency and identify variables of technical inefficiency.

3.5. Stochastic frontier model

Efficiency measurement has been the concern of researchers with an aim to investigate the efficiency levels of farmers engaged in agricultural activities. Based on Farrell's (1957) pioneering article, several approaches to efficiency measurement have been developed. Among these, Stochastic Frontier analysis (SFA) models and Data Envelopment Analysis (DEA) models have proved an extremely useful tool in measurement of the technical efficiency of production units.

The main advantage of non-parametric DEA is that it does not require specification of the functional form of the production function. Furthermore, DEA simultaneously utilizes multiple outputs and multiple inputs with each being stated in different units of measurement.

DEA focuses on revealed best practice frontiers rather than on central-tendency properties or frontiers and it generates a set of “peer” units with which a unit is compared. However, several properties that represent strengths in one capacity may act as limitations in another. DEA is deterministic and attributes all the deviations from the frontier to inefficiencies, i.e. at first sight, the method does not have any statistical foundation; it is not possible to make inference about estimated DEA parameters, sensitivity, asymptotic properties, etc. Recently, bootstrap techniques have been applied in order to obtain measures of statistical precision in the DEA estimates (Simar and Wilson, 2000a, 2000b, Löthgren and Tambour, 1999).

In contrast, the parametric stochastic frontier approach treats deviations from best-practice as comprising both random error (white “noise”) and inefficiency. SFA also assumes a structure for the best-practice frontier and then fits a curve. An advantage of the econometric approach is that it allows for formal statistical testing of hypotheses and the construction of confidence intervals (Hjalmarsson et al., 1996). The main drawback of the approach is that it requires a pre-specification of the functional form and an explicit distributional assumption for the technical inefficiency term.

The limitation of SFM is to pre-determine a functional form and assume the distribution for technical inefficiency (half-normal, gamma, truncated and exponential) for the evaluation of technical inefficiency. Among the possible algebraic forms of production function, Cobb-Douglas and trans log functions have been the most popularly used models in the most empirical studies of agricultural production analysis.

A number of researchers stated that Cobb-Douglas functional form has advantages over the other functional forms in that it provides a comparison between adequate fit of the data and computational feasibility. It is also convenient in interpreting elasticity of production and it solves problems with respect to degrees of freedom. According to Coelli (1995), the Cobb-Douglas functional form has most attractive feature which is its simplicity. But, the Cobb-Douglas functional form imposes severe restriction on the technology by restricting the production elasticity to be constant and the elasticity of input substitution to be unity.

Generally, the SFM approach is preferred to estimate technical efficiencies and its determinants of wheat production in this study, due to the facts related to nature of agricultural productions depends on climatic conditions and is affected by measurement errors that attribute for statistical noise in data sets and stochastic frontier models allows decomposition of error terms between statistical noises and inefficiencies measure that enables statistical tests on the validity of model specification and also it show best performing producers(which near to frontier output or maximum output) rather than average producer and best-practicing technology(technology which able farmers or producers) more near to frontier output than other producers who use the same input in different manner.

Based on the above fact this paper was used SFA to estimate technical efficiencies of wheat production in study area. A stochastic frontier method requires a prior specification of the functional form. Among the possible algebraic forms of production function Cobb-Douglas and translog production function are most common production function types, which apply in agricultural production analysis.

SFM in Cobb-Douglas or trans log production function, can be estimated using different types of econometric software such as FRONTIER 4.1, STATA, and SAS. The most commonly used software is FRONTIER 4.1 and STATA. The model to estimate parameters for this study were analyze by using the computer program, STATA (version 17), by employing single stage estimation procedure. This software has the advantage of allowing simultaneous estimation of the production function coefficients and those of the technical inefficiency model.

3.6. Selection of the Functional Form

The selection of functional form is a problem related to parametric frontiers. The Cobb-Douglas and Trans log functions have been the most often employed functional forms among all available algebraic forms in the majority of empirical production analysis studies. Each functional type has unique benefits and restrictions.

According to some academics, the Cobb-Douglas functional form is superior to the other functional forms since it compares the computational feasibility with a sufficient fit of the data. Additionally, it makes interpreting the flexibility of production easy, and it is incredibly frugal in terms of degrees of freedom.

According to (Majumdar, 2017) it is therefore frequently utilized in studies of frontier production functions (1999). The Cobb-Douglas functional form has also been widely used in the majority of empirical estimation of frontier models due to its simplicity qualities. The Cobb-Douglas production frontier functional form was fitted to estimate the level of technical inefficiency of farmer's wheat production in the study area.

To summarize, the choice of this functional form is due to the fact that, first, the Cobb-Douglas has been the most commonly used production functional form in the specification and estimation of production frontiers in empirical studies in most efficiency especially farm efficiency studies in both developed and developing countries. Second, because of the logarithmic nature of the production function that makes econometric estimation of the parameters a very simple matter (in terms of analysis and interpretation).

The Cobb-Douglas functional form is very useful for analyzing production elasticity and is particularly frugal with respect to degrees of freedom. Cobb-Douglas functional form was thus employed in this investigation for that reason. Quintals were used to measure the amount of wheat produced during the 2022/2023-2023/2024 production year. The production inputs (factors) used in the same manufacturing year was the independent variables.

3.7. Variables in Technical Inefficiency Measurement and Expected sign

3.7.1. Production function variables

These include output of wheat product and factor of production measured in physical terms. These variables were used in determining the stochastic frontier production function of wheat in the study area. These are listed as follow.

OUTPUT (Y): This is dependent variable under stochastic frontier production function model. It is the amount of wheat which was attained from the given factor of production in cropping season by the sample farmer through rain-fed farming and measured in kilogram.

INPUT: Defined as the factor of production used in the production of wheat namely: land size, labor, oxen, DAP, UREA, chemicals, combiner, tractor, organic fertilizer and seed used for wheat production.

LAND: It is the total area of plot(s) used for production of wheat during the production year by each sample farmer. During survey the data on size of land was collected in terms of timad (one fourth of a hectare) which later converted to hectare.

LABOR: It is the total amount of labor used for different agronomic practices (plowing, planting, weeding, cultivation and harvesting) of wheat production during production season. It includes both family labor and hired labor and thus, labor inputs for major activities were converted into man-equivalent.

SEED: It refers to the total quantity of wheat seed in kilogram by each sample farmer.

UREA: Total amount of urea fertilizer used by each sample farmer for wheat production and measured in kilogram

DAP: It refers the total amount of Di-Ammonia Phosphate (DAP) fertilizer employed for the production of wheat by each sample farmer and measured in kilogram.

OXEN: It is the amount of oxen-power employed for plowing wheat land preparation to planting and measured in oxen-days by each sample farmer

CHEMICAL: the amount of chemicals such as herbicides, insecticides, and pesticides applied by the sample households for protection of weed, insects, and pests in wheat production, respectively and measured in liters.

ORGANIC FERTILIZER: The use of organic fertilizers plays a significant role in sustainable agriculture and for improving soil health. They are easily available at low cost and also very easy to apply in fields. The empirical production function that needs to be estimated is expressed as follows using a linear representation:

$$\ln y_i = \beta_0 + \beta_1 \ln labor + \beta_2 \ln landsize + \beta_3 \ln seed + \beta_4 \ln oxen + \beta_5 \ln chemical + \beta_6 \ln DAP + \beta_7 \ln organic\ fertilizer + \beta_8 \ln UREA + v_i - u_i$$

Where **ln** is denotes the **natural logarithm**

β_0 is the coefficient of the input variables

β_1, β_2, \dots are parameters were estimated

Y_i is the production of the i^{th} farmer

i = represent the i^{th} farmer in the sample,

$e_i = v_i - u_i$ which is the residual random term composed of two elements v_i and u_i .

v_i accounts for the external factors beyond the small holder farmer's control, like weather, diseases, measurements errors and fluctuation in prices of inputs as well as other statistical noises

u_i is non-negative random variable which shows the technical inefficiency in wheat production relative to another uncontrolled factors

3.8. Determinants of technical inefficiency in wheat production

For the investigation of socioeconomic factors, institutional factors and environmental factors that influencing technical inefficiency levels, the following model would be estimate:

$$TIE_i = \beta_0 + \beta_{1i} Age_i + \beta_{2i}(Educi) + \beta_{3i}(Famsizei) + \beta_{4i}(gender_i) + \beta_{5i} LFrage_i + \beta_{6i}(Soilfi) + \beta_{7i}(farm\ exp) + \beta_{8i}(Dist\ mrkti) + \beta_{9i}(Excsi) + \beta_{10i}(Creditacci) + \beta_{11i}(Coopi) + \beta_{12i}(wateravaili) + \beta_{13i}(high\ fertilizer\ price) + \beta_{14i}(training) + \beta_{15i}(price\ incentives)$$

i = represent the i^{th} farmer in the sample

β_0 is the coefficient of explanatory variables

The $\beta_1, \beta_2, \dots, \beta_{16}$ variables represent the socioeconomic, institutional, and environmental factors of the farm explaining inefficiency of the i^{th} farmer.

As a result, the technical inefficiency is explained by the following determinants:

β_{i_1} = Age of the household head (dummy)

β_{i_2} = education (years of education)

β_{i_3} = household size (total numbers of family member who lives in one roof)

β_{i_4} = gender (dummy variable male or female)

β_{i_5} = land fragmentation (dummy variable)

β_{i_6} = Soil fertility (dummy variable)

β_{i_7} = farm experiences (years)

β_{i_8} = distance to market center in hours

βi_9 = extension contact (dummy variables)

βi_{10} = access to credit (dummy variables)

βi_{11} =cooperative (dummy variables)

βi_{12} = water availability in the area (dummy variable)

βi_{13} = high fertilizer prices (dummy variables)

βi_{14} = training (dummy variables)

βi_{15} = price incentives (dummy variables)

The validity of the models would be used for the analysis and hypothesis test would investigate using the general Likelihood ratio test. Generalized Likelihood ratio computation was defined as;

$$LR = -2 [\ln LH0 - \ln LH1]$$

Where, LR= Log likelihood ratio

LH0 =Value of log likelihood of null hypothesis

LH1= Value of log likelihood of alternative hypothesis

Age: the age of the household is the proxy for the experience of the household head in farming. The knowledge, the skills as well as the physical capability of farmers is likely to increase as their age increases. A study conducted by (Abate et al., 2019), found that as the age of producers increases, the level of red pepper technical efficiency increases.

Education: literate farmers may have a relatively adequate knowledge to apply improved methods to agricultural activities and thus the farmers may be able to far away themselves from being technically inefficient than illiterate one.

Gender: it is a dummy variable that male headed households have better opportunity to engage in farming activities than female headed households.

Family size: it refers to the number of person (family member) in the household. It is the sum of labor force and non-labor force in the household. It is the dominant source of labor force.

Farmer experiences: farmers with experience in wheat production are likely to have a deep understanding of the best agronomic practices for growing wheat. This includes knowledge

of optimal planting times, seed varieties, soil preparation, fertilization, irrigation, pest and disease management, and harvesting techniques. This knowledge can lead to more efficient and successful wheat production

Access to credit: It is an important element in agricultural production systems. It allows producer to satisfy their cash needs induced by the production cycle. Amount of credit increases farmers' efficiency because it temporarily solves shortage of liquidity/working capital.

Distance to nearest market (Distance): Distance to market refers to the distance measured in kilometers to walk from the farmers' homestead to market. Proximity to market encourages market participation and intensity of participation because of its effect on reducing transaction costs. Closeness to market creates access to market information; so that, households near to market have better opportunity to participate in the market (Elamer et al., 2021)

Farmers cooperatives: A farmer usually belongs to various types of social association/groups

and also forms part of various networks. Membership in social association implies that farmers meet regularly and allow discussions on farm issues and farmers within a group learn from each other how to grow and market new crop varieties.

Extension contacts: In order to give effective extension service to the farmers, the region assigned three DAs in each kebele. This can help the farmers to know modern agricultural technologies. The concept of agricultural growth suggests two channels of impacts of extension in agriculture.

Training: this variable is obtained as expected on the technical efficiency of farmers.

High fertilizer prices: Nitrogen (N), phosphorus (P), and potassium (K) are essential elements needed for crop growth, and fertilizers containing these elements are widely used in agriculture production. While synthetic fertilizer use has been one of the main contributors to crop yield increases over the last century, the unabsorbed fertilizer pollutes aquatic ecosystems through leaching and surface runoff (Wang, T., Jin, H., & Sieverding, H. L. (2023).

Land fragmentation: This refers to total number of plots that the farmer has managed. Plots in the area are highly fragmented and scattered over many places that would make difficult to perform farming activities on time and effectively. Increased land fragmentation leads to inefficiency by creating shortage of family labor, costing time and other resources that should have been available at the same time (Kenea, 2010).

Water availability and management: A major factor influencing the yield and quality of wheat is the availability of water. The effect of limited water is to subject the crop to moisture stress. As population growth continues around the world, there are many concerns about water scarcity. This trend shows the current need for saving water resources to prevent significant water shortages in the future

3.9. Summary of the Variables Include This Study

Table 3.2. Variables incorporated in the production function

No.	Variable	Descriptions	Variable type	Measurement	Expected sign
1		Dependent variable			
	LnY	Log of total output in wheat production	Continuous	Kilogram/Qun	
1		Independent variables			
	Lnlandsize	Log of total land cultivation in wheat production	Continuous	Hectare	-
2	Lnlabor	Log of total man day employee in wheat production	Continuous	Man day	+
3	Lnseed	Log of total number of seed use in wheat production	Continuous	Kilogram	+
4	LnDAP	Log of total amount of DAP use for wheat production	Continuous	Kilogram	+
5	LnUREA	Log of total amount of urea use for wheat production	Continuous	Kilogram	+
6	LnOxen	Log of total Oxen Day use for wheat production	Continuous	Oxen day	+

7	LnChemicals	Log of total chemicals use for wheat production	Continuous	Liter	+
8	LnOrganic fertilizer	Log of total organic fertilizer for wheat production	Continuous	Quntals	+

Table 3.3. Variables Incorporated in the determinant of technical inefficiency level in wheat production

No.	Variables	Descriptions	Variable type	Measurement	Expected sign
Dependent variable					
1	Technical Inefficiency	Technical inefficiency scores each Farmer	Continuous	SFM	
Independent variables					
1	Gender	Gender of household	Dummy	1, for male and 0, for female	-
2	Education	The education status of household Head in year	Dummy	1, educated and 0, for illiterate	-
3	Family size	Total number of persons in the household head	Discrete	Count	-
4	Farmer experience	Total years of farmer experience	Continuous	Years	+
5	Water availability and management	Water availability and management in the area	Dummy	1, for available and 0, for not available	-
6	Soil fertility	Quality of Soil fertility in the area	Dummy	1, for good soil fertility and 0,	-

No.	Variables	Descriptions	Variable type	Measurement	Expected sign
				low soil fertility	
7	Land fragmentation	Land fragmentation in the area	Dummy	1, for land fragmentation and 0, no land fragmentation	+
8	Access to credit	Access to credit during wheat Production season	Dummy	1, for access to credit and 0, for otherwise	+
9	Extension Contact	Access to extension service in Wheat production period	Discrete	Count number	+
10	Farmers cooperatives	Farmers cooperatives in different institutions	Dummy	1, for participate in cooperative and 0, for non-cooperative participate	+
11	Training	To develop their knowledge, the participation of farmer in the local training	Dummy	1, for training takers and 0, for non-takers training	-
12	High fertilizer prices	The increment of fertilizers prices	Dummy	1, for high price of fertilizers and 0, for low price of fertilizers	+
13	Price incentives	The encouragement of the farmers moral to produce more wheat productivity	Dummy	1, forgot any support and 0, for otherwise	-
14	Distance from market center	Farm site from the market center	Continuous	Kilometer	+

No.	Variables	Descriptions	Variable type	Measurement	Expected sign
15	Age	The age of the households	Dummy	1, for productive age and 0, otherwise	+

CHAPTER FOUR

4. RESULT AND DISCUSSION

The results in this study were based on cross-sectional data collected from 338 sample households selected from Jida woreda in North Shewa zone. Discussion part of the study was in two main sub-sections. The first section presents the descriptive statistics results and the second section present the result from stochastic frontier method.

4.1. Descriptive Statics Result

The productivity of agricultural output is not only depending on the amount, type, quality and availability of inputs used, but also it depends on demographic and other characteristics of farmer. Before presenting the results obtained from econometric model in SFM, it is important to present demographic, socio-economic, institutional characteristics, farm, environmental condition and inputs per unit of land and output per unit of land which were used in SFM of the sample farm households. This would help to draw a general picture about the study area and sampled households.

4.1.1. Demographic and Socioeconomic characteristics of sample household

Table 4. Age and marital status

. tab gend marit

gender of household	marital status of household				Total
	single	married	divorced	widow	
female	16	57	65	0	138
male	0	173	13	14	200
Total	16	230	78	14	338

Source: own computation, 2024

Marital status: according to table 4, among the sampled farmers considered, 230 were married. While, 78 and 14 were divorced and widowed respectively.

Gender: the analysis results indicate that about 200 of the sampled farmers were male headed and the remaining 138 were female headed.

Table 4.1 Education, family size, and farmer experiences

. sum edu famsiz farmexp

Variable	Obs	Mean	Std. dev.	Min	Max
edu	338	7.159763	3.551809	0	14
famsiz	338	6.08284	2.364224	2	14
farmexp	338	11.01479	5.76208	2	28

Source: own computation, 2024

Education is a tool to improve the quality of labor by improving the knowledge and managerial skill gap of farmer for all agricultural activity and have a tendency to adopt new technologies. The averages educational level of sampled household head in the study area was 7.1yrs with the minimum of zero grade or illiterate and maximum of grade 14 formal educational levels. The majority of the household heads were literate.

Family size plays an important role in wheat production and most farmers depend mainly on family labor. The average family size of the sample households was 6 persons per household which is greater than 4.6 person per household as Ethiopia based on household size and composition around the world in 2017, based on the 2007 national census conducted the Central Statistical Agency of Ethiopia.

The mean famer experiences were about 11.01and with the minimum 2 years experiences and 28 maximum experiences with the standard deviation of 5.76 which is a bit higher than the previous studied (Adarejew G. 2018) persons per household.

Summary input-output variable used in production function

The production function for this study was including eight inputs which were used by wheat producer sample household. As below table presented on average the sample household produced 14.9645 qt of wheat, which is the dependent variable for the production function.

As result show the productivity level was low compared to the country average productivity 35.6 qt, and 26.5 qt North Shewa zone. The land allocated by sampled household during survey period for wheat production ranges from 1 up to 7 ha with an average of 2.3 ha of land.

Table 4.2: Input-output variable used in production function

. sum wheatperhect DAP UREA landsiz oxen laborfor preferredseed chemica organicfertilizer

Variable	Obs	Mean	Std. dev.	Min	Max
wheatperhect	338	13.78994	3.857278	8	25
DAP	338	3.517751	1.339198	1	6
UREA	338	2.668639	1.594582	1	9
landsiz	338	3.650888	1.999113	1	10
oxen	338	3.06213	1.281801	1	7
laborfor	338	2.381657	1.131904	1	6
preferredseed	338	200.4142	56.25008	100	350
chemica	338	4.266272	2.140492	1	10
organicfertilizer	338	6.085799	2.358463	2	14

Source: own computation, 2024

On average, the amount of seed that the sample household used for wheat production was 200.4 kilogram. The other important variable which contributes for wheat production was DAP and urea. On average sampled household was used 3.5- and 2.6-kilogram DAP and UREA respectively. Like other input labor and oxen were inputs which supported wheat production in study area. On average 3.06 and 2.3 oxen day and man day were used for wheat production respectively in study area. On average, 4.26 and 6.08 chemicals in liter per hectare and organic fertilizers in quintals per hectare were used for wheat production respectively in study area.

4.2. Farm characteristics of sample households

4.2.1. Land size

Characteristics of land distribution, land size, distance from market center and land fragmentation for wheat by sample household were studied according to the below listed. As respondent stated during the survey period, more amount of land used for crop production than others. From the total 338 household farmer the land size was one hectare. The maximum land size of the Jida woreda farmers was 10 hectares.

Table 4.3: land fragmentation, distance from market center and land size

. sum distmarkt landsiz landfrag

Variable	Obs	Mean	Std. dev.	Min	Max
distmarkt	338	22.34024	5.80593	10	36
landsiz	338	3.650888	1.999113	1	10
landfrag	338	.4822485	.5004256	0	1

Source: own computation, 2024

As current econometric evidence shows land is one of conventional factors of production for agricultural output which limit agricultural production and food security, which is needed by all household to achieve their livelihood phenomena. As respondent stated during the survey period, more amount of land used for crop production than others. The average own land holding of the sample household in study area was about 3.65 ha. The farm site of household very far from a good market center. As we concluded from the above table minimum distance

of market center is 10 km and maximum 34 km in Jida woreda. These shows decrease the wheat production in case of cost transportation.

4.2.2. Labor

Labor and its characteristics are other scarce productive resource for production of agricultural output, as the result of survey indicated the majority of survey household (46.15 percent) was used two labors hired and 20.41 percent of sample household used three hired labors.

During survey time the household head stated that family labor was also used for exchange with other labors. Therefore, family labor was dominantly used for wheat production in study area. This show that features of wheat production in study area was high dependence on family labor. This may be due to number of person available to labor supply, quality, motivation, honesty of labor and availability of wage and salary for paid labor.

Table 4.4: Labor source for wheat production by sample household

. tab laborfor

labor force	Freq.	Percent	Cum.
1	65	19.23	19.23
2	156	46.15	65.38
3	69	20.41	85.80
4	24	7.10	92.90
5	19	5.62	98.52
6	5	1.48	100.00
Total	338	100.00	

Source: own computation, 2024

4.2.3. Livestock

Livestock production is one of the farming activities in addition to crop production in study area. Therefore, smallholder farmers participated on both crop and livestock production in study area. The numbers of livestock provide as sources of draught power, food, manure, cash income and also used means of wealth for sampled household head farmers. From the

number of livestock oxen used for draught power, in order to produce different crops. Sampled households head in the study area used pair of oxen for ploughing and hoeing of land preparation for the production of wheat. As we summarize from the below table, most farmer 26.63% have two timad oxen. These shows to increase the high wheat productivity per hectare Oxen is very small. 27.22% used three timad oxen.

Table 4.5: Livestock (Oxen) ownership of sampled household by timad

. tab oxen

oxen	Freq.	Percent	Cum.
1	35	10.36	10.36
2	90	26.63	36.98
3	92	27.22	64.20
4	72	21.30	85.50
5	39	11.54	97.04
6	9	2.66	99.70
7	1	0.30	100.00
Total	338	100.00	

Source: own computation, 2024

4.3. Institutional and Other Characteristics of Sample Households

Table 4.6: extension services and credit access of households

. tab creditaccess extserv

credit access	extension services		Total
	no extens	there is	
otherwise	145	123	268
available	33	37	70
Total	178	160	338

Source: own computation, 2024

Accordingly, sample households didn't visit by extension workers were 178 farmers, during 2023/2024 wheat production year. Around 160 farmers contact with their extension services. But, as we concluded from respondents, there is no always extension contact services. Access to credit may enable farmers to purchase productive inputs on time and it may lead to higher productive efficiencies for farmers.

The farmers used credit from formal and informal source to purchase inputs, buy livestock and food items as well as a start-up capital for non/off farm participation purpose. As we summarize from the above table, the feedback of several respondents is no credit access in their woreda. 268 respondents answered there was no credit access in their kebeles. The left only 70 respondents are answered as credit access available in their kebeles.

4.3.3. Training and farmer cooperatives

Table. 4.7: Training and farmer cooperatives

. tab farmcoop train

farmer cooperatives	training		Total
	otherwise	there is	
no farmer cooperative	169	67	236
there is farmer coope	41	61	102
Total	210	128	338

Source: own computation, 2024

From the above table, most of farmers didn't get a training that support them to produce a preferred wheat production. From the above survey, 210 respondents didn't get the trainings. These brings the low productivity of wheat production in the study area.

As well as to sharing their knowledge each other farmer cooperative is very important. From the survey, 236 out of the farmer cooperatives were didn't participate in their kebeles farmer cooperatives. This shows there is no cooperatives in the study area. As we concluded from the respondents, the absence of a good cooperatives between the farmers brings the low productivity of wheat production.

4.3.4. Price incentives and high price of fertilizers

Table. 4.8: High price of fertilizers and price incentives

. tab highfertiprice priceince

high price of fertilizers	price incentives otherwise there is		Total
no high price of fert	14	26	40
there high price of f	276	22	298
Total	290	48	338

Source: own computation, 2024

When we see the above survey, 290 respondents are answer as there is no price incentives their local. From 338 household 48 farmers only judge there is price incentives. When we see the above survey, 298 respondents responded there was high increments on price of fertilizers in 2022/2023 and 2023/2024 years. For this reason, the production of wheat decreased from the previous. Only 40 respondents answered as there is no high price of fertilizers.

4.4. Econometric Result

After identification of the variables to be used in production function as well as inefficiency model, the next step is the estimation of SFM and farmer level technical inefficiency scores. In the following sections, the SFM was estimated and TIE levels of the farmers was measured and discussed.

4.4.3. Parameter estimates of the SFM

Allowing for the estimates of frontier production function where the farmers' production technology is represented by the Cobb-Douglas production function, estimation was made using a single-stage estimation procedure for both parameters of SFM and inefficiency model. The SFM used STATA version 17 computer programs.

The model includes of 24 parameters; among these 8 of which are associated with the explanatory variables (factor of production for wheat) of the frontier production function, 16 are associated with the explanatory variables influencing the level of technical inefficiency and other parameters associated with the distribution of random error(v_i) and (u_i).

Table 4.9. Maximum estimate for SFM with CD production function

Stoc. frontier normal/half-normal model

Number of obs = 338

Wald chi2(8) = 507.62

Log likelihood = -742.2144

Prob > chi2 = 0.0000

wheatperhct	Coefficient	Std. err.	z	P>|z|	[95% conf. interval]	
wheatperhct						
DAP	.7027606	.1009087	6.96	0.000	.5049833	.9005379
UREA	.3473635	.085296	4.07	0.000	.1801864	.5145406
landsiz	.0467457	.0630558	0.74	0.458	-.0768414	.1703328
oxen	-.2352984	.0954845	-2.46	0.014	-.4224445	-.0481522
laborfor	.1822313	.1084528	1.68	0.093	-.0303323	.3947949
preferredseed	.0380094	.0020076	18.93	0.000	.0340745	.0419442
chemica	.0780626	.0587146	1.33	0.184	-.0370159	.1931411
organicfertilizer	-.6185373	.0625514	-9.89	0.000	-.7411358	-.4959388
_cons	8.77776	.7855334	11.17	0.000	7.238142	10.31738

Source: own computation, 2024

The above table results reveal estimated coefficients of the stochastic frontier model have expected signs except land size, organic fertilizers and oxen. As table shows that preferred seed, urea, DAP, organic fertilizers and oxen were significant at 5% level of significant respectively.

Since, the increase in these inputs can be increase production of wheat significantly as study expected. Organic fertilizers and Oxen were negative sign and significant. The parametric coefficients of input or partial elasticity of significant input variables were, 0.7 for dap, 0.34 for urea, 0.038 for preferred seed, -0.23 for Oxen, and -0.61 for organic fertilizer. These values for each factor of production shows that the relative contribution of each input in wheat production.

Decisions in economics are always made based on the margin. As result 1 percent increasing the utilization of these input for wheat production is provide increase the amount of wheat output with 0.7%, 0.34%, and 0.038%, of dap, urea, and preferred seed respectively by assume other factor of production was constant. As 1% of wheat production increase by 1 unit, the amount of wheat output decrease with 0.23 and 0.61 for Oxen and organic fertilizer respectively by assume other factor of production was constant.

The highest coefficient of input of DAP (0.7) indicated that dap was the main determinant input of wheat production in the study area. As result wheat production is relatively more sensitive to DAP utilization than other inputs.

4.5. Determinants of technical inefficiency

The estimated level of technical efficiency among smallholder farmers is not enough to derive recommendations for policy intervention. It is also necessary to identify the sources of variation in the technical efficiency estimates among the farmers and quantify their effect.

Based on the below result, having the information about the existence of technical inefficiency in input used and other farm practices. Since, measuring its magnitude, identify the major factors causing this inefficiency level is the most important objective of the study.

As different Empirical studies on efficiency showed that the determinants of inefficiency vary considerably and highly dependent on demographic and other characteristics of farmer (educations status, family size, age, gender), environmental factor (water availability, soil fertility, land fragmentation), institutional factor (access to credit, extension service, farmer cooperatives, high price of fertilizers, price incentives, training and distance to market). Therefore, those above variables considered as determinants of inefficiency in this study by assuming another determinant is constant.

Table 4.10. Determinants of technical inefficiency

Stoc. frontier normal/half-normal model

Number of obs = 338

Wald chi2(8) = 289.73

Log likelihood = 134.90975

Prob > chi2 = 0.0000

logwheatperhect	Coefficient	Std. err.	z	P>|z|	[95% conf. interval]	
logwheatperhect						
logDAP	.0923044	.0353941	2.61	0.009	.0229332	.1616756
lgUREA	.0391082	.0194254	2.01	0.044	.0010351	.0771812
loglandsiz	.0097356	.0160253	0.61	0.544	-.0216734	.0411446
logoxen	-.0422534	.0195933	-2.16	0.031	-.0806554	-.0038513
loglaborfor	.012477	.0182497	0.68	0.494	-.0232917	.0482457
logpreferredseed	.3729735	.0225912	16.51	0.000	.3286957	.4172514
logchemica	.024841	.0190344	1.31	0.192	-.0124656	.0621477
loorganicfertilizer	-.0719368	.0225027	-3.20	0.001	-.1160412	-.0278324
_cons	.8195344	.1408815	5.82	0.000	.5434118	1.095657
lnsig2v						
_cons	-4.584233	.2269603	-20.20	0.000	-5.029067	-4.139399
lnsig2u						
gend	-2.272284	.333363	-6.82	0.000	-2.925663	-1.618904
edu	-.3853369	.0552157	-6.98	0.000	-.4935576	-.2771161
marit	1.018496	.3212301	3.17	0.002	.3888969	1.648096
famsiz	-.0497242	.0720276	-0.69	0.490	-.1908956	.0914473
farmexp	.0197254	.0266287	0.74	0.459	-.0324659	.0719167
wataiv	-2.894737	.7942221	-3.64	0.000	-4.451384	-1.33809
soilfert	-1.086183	.2948989	-3.68	0.000	-1.664174	-.508192
landfrag	1.203286	.4298943	2.80	0.005	.3607088	2.045864
age	.7217764	.3270361	2.21	0.027	.0807975	1.362755
creditaccess	1.073179	.3905348	2.75	0.006	.3077448	1.838613
extserv	.0854996	.2430413	0.35	0.725	-.3908526	.5618518
distmarkt	-.0043928	.0187413	-0.23	0.815	-.0411251	.0323395
farmcoop	.8176861	.5608829	1.46	0.145	-.2816242	1.916996
train	-1.106454	.3894899	-2.84	0.005	-1.86984	-.3430679
highfertiprice	3.217036	.8668029	3.71	0.000	1.518134	4.915939
priceince	-1.281231	.7131869	-1.80	0.072	-2.679051	.11659
_cons	-2.828251	.	.	.	.	.
sigma_v	.1010524	.0114674			.0809006	.1262237

Source: own computation, 2024

As above table 4.10 showed that the maximum likelihood estimates of the stochastic production frontier model showed that among 16 variables used in the analysis; gender, education, marital status, water availability, soil fertility, land fragmentation, age, credit access, training, and high price of fertilizers were found to be statistically and significantly affecting the level of TIE of wheat producers.

According to table 4.10 factors which significantly affect technical inefficiency of wheat production in study area were described below. Before, interpreting these variables the degree of multi-co linearity among continuous and categorical/Dummy explanatory variables was checked using variance inflation factor (VIF) and contingency coefficient (CC), respectively.

Table 4.11 VIF for TIE variables

. vif

Variable	VIF	1/VIF
highfertip~e	3.77	0.265268
creditaccess	2.78	0.359151
famsiz	2.68	0.373223
priceince	2.65	0.377394
train	2.46	0.406311
farmcoop	2.40	0.416078
edu	2.35	0.425735
soilfert	2.35	0.426294
marit	2.18	0.458109
landfrag	2.09	0.478540
wataiv	1.87	0.534847
farmexp	1.72	0.581470
age	1.50	0.666906
extserv	1.13	0.885469
distmarkt	1.03	0.972930
Mean VIF	2.20	

Source: own computation, 2024

The values of VIF of variables entered into the model were below 10, which indicates that severe there is no problem of multi-co linearity among explanatory variables that were entered into the model.

Gender: as we see from the above table 4.10 gender was statically significant at 1%. The sign of gender was negative and affecting the TIE by -2.27%. The result is inconsistent with the findings of (Aderajew Gebrei, 2018)

Water availability: according to the above table 4.10, water availability was statically significant at 1% and negatively affects the level of technically inefficiency in wheat production.

Soil fertility: as the above table 4.10, soil fertility was statically significant at 1% and negatively affects the level of technically inefficiency in wheat production.

Land fragmentation: from the above table 4.10, land fragmentation was statically significant at 5% and positively affects the level of technically inefficiency in wheat production. The finding is inconsistent with Tadese Getachew(2021)

Marital status: from table 4.10, marital status was statically significant at 5% and positively affects the level of technically inefficiency in wheat production.

Age: from table 4.10, age was statically significant at 5% and positively affects the level of technically inefficiency in wheat production.

Credit access: from table 4.10, credit access was statically significant at 5% and positively affects the level of technically inefficiency in wheat production. Farmers with access to credit are better able to access expensive efficiency enhancing technologies like modern inputs and agricultural tools than other who were not access credit. This finding is consistent with (Adarejaw Gebre, 2018)

Training: according to table 4.10, training was statically significant at 5% and negatively affects the level of technical inefficiency in wheat production.

High price of fertilizer: according to table 4.10, high price of fertilizer was statically significant at 1% and positively affects the level of technical inefficiency in wheat production.

Education: is expected to enhance managerial and technical skills of wheat producer farmers in study area and it is one of the basic determinants of technical progress for wheat production activity. The variable is use for making decision regarding to input choice, allocation of input and he/she become active to manage other farm tools. Literate farmers may have a relatively adequate knowledge to apply improved methods to agricultural activities and thus the farmers may be able to faraway themselves from being technically inefficient than illiterate one.

The coefficient of the variable entered into the technical inefficiency effect model also indicated that the variable is significant at 1 percent level of significant and negatively affects

level of technical inefficiency in wheat production. This result indicates that literate farmers are technically more efficient than illiterate ones.

Educated the farmer he/she may be better in communicating with other leader farmers and also, they a can access information from different sources which help to improve their efficiency level. Therefore, by increasing the education status of farmers through education and training, the government can decrease the inefficiency level of farmers in wheat production. The finding was consistent with the Aderejaw Gebre(2018)

4.6. Cobb-Douglas function by logarithms

Table 4.12 CD stochastic frontier normal/half-normal model

Stoc. frontier normal/half-normal model

Number of obs = 338

Wald chi2(8) = 289.73

Log likelihood = 134.90975

Prob > chi2 = 0.0000

logwheatperhect	Coefficient	Std. err.	z	P>|z|	[95% conf. interval]	
logwheatperhect						
logDAP	.0923044	.0353941	2.61	0.009	.0229332	.1616756
lgUREA	.0391082	.0194254	2.01	0.044	.0010351	.0771812
loglandsiz	.0097356	.0160253	0.61	0.544	-.0216734	.0411446
logoxen	-.0422534	.0195933	-2.16	0.031	-.0806554	-.0038513
loglaborfor	.012477	.0182497	0.68	0.494	-.0232917	.0482457
logpreferredseed	.3729735	.0225912	16.51	0.000	.3286957	.4172514
logchemica	.024841	.0190344	1.31	0.192	-.0124656	.0621477
loorganicfertilizer	-.0719368	.0225027	-3.20	0.001	-.1160412	-.0278324
_cons	.8195344	.1408815	5.82	0.000	.5434118	1.095657
lnsig2v						
_cons	-4.584233	.2269603	-20.20	0.000	-5.029067	-4.139399
lnsig2u						
gend	-2.272284	.333363	-6.82	0.000	-2.925663	-1.618904
edu	-.3853369	.0552157	-6.98	0.000	-.4935576	-.2771161
marit	1.018496	.3212301	3.17	0.002	.3888969	1.648096
famsiz	-.0497242	.0720276	-0.69	0.490	-.1908956	.0914473
farmexp	.0197254	.0266287	0.74	0.459	-.0324659	.0719167
wataiv	-2.894737	.7942221	-3.64	0.000	-4.451384	-1.33809
soilfert	-1.086183	.2948989	-3.68	0.000	-1.664174	-.508192
landfrag	1.203286	.4298943	2.80	0.005	.3607088	2.045864
age	.7217764	.3270361	2.21	0.027	.0807975	1.362755
creditaccess	1.073179	.3905348	2.75	0.006	.3077448	1.838613
extserv	.0854996	.2430413	0.35	0.725	-.3908526	.5618518
distmarkt	-.0043928	.0187413	-0.23	0.815	-.0411251	.0323395
farmcoop	.8176861	.5608829	1.46	0.145	-.2816242	1.916996
train	-1.106454	.3894899	-2.84	0.005	-1.86984	-.3430679
highfertiprice	3.217036	.8668029	3.71	0.000	1.518134	4.915939
priceince	-1.281231	.7131869	-1.80	0.072	-2.679051	.11659
_cons	-2.828251	.	.	.	.	.
sigma_v	.1010524	.0114674			.0809006	.1262237

Source: own computation, 2024

The above results reveal estimated coefficients of the stochastic frontier model have expected signs except Oxen, organic fertilizer and land size. As above result shows that preferred seed and UREA, DAP, Oxen, organic fertilizers were significant at 1 and 5 percent level of significant respectively. Since, the increase in these inputs can be increase production of wheat significantly as study expected. Expect the Oxen, organic fertilizers, DAP, UREA and preferred seed the remaining variables are insignificant.

When the wheat production increase by 1 unit, the DAP, UREA, and preferred seed increases the productivity of wheat output by, 0.09, 0.03, 0.37 percent respectively. But, when the

production of wheat increases by 1 unit, the Oxen and organic fertilizers decreases the wheat productivity of Jida worda by 0.04 and 0.07 percent respectively. These shows only increase the Oxen timad and organic fertilizer didn't increase the wheat productivity.

Table 4.13 Stochastic frontier normal/exponential model

Stoc. frontier normal/exponential model				Number of obs = 338		
Log likelihood = 79.481235				Wald chi2(8) = 111.94		
				Prob > chi2 = 0.0000		
logwheatperhct	Coefficient	Std. err.	z	P>|z|	[95% conf. interval]	
logwheatperhct						
logDAP	.0645711	.0318813	2.03	0.043	.0020849	.1270573
lgUREA	.0584476	.025505	2.29	0.022	.0084587	.1084365
loglandsiz	.0235988	.0217751	1.08	0.278	-.0190796	.0662773
logoxen	-.067404	.0273159	-2.47	0.014	-.1209423	-.0138658
loglaborfor	.010173	.0246389	0.41	0.680	-.0381183	.0584644
logpreferredseed	.3305938	.0339071	9.75	0.000	.264137	.3970505
logchemica	.0368275	.0263825	1.40	0.163	-.0148812	.0885363
loorganicfertilizer	-.0531977	.0325068	-1.64	0.102	-.1169098	.0105145
_cons	.9578805	.1920018	4.99	0.000	.5815638	1.334197
lnsig2v						
_cons	-3.796354	.1770883	-21.44	0.000	-4.143441	-3.449267
lnsig2u						
gend	-1.783335	.489144	-3.65	0.000	-2.74204	-.8246305
edu	-.3408115	.0809506	-4.21	0.000	-.4994718	-.1821512
marit	.2672031	.4969297	0.54	0.591	-.7067612	1.241167
famsiz	.0208457	.1060875	0.20	0.844	-.187082	.2287735
farmexp	.0217853	.0401906	0.54	0.588	-.0569868	.1005574
wataiv	-2.650359	.6680618	-3.97	0.000	-3.959737	-1.340982
soilfert	-.575298	.3962795	-1.45	0.147	-1.351992	.2013956
landfrag	.5489776	.5689269	0.96	0.335	-.5660986	1.664054
age	.6990684	.4085733	1.71	0.087	-.1017206	1.499857
creditaccess	.6863363	.7145816	0.96	0.337	-.7142179	2.08689
extserv	.0419914	.3438831	0.12	0.903	-.6320071	.7159898
distmarkt	.0313944	.0275191	1.14	0.254	-.0225421	.085331
farmcoop	1.298991	.6421602	2.02	0.043	.0403804	2.557602
train	-1.156153	.5264234	-2.20	0.028	-2.187924	-.1243825
highfertiprice	1.251729	1.361021	0.92	0.358	-1.415824	3.919281
priceince	-.8720083	.8363811	-1.04	0.297	-2.511285	.7672685
_cons	-2.037442	2.333061	-0.87	0.383	-6.610157	2.535273
sigma_v	.1498415	.0132676			.1259689	.1782383

Source: own computation, 2024

As above result shows that there is no change the effect of significant variables on wheat output in case of the model changed to frontier normal/exponential model, expect organic fertilizer variables. Organic fertilizer was significantly affected the wheat output in the frontier normal/ half-normal model. But, in the exponential model it is insignificant.

Table 4.14 Stochastic frontier normal/truncated-normal model

Stoc. frontier normal/truncated-normal model
Log likelihood = -14.284034

Number of obs = 338
Wald chi2(8) = 36.31
Prob > chi2 = 0.0000

logwheatperhct	Coefficient	Std. err.	z	P>|z|	[95% conf. interval]	
logDAP	.0310937	.0320113	0.97	0.331	-.0316473	.0938347
lgUREA	.1010136	.0276034	3.66	0.000	.046912	.1551153
loglandsiz	.0313508	.0262	1.20	0.231	-.0200004	.0827019
logoxen	-.0520595	.0344545	-1.51	0.131	-.1195891	.0154702
loglaborfor	.0325929	.0298833	1.09	0.275	-.0259773	.091163
logpreferredseed	.2046398	.0469485	4.36	0.000	.1126225	.2966571
logchemica	.0187486	.0318351	0.59	0.556	-.0436471	.0811443
loorganicfertilizer	-.0308678	.029833	-1.03	0.301	-.0893393	.0276038
_cons	1.377188	.3666746	3.76	0.000	.6585187	2.095857
/mu	-.0224067	2.327303	-0.01	0.992	-4.583836	4.539023
/lnsigma2	-2.75204	.1662117	-16.56	0.000	-3.077809	-2.426271
/lgtgamma	-6.522833	110.2254	-0.06	0.953	-222.5606	209.5149
sigma2	.0637976	.0106039			.0460601	.0883658
gamma	.0014673	.1615012			2.20e-97	1
sigma_u2	.0000936	.0103171			-.0201276	.0203148
sigma_v2	.063704	.0050714			.0537642	.0736438

H0: No inefficiency component: z = 0.108

Prob <= z = 0.5432

Source: own computation, 2024

As we see from the table 4.14, from the 8 independent variables of wheat production inputs only two variables significant. So, from the three types of distribution of the inefficiency term frontier normal/half-normal model was more preferred for this studied.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

The study observed that efficiency of wheat producer farmers varied due to the presence of inefficiency effects in wheat production. From the production inputs UREA, DAP, Oxen, organic fertilizers and preferred seed were significant at 5 and 1 percent level of significant respectively. Since, the increase in these inputs can be increase production of wheat significantly were more increase the productivity of wheat production in Jida woreda. From

the factors affecting technical inefficiency of wheat production gender, education, marital status, water availability, soil fertility, and high price of fertilizers were statically significant at 1 percent. Training, credit access, age and land fragmentation were statically significant at 5 percent. High price of fertilizer, credit access, age, land fragmentation and marital status were positively affected the technical inefficiency of wheat production in the study area. The remaining variables were negatively affected the technically inefficiency of wheat production in the study area. The estimation of technically inefficiency of wheat production was estimated by gender, education, marital status, water availability, soil fertility, training, credit access, age, land fragmentation and high price of fertilizers in the study area.

5.2. Recommendation

As study results indicated that gender, education, marital status, water availability, soil fertility, high price of fertilizers, training, credit access, age and land fragmentation influenced the technically inefficiency of wheat production in Jida woreda. The mentioned factors have important policy implications in that to reduce the existing level of inefficiency of farmers in the production of wheat. Therefore, the following important policy recommendations were given based on the results of the study discussed above.

The policy makers to reduce the existing level of wheat production shortage particularly for study area and generally for Ethiopia through improving agricultural production should not only concentrate on the opening and diffusion of externally supplied production enhancing inputs but they should also give due attention towards improving the existing level of efficiency with existing level of input by determine factors raising inefficiency level and provide remedies is short run solution.

According to the results of the study some recommendations were suggested to be addressed either by the government or by any other concerned body. These are: -

1. The Government should timely supply fertilizer and quality improved seed to improve farmers' efficiency in production of wheat. As study result DAP, UREA and preferred seed were mostly important for input production of output wheat. Those three variables are statically significant and positively affect wheat productivity.
2. As study result show TIE and education have negative relation in wheat production, therefore an effort by regional government towards increasing formal and informal schooling would be consistent and sustainable in this area so that farmers can use the available inputs more efficiently under the existing technology.

3. The negative effect of soil fertility on TIE wheat production calls awareness creation towards improving soil fertility for wheat production. What can be recommended here are farmers should be keep their soil fertility for wheat production.
4. The positive effect of high price of fertilizers on TIE was, to decrease wheat production and crop production in general. So, high price of fertilizer was increasing the technical inefficiency of farmers. Because the sign of high price of fertilizer was positive. Therefore; any concerned bodies and different institutions should give emphasis towards high price fertilizers and consistently follow up farmers for what purpose they used the availability of fertilizers.
5. The positive effect of credit access on TIE was to increase the technical inefficiency of wheat production in the study area. So, to decrease the technical inefficiency in the study area credit access was very important. The concerned body should attend the aid of credit access.
6. The negative effects of water availability on TIE was bring to decrease the technical inefficiency of wheat production in the study area. So, the government and farmers should attend their goals on keeping the water in their environments.

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Appendix I

English version QUESTIONNAIRES

SALALE UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

DEPARTMENT OF ECONOMICS

QUESTIONNAIRES

Dear respondents: this questionnaire is designed to collect data so as to examine the estimation of technical inefficiency of wheat production in Jida woreda. Your cooperation in providing genuine answers to the following questions are highly important for the success of this study. Your responses will be kept confidential.

General Direction

Please encircle your letter of choice from choose questions and fill the blank spaces with appropriate answer/s

Part I: Socio-demographic factors

1. Gender of the household A. female B. Male
2. Educational status of the households. A. Zero class B. 1-8 years C. 9-12 years D. diploma E. Degree F. Above degree
3. Years of education: _____
4. Marital status of Household head: A. Single B. Married C. Divorced D. Widow
5. Number of family Size with their age.

	Age	✓	Total family size
Male	<18		
	18-30		
	30-40		
	40-50		
	>50		
Female	<18		
	18-30		
	30-40		
	40-50		
	>50		

6. How long since you started producing wheat? Years

Part II: Environmental factors

7. Is there a good water availability and management in your kebele's? A. No B. Yes, if your answer is No, why?.....
8. Quality of your farmland soil fertility. A. High soil fertility B. Medium soil fertility C. Low soil fertility D. Very high soil fertility E. Very low soil fertility
9. Is there land fragmentation around your farmland? A. No B. Yes, if your answer is Yes, why?.....
10. Is drought affect your wheat production annually? A. No, B. yes
If your answer is No, why?.....

Part III: Production factors

11. How many did you use DAP or UREA per hectare to produce wheat in Quintals?
12. From both organic fertilizer and inorganic fertilizer which more preferred for you?..... If your answer is inorganic fertilizer, why?.....

13. Do you have a large land size to produce wheat production? A. Yes B. No. if your answer is Yes, how many do you have a total hectare?..... If No, how many do you have a total hectare?.....

14. What kind of seed used? A. Good quality seed B. Low quality seed C. Medium quality seed D. Very low-quality seed. If your answer is very low-quality seed, why?.....

15. How many kilograms per hectare of selected seed type do you use?

16. How many quintals of wheat do you produce from one hectare of land?

17. From both tractor and oxen, which more do you use? A. Tractor B. Oxen

If your answer is Oxen, why?

18. Do you have a labor force? A. Yes B. No

If your answer is yes for 13, how many do you have?..... If No, why you are not used?.....

19. How many liters of chemicals do you use for one hectare?.....

Part IV: Institutional factors

20. Do you take enough loans? A. Yes B. No. If your answer is No, why?.....

21. How many times contact with extension services? A. Yearly once B. Quarterly twice C. Sometimes D. No extension contacts. If your answer is no extension contact, why?.....

22. How far your farm site is from the market center in Km?

23. Do you have a farmers' cooperatives? A. Yes B. No. If your answer is No, why?.....

24. Do you take often training? A. Yes B. No. If your answer is No, why?.....

25. Is your productivity down because of fertilizer prices have gone up? A. Yes B. No

E. Other

26. As your estimation which factors more affecting the wheat productivity in your woreda? please would you mention it?.....

Thank you

Appendix II

Translated questionnaire

YUUNIVARSIITII SALAALEETTI

KOOLLAJII BIIZINASII FI IKONOOMIKSII

KUTAA BARUMSAA IKONOOMIKSII

BARGA AFFII

Kabajamtoota deebii kennitoota: gaaffileen kun tilmaama gahumsa dhabuu teeknika oomisha qamadii aanaa Jiddaatti akka qoratamuuf ragaa walitti qabuuf kan qophaa'ee dha. Gaaffilee armaan gadii kanaaf deebii dhugaadhan kennuu irratti tumsi keessan milkaa'ina qorannoo kanaaf baay'ee barbaachisaa dha. Deebiin keessan iccitii ta'ee ni eegama.

Kallattii Waliigalaa:-maaloo gaaffilee armaan gadiif deebii sirriidha jettu filadhuutii filannoo kee qubee irra marsi, akkasumas iddoo duwwaa irratti deebii kee barreessi.

Kutaa I: Odeeffannoo Diimoogiraafii

1. Saala abbaa manaa: A) Dhiira B) Dubartii
2. Bara barnootaa abbaa manaa:
3. Haala fuudha fi heeruma abbaa manaa : A) kan hin fuune/te B) kan fuudhe/rumte
C) kan hiike/te D) kan abbaan manaa/haati warraa jalaa boqote/tte
4. Baay'ina maatii umrii isaanii wajjin

	Umrii	Baay'ina maatii	Baay'ina maatii waliigalaa
Dhiira	<18		
	18-30		
	30-40		
	40-50		
	>50		
Dubartii	<18		
	18-30		
	30-40		
	40-50		

5. Erga oomisha qamadii oomishuu eegaltee waggaa meeqa?
.....

Kutaa II: Sababoota Naannoon dhufan

6. Ganda kee keessa bishaan gahaa fi to'annan bishaanii gahaan jira? A) Eeyyeen jira B) Hin jiru
7. Yoo deebiin kee lakkoofsa 6ffaa hin jiru ta'e maaliif jettee yaadda?.....
8. Gaabbinni biyyee lafa qonnaa keetii akkami jettee yaadda? A) Sirritti gabbataadha B) Giddugaleessa C) Gadaanaadha D) Baay'ee gadaanaadha
9. Yoo deebiin kee gaaffii 8ffaa gadaanaa ykn baay'ee gadaanaa ta'e maaliif jettee yaadda?.....
10. Sababa lafa qoqqoddachuun ga'ee kee xiqqaateera? A) Eeyyeen jira B) Hin jiru
11. Yoo deebiin kee gaaffii 9ffaa eeyyeen jira ta'e maaliif jettee yaadda?.....
12. Hongeen oomisha qamadii kee kan waggaan argattu miidhee jira? A) Eeyyeen jira B) Hin jiru
13. Yoo deebiin kee gaaffii 12ffaa eeyyeen ta'e akkamiin miidhe, ibsi.....

Kutaa III: Sababoota Galteewwan oomisha qamadiif oolan

14. Qamadii heektaara tokkorratti oomishuuf, xaa'oo gosa DAP ykn UREA jedhamu kumtaala meeqa fayyadamta? DAP..... UREA.....
15. Xaa'oo karaa ammayyaatiin oomishame fayyadamuu filatta moo kompostii ofiif qopheeffatte fayyadamuu filatta? A) Kompostii B) kan ammayyaa
16. Yoo deebiin kee kan karaa ammayyaatin oomishame ta'e maaliif?.....
17. Oomisha qamadiif kan oolu lafa bal'aa qabdaa? A) Eeyyeen qaba B) Hin qabu
18. Yoo deebiin kee gaaffii 12ffaa eeyyeen qaba ta'e waliigala heektaara meeqa qabda?..... Hin qabdu yoo ta'e waliigala heektaara meeqa qabda?.....
19. Heektaara tokkorraa Qamadii Kuntaala meeqa oomishta?.....
20. Gosa sanyii akkamiit fayyadamta? A) Sanyii filatamaa baay'ee gaarii ta'e B) Sanyii filatamaa giddugaleessa C) Sanyii filatamaa hin taane D) Sanyii qulqullinni isaa baay'ee gadaanaa ta'e
21. Yoo deebiin kee gaaffii 14ffaa C ykn D ta'e maaliif jettee yaadda?.....
22. Lafa qonnaa qotuuf, Tiraaktara fi Qotiyyoo keessaa kam irra caalaatti fayyadamta? A) Qotiyyoo B) Tiraaktara

23. Yoo deebiin kee gaaffii 16 Qootiyyoo ta'e maaliif?
.....
24. Qamadii Heektaara tokko facaasuuf, sanyii filatamaa Kiiloogiraamii meeqa fayyadamta?.....
25. Hojjetoota si gargaaran qabda? A) Eeyyeen qaba B) Hin qabu
26. Yoo deebiin kee gaaffii 18ffaa eeyyeen qaba ta'e hojjetaa meeqa qabda?..... Yoo hin qabu jette immoo maaliif?.....
27. Keemikaala garagaraa kan araamaa balleessu, kan nyaattoo garagaraa balleessu fi gaabbina Qamadiif ta'u ni fayyadamtaa? A) Eeyyeen nan fayyadama B) hin fayyadamu
28. Yoo deebiin kee gaaffii 29 hin fayyadamu ta'e maaliif?..... Yoo fayyadamte immoo Heektaara tokkoratti Liitira meeqa fayyadamta?.....

Kutaa IV: Sababoota karaa dhaabbataatiin dhufan

29. Oomisha Qamadii kana ittiin cimsuuf liiqii gahaa ta'e ni argatta? A) Eeyyeen nan argadha B) Hin argadhu
30. Yoo deebiin kee gaaffii 31, hin argadhu ta'e maaliif?.....
31. Ekisteenshinii ykn ogeessa qonnaa wajjin yeroo meeqa walqunnamtanii beektu? A) Waggaatti altokko B) Kurmaanan C) Darbee darbee D) Gonka wal hin qunnamnu
32. Yoo deebiin kee gaaffii 21ffaa C ykn D ta'e maaliif?.....
33. Giddugalli gabaa bareedan Kiilomeetira meeqa lafa qonnaa keetirraa fagaata?.....
34. Akka ganda keetitti Gurmii ykn waldaalee hojii gamtaa keessatti ni hirmaatta? A) Eeyyeen B) Hin hirmaadhu
35. Yoo deebiin kee gaaffii 36ffaa B ta'e maaliif?.....
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36. Haala Oomisha Qamadii irratti yeroo hedduu leenjii fudhattee beekta? A) Eeyyeen B) Hin beeku
37. Yoo deebiin kee gaaffii 24ffaa B ta'e maaliif?.....
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38. Sababa gatiin Xaa'oo dabaleef oomishtummaan Qamadii keessanii gadi bu'ee jira? A) Eeyyeen B) Gadi hin buune
39. Oomisha Qamadii oomishuu irratti gargaarsa addaa argattee beektaa? A) Eeyyeen B) Hin arganne
40. Yoo deebiin kee gaaffii 41ffaa eeyyeen ta'e gargaarsa akkamiit argatte?
- Yoo hin arganne immoo maaliif?

Kutaa V: kan biroo

41. Akka tilmaama keetitti wanti oomishitummaa Qamadii aanaa Jiddaa humnaa ol
hir'ise maali jettee yaadda?
Maaloo nuuf tarreessi.....

Baay'ee galatoomaa!