ANALYSIS OF SMALLHOLDER FARMERS' SORGHUM COMMERCIALIZATION: THE CASE OF ARSI ZONE, OROMIA REGIONAL STATE, ETHIOPIA

MSc THESIS

BELAY ROBA TADESSE

HAWASSA UNIVERSITY COLLEGE OF AGRICULTURE, HAWASSA, ETHIOPIA

NOVEMBER, 2022

ANALYSIS OF SMALLHOLDER FARMERS SORGHUM COMMERCIALIZATION: THE CASE OF ARSI ZONE, OROMIA REGION, ETHIOPIA

BY: BELAY ROBA TADESSE

MAJOR ADVISOR: BERHANU NEGA (PhD)

A THESIS SUBMITTED TO THE SCHOOL OF ENVIRONMENT, GENDER AND DEVELOPMENT STUDIES, HAWASSA UNIVERSITY COLLEGE OF AGRICULTURE

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN RURAL DEVELOPMENT

NOVEMBER,2022

SCHOOL OF GRADUATE STUDIES HAWASSA UNIVERSITY

ADVISORS' APPROVAL SHEET

This is to certify that the thesis entitled "Analysis of determinants of smallholder farmers sorghum commercialization: the case of Arsi zone, Oromia regional state, Ethiopia" submitted in partial fulfillment of the requirements for the degree of Masters with specialization in Rural Development, the graduate program of the department/school of environment, gender and development studies, and has been carried out by Belay Roba ID. No; GPRDR/0003/13, under my/our supervision.

Therefore I/we recommend that the student has fulfilled the requirements and hence hereby submit the thesis to the department.

_____	_____	_____
Name of major advisor	Signature	Date
_____	_____	_____
Name of co-advisor	Signature	Date

DEDICATION

This thesis work is dedicated to my beloved family for their kindness, devotion and endless support.

STATEMENT OF THE AUTHOR

I hereby declare and affirm that this thesis is my genuine work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in in partial fulfillment of the requirement for the MSc degree in Rural Development at Hawassa University and is deposited at university library to be made available to borrowers under the rule of the library. I solemnly declare that this thesis work is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

Brief quotations from this dissertation are allowable without special permission provided that accurate acknowledgment of the source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department, head of the school or the Directorate for postgraduate program of Hawassa University when in his judgment the proposed use of the material is in the interest of scholarship. In all other instances, however, permission must be obtained from the author.

Name: Belay Roba Tadesse Signature. _____

Place: University of Hawassa, Hawassa

College: College of Agriculture

Department: Rural Development

Date of submission: _____

ACKNOWLEDGMENTS

First and foremost, I am highly grateful to almighty God that bestowed me courage and patience throughout the study period.

I would like to express my sincere appreciation and gratitude to my advisor Berhanu Nega (PhD) and additional support from Mekonnen Sime (PhD) for their vital contribution to this thesis through giving me inspiring guidance ,encouragement, and comments. In my journey towards this degree, i have found inspiration and critical support from my advisor, and Mekonnen Sime (PhD) they have given their heartfelt guidance, and invaluable suggestion starting from the development of the proposal to the final write up of this thesis. Indeed, it was a privilege and wonderful knowledge to acquire the opportunity to work with them. I am thankful to Melkassa research center Department of agricultural extension and communication for giving me the scholarship through a fund procured from the Ethiopian institute of agricultural research (EIAR). I am most grateful to staff members of Melkassa agricultural research center departments of agricultural extension and communication. I acknowledge the help provided by the Gololcha and Shene Kolu office of Agricultural and Natural Resources and my sampled farmers who patiently responded to the interview schedule.

My attainment at this point was by the important role played by many people and I would like to express my profound gratitude to my father Roba Tadesse and my Brother Mesfen Roba for their all-round moral and financial support. Also, my special thanks go to my friend Abebe Gurumu, Kebede Dida and Kedir Oshine for their encouragement and kindness during this research work. Finally, my special thanks go to my family members for giving me support and encouragement during this study.

LIST OF ACRONYMS

ADLI	Agricultural Development Led Industrialization
AGP	Agriculture Growth Program
CCI	Households Commercialization Index
CSA	Central Stastical Agency
DAs	Development Agents
ETB	Ethiopian Birr
FGD	Focus Group Discussion
FAO	Food and Agriculture Organization [of the United Nations]
FTC	Farmer Training Center
GDP	Gross domestic product
GTP I	Growth and Transformation Plan I
GTP II	Growth and Transformation Plan II
NPA	National Planning Commission
OLS	Ordinary Least Square
PASDEP	Participatory,Accelerated & Sustainable Development to End Poverty
PRSP	Poverty Reduction Strategy Paper
SRS	Simple Random Sampling
STATA	South Texas Art Therapy Association
SPSS	Statistical Package for social scince

TABLE OF CONTENTS

Contents page

LIST OF TABLES

Tables **Page**

LIST OF FIGURES

Figure **Page**

LIST OF TABLES IN THE APPENDICES

Appendix Table **Page**

ANALYSIS OF SMALLHOLDER FARMERS SORGHUM COMMERCIALIZATION:

THE CASE OF ARSI ZONE, OROMIA REGION, ETHIOPIA

By: Belay Roba

Advisor: Berhanu Nega (PhD)

ABSTRACT

In several developing countries, including Ethiopia, the change from a subsistence-oriented production system to a market-oriented production system. Sorghum has been considered a strategic by the Ethiopian government crop enhancing food security and an essential source of income for farmers. Previous research has focused on the adoption of sorghum however, there are no adequate studies in Ethiopia, particularly in the Arsi zone focusing on determinants of smallholder sorghum market participations. This study aimed at analyzing factors determining smallholder farmers decision to participate in the sorghum output market and the level of output marketed in Gololcha and Shene Kolu Districts of the Arsi zone. A three-stage random sampling technique was employed to select a sample of 130 smallholder sorghum producer household heads. Primary data were collected using structured questionnaires and focus group discussions while, secondary data were collected from offices, journal articles, books and central statical authority. Both qualitative and quantitative data were collected. Quantitative data were analyzed using descriptive and inferential statistics while pairwise ranking and narration was used for qualitative data analysis. Similarly, the households' commercialization index (HCI) to measure the level of output sorghum market participation were used. Furthermore, Heckman's two-step estimation econometric model was used. Results of HCI indicated that 48.46% of households are fully subsistent,16.92% are less commercialized,21.54% are medium commercialized,8.46% are highly commercialized and 4.6% are very highly commercialized farmers. The result of the first stage binary probit model revealed that the gender of the household head, access to market information, and volume of sorghum production influenced the decision to sell sorghum positively and significantly, while the age of the household head, and volume of sorghum consumption influenced negatively and significantly. Heckman's second-step selection estimation indicated that household family size, household access to credit and sorghum current market price influenced the level of sorghum commercialization positively and significantly while household sorghum consumption and household non-farm income were affected negatively and significantly. Therefore, government authorities and other concerned bodies should take into consideration the aforementioned demographic, socioeconomic, and institutional factors to improve the performance of sorghum market participations in Arsi zone of Oromia regional state.

Key words: Gololcha and Shene Kolu, *Sorghum, Smallholder, commercialization, determinants Heckman two step estimation*

CHAPTER ONE: INTRODUCTION

1.1. Background of the study

The majority (more than 80%) of Ethiopian farmers are smallholders and more than 85% of the rural population relies on agricultural production for their livelihoods (Emerta and Aragie, 2013).This shows that smallholder farming takes a major share in the overall efforts being exerted to realize the agricultural growth and development plan of the country. Even though smallholders farming is responsible for a large proportion of Ethiopian food production (Zerssa *et al*., 2021), about 60% of farmers cultivate less than 0.90 ha of very fragmented landscapes (Headey and Jayne, 2014). Smallholder farmers, who constitute the bulk of the rural poor have also not fully benefited from agriculture's multiple functions because they predominantly practice consumption-oriented subsistence agriculture which excludes them from the formal market system and the related income-mediated benefits (World Bank, 2008).

Hence, in the long run, this subsistence agricultural production may not be a viable production system to ensure food security (Pingali, 1997). Thus, with the ever-increasing population and the limited farmland, meeting the challenge of improving rural incomes will require a transformation of the low input-output farming systems to one that is highly commercialized (Govereh *et al*., 1999).Because of this promoting commercialization of agricultural production is a cornerstone of the rural development and poverty reduction strategies of Ethiopia, as well as numerous other developing countries. Policymakers in Ethiopia and elsewhere view agricultural commercialization as an essential part of the process of agricultural modernization, specialization, and structural transformation of the economy toward more rapid and sustainable growth (Pender and Alemu, 2007).

Commercialization also results in welfare gains through the realization of comparative advantages, economies of scale, and from dynamic technological, organizational and institutional change effects that arise from the flow of ideas due to exchange-based interactions (Berhanu and Moti, 2010). This implies that commercializing smallholder agriculture is an indispensable pathway towards economic growth and development for most developing countries relying on the agricultural sector as a means of livelihood (Pingali and Rosegrant, 1995).

Knowing this the Ethiopian government has prioritized commercialization of farming as a policy and implemented agricultural commercialization clusters with the primary goal of commercialization of smallholders' agriculture and agro-industrial development, offering a strategic entry point for private sector engagement (Pauw , 2017).This entails that the poverty-reduction strategy seeks to achieve growth through the commercialization of smallholder agriculture (Gebreselassie and Sharp,2008).

Consequently, promoting the commercialization of agricultural production is a cornerstone of the rural development and poverty-reduction strategies of Ethiopia (Mohammed Nasir *et al*.,2017).However, information on the current status of smallholder commercialization in key agricultural enterprises in Ethiopia is scant.

The Ethiopian agriculture sector is composed of the crop, livestock, forestry, and fishing subsectors of which the crop subsector takes the lion's share of the agriculture sectors, comprising 65.3%, followed by livestock production (NBE, 2017).In Ethiopia, cereal grain crops that are classified within the grain crops category are also produced in greater volume compared to the other crops by commercial farms because they are the principal staple crops and export commodities (CSA, 2020). Especially, five major bowls of cereal (teff, maize, sorghum, barley,

and wheat) are the core of Ethiopia's agriculture, accounting for about 75% of the total area cultivated (Taffesse *et al*.,2012).

Specifically, among cereal crops, sorghum in Ethiopia is the fourth most important crop after teff, wheat and maize in terms of area cultivated, yield and production (Seyoum Taffesse *et al*. ,2013). Currently sorghum is produced by about five million smallholders farmers and its production is estimated to be 4 million metric tons from nearly 2 million hectares of land giving the national average grain yield of around 2 tons per hectare (CSA,2012). In Ethiopia sorghum provides more than one third of the cereal diet and is almost entirely grown by subsistence farmers to meet needs for food, income, feed and brewing purposes (McGuire, 2007).

The grain is also used for the preparation of other traditional foods and local beverages like tella. Other countries experience showed that it can also be used as raw material for industry and can be processed into malted foods, beverages and beer (Felix *et al*.,2014). Sorghum is grown in many parts of in all regions of Ethiopia especially in the arid and semi-arid area includes Amhara, Oromia, and Tigray regions are the major producers of sorghum covering 86% of the total area and 89% of total production in the last 5 years. The sorghum took a share of 34% of the area covered by cereals in commercial farms (Taffesse *et al*.,2017).

In Ethiopia, during the period 1997-2009, sorghum production has increased by nearly 6% per annum because of area expansion 93.3% and yield increase 2.7%. In the recent past, production has increased from 1.7 million metric tons in 2004 to 3.9 million in 2010/11 (Taffesse *et al*.,2017). This shows as there is slight increase in the production of sorghum over the last on decade in Ethiopia. The productivity and production increase happened because of area increases coupled with introduction of improved varieties. Sorghum in 2015, 5.9 million smallholder farmers produced 4.7 million tons of sorghum grain from an area of 1.8 million hectares and

contributes 16% of total cereal production and 15% of total area allocated for cereals (CSA, 2020).

Arsi zone is one of the sorghum producing area in Oromia region. In the study area different crops are grown such as sorghum, maize, barley, wheat, common bean etc. and vegetables and fruits but sorghum is dominant crop in terms of area coverage as well as productivity. Despite this production potentials and importance of sorghum crops there is a dearth of empirical evidence on factors influencing smallholder commercialization of different crop such as on Haricot Bean (Haile and Gebre, 2022;Stephen *et al*., 2017;Ejeta and Masresha, 2020) ;teff crop (Edosa, 2018); Wheat (Endalew *et a*l., 2020) and horticultural crops (Aman *et al*., 2014) in Ethiopia but lack on Sorghum crop in the country and specifically no in the study area. Therefore, the study is intended to analysis the determinants of smallholder sorghum crop market participation decision and level of market participation in Arsi zone.

1.2. Statement of the Problem

In Ethiopia, 95% of the total area is cultivated by smallholder farmers and 90% of the total agricultural products are obtained from smallholder farmers (Mazengia, 2016).Commercialization of smallholder crop production refers to a market-oriented production system based on market signals including product choices, input uses, and decision-making based on profit maximization (Berhanu and Moti, 2010). Accordingly, a study by Ogutu *et al*.(2020) revealed that agricultural commercialization improves food supply with broader growth and welfare. According to, Rios (2011) creating smallholder access to markets for higher-value agricultural products, cereals, is an excellent opportunity to enhance the livelihood of lower-income farmers to alleviate poverty.

Cognizant of the fact government of Ethiopia had made efforts to commercialize and transform subsistence-oriented smallholder agriculture production as a strategy for its economic transformation. But the process is below the expectation of the country's strategy and the smallholder farmers are not yet out of the subsistence production system (NPC, 2016). Studies indicate even though the commercialization of smallholder farming has a high potential to enhance incomes and welfare outcomes, farmers are not yet out of subsistence-oriented agriculture in developing countries and particularly in Ethiopia because of different factors affecting commercialization such as population growth and demographic change, institutions, markets, and their integration, transaction costs, asset holdings of the households, and policy aspects (Pender and place,2006;Afework and Endrias, 2016;Berhanu and Moti, 2010).

Previous studies (Kabiti *et al*., 2016; Negesse Senbeta, 2020;Ejeta and Masresha, 2020;Aman *et al*., 2014; Mazengia, 2016) conducted in different zone of Ethiopia on different crops than that of sorghum also showed that a lot of factors affect the commercialization of smallholder crop production. In many developing country promoting smallholder commercialization of cereal production is one way of agricultural transformation and development to benefit farmers from commercialization through participation in the market (MoFED, 2010). In Ethiopia, sorghum from cereal crops as reported by FAO (2013) accounts for 19% of the domestic cereal production and 20% of the total area under cereals. It is also widely grown in diverse climatic conditions and the major staple crop grown in the poorest and dry areas where other crops can survive least and food insecurity is widespread Fetene *et al*.(2010) and grows in various soil conditions Dillon *et al*.(2007) which plays a crucial role in improving household food security level and source of income.

Particularly in the proposed areas are mainly characterized as potential producers of cereals such as maize, barley, sorghum, Teff, etc. Despite sorghum production potential and importance of cereal crops for assuring food security status of the country as well as the study area smallholder farmers are producing sorghum mostly for subsistence and not for commercial purposes (Gebre *et al*., 2021). Due to this reason, they earn little economic benefit from their sorghum produce though the commercial transformation of this subsistence production is an essential corridor to achieve food security at the national and household level (Amsalu Mitiku, 2014).

Even though sorghum has great potential in the study area smallholder farmers face challenges to commercialize sorghum. Understanding the intensity of smallholder farmers sorghum commercialization and its contributing factors has significant policy implications to tackle the problem. Thus, there is dearth of information on the commercialization process and marketing behavior of small holders in Ethiopia. Despite their importance, most of the studies conducted on the determinants of smallholders' market participation have methodological gaps of only capturing the revealed marketing decisions of households while they ignored the volume of supply (Bedaso *et al*., 2012;Berhanu and Moti,2010;Haile and Gebre, 2022;Mazengia, 2018).

In addition to methodological gap pervious study on sorghum concentrated on factor affecting adoption of sorghum (Kinfe and Tesfaye, 2018;Mahdi,.*et al*., 2010;Silamana *et al*.,2019;Yoseph Wolebo *et al*.,2019) and genetic diversity of sorghum example by (Nagara, 2017;Enyew Muluken *et al*.,2022) and popularization of sorghum by large scale demonstration in study area by Solomon *et al*.,(2021). But adoption of improved sorghum seed by itself is mandatory to boost farmers' income and food security. Here, more study needs to fill this gap. Besides some empirical studies were conducted in the country and acknowledging and improving the gap as mentioned above date information on factors influencing the commercialization of producers in

the sorghum market in Ethiopia is lacking. Moreover, to the best of my knowledge, nothing has been done in the study area. Hence, this research is proposed to analyze determinants of smallholder market participation decisions and the current level of smallholder sorghum market participation and factors correlated with it in target sorghum producers in the study areas in order to fill the research gap.

1.3. Objective of the study

1.3.1. General objective

The general objective of this study was to analyze smallholder sorghum market participations and level of market participations in Arsi zone of Oromia regional state emphasizing on output side commercialization.

1.3.2. Specific objectives

The specific objectives were the following:

1. To assess smallholder farmers sorghum market participations level
2. To identify factors affecting smallholder farmers market participation decisions
3. To analyze factors influencing the level of smallholder sorghum market participations

1.4. Research questions

In this research study the following research questions were addressed

- What is the level of smallholder sorghum market participations in the study area?
- What are the factors affecting the smallholder sorghum producers' market participation decisions?
- What are factors influencing level of smallholder's sorghum market participations?

1.5. Significance of the study

The study identified and analyzed the level of smallholder market participations of sorghum and market participation decisions of sorghum-producing smallholders on smallholder farms. This information helps to understand the level and intensity of smallholder farmers in sorghum market participation of farmers at the household level. In addition, the study identified different factors affecting market participation and the intensity of sorghum in the study area. The factor identified for affecting sorghum-growing farmers is relevant for agricultural policymakers to design interventions that improve smallholder farmers participation in the sorghum supply at farm levels.

The finding will be helpful to tackle challenges for sorghum production and marketing and foster opportunities to improve production and productivity to empower smallholder farmers to commercialize sorghum. Generally, the identification of factor determining smallholder sorghum- growing farmers to the market participations is important for farmers, policymakers, and researchers to get enough information on the market participations level of farmers at household level and its determining factors to market participation, which in turn would help them to suitably modify the strategies.

1.6. Scope and limitation of the study

This study faced challenges in reaching more sorghum production areas/ zones and farmers due to time, finance, and other resource limitations. Hence, it is limited to only two districts (Gololcha and shenen kolu districts from the Arsi zone) of the Oromia Region. Accordingly, the study confines only to Gololcha and shenen kolu district from Arsi zone. The study focused only on identifying and analyzing the level of sorghum market participations and the determinants among smallholder farmers sorghum market participations.

1.7. Organization of the thesis

Here in after, the Thesis is organized into five major chapters. Chapter one presents the introduction part of the study, focusing mainly on the background, statement of the problem, objectives, significance, and scope of the study. Chapter two presents a literature review that deals with different literatures about theoretical concepts of stallholder's market participations, the process of stallholder's commercialization and its measurements, and previous theoretical and empirical studies related to determinants of stallholder's market participations. Chapter three deals with the methodology part of the study, data sources and type, sampling procedure, data analysis methods, model specification, and methods of data presentation. Chapter four discusses the descriptive and econometric analysis part of the study. Finally, Chapter five conclude the study and presents policy implications.

CHAPTER TWO: LITERATURE RIVIEW

2.1. Concepts and Definitions of Terminologies

Smallholder farmer: Different writer who define the concept of smallholder farming. There is no clear definition of small farms and smallholder farmers. Lipton (2005) defines smallholder family farms as "operated units in which most labor and enterprise come from the farm family, which puts much of its working time into farm. On the other side, the World Bank's Rural Strategy defines as those with a low asset base, operating less than two hectares of cropland (Csaki, 2001). The simplest and conventional meaning of a smallholder is the case when the land available for a farmer is very limited (Chamberlin, 2008).

However, the meaning goes beyond this conventional definition and consists of some general characteristics that small farms or smallholders generally exhibit (Chamberlin, 2008). has identified four themes on the basis of which smallholders can be differentiated from others. These themes include land holding size, wealth, market orientation, and level of vulnerability to risk. Accordingly, in this study is used to refer producer with limited resources i.e. Resource poor in terms, labor, capital that describes farming system subsistence-oriented and highly vulnerable to risk in the study area (Opondo *et al*., 2017).

Smallholder commercialization production: Commercialization as a concept is multi-dimensional and no one definition has been able to capture all its facets. The definitions differ in focus and breadth, which has also influenced its measurement. Agricultural commercialization is more than marketing agricultural outputs because commercialization can also occur on the input side with use of purchased inputs in agricultural production (von Braun *et al*., 1994).As defined

by Pingali and Rosegrant (1995) agricultural commercialization as “when household decisions on product choice and input use are made based on the principles of profit maximization”.

Other bodies of the wider literature broadly defined commercialization as having greater engagement with markets, either for inputs, outputs, or both by small family farms. For example, Govereh *et al.*(1999) defined agricultural commercialization as “the proportion of agricultural production that is marketed”. Agricultural commercialization aims to bring about a shift from production for solely domestic consumption to production dominantly market oriented.

2.2. Theoretical foundation of the study

The theoretical foundation of this study is based on within framework of agricultural household decision theory especially designed by Singh *et al*.(1986).Agricultural household decision theory allows the separation of households in to subsistence and market oriented based on commercialization level of households. The important feature of the model is that behavior of profit maximization for production, consumption and supply to market is determined differently due to price determination in the perfectly competitive markets. The key assumption of this model is the decision of farm household is based on the principle of utility maximization either in the form of net seller or net buyer. The main reason for the adoption of such methods is that market participation involved two-way decision; the decision to participate and the actual degree of participation.

Agricultural commercialization means change from subsistence type of production to market oriented on both sides, either on output side with increased output being marketed or input side with increased use of inputs with the aim of profit maximization it occurs (Abasiekong and Oluwatoyin, 2021).In this study output side commercialization is considered.

Various theories support commercialization. An integrated system of settlements composed of towns and cities of different sizes and functions serve not only their own populations but also the surrounding hinterlands by providing needed services and inputs for agricultural production promotion and by offering opportunities for marketing products (Hagget *et al*., 1977). This theory if reinforced by Johann Heinrich von Thunen classic model of land use. It is reported by Horvath that urban centers promote various kinds of agricultural land use in the vicinity (Horvath, 1967).

Other researchers such as Allan (2015) also emphasize on the role of infrastructure and market access in agricultural commercialization as they provide more opportunities for adoption of new technologies and enterprises. According to Pingali and Rosegrant (1995), the process of agricultural commercialization needs new technology, improved seeds, investment in infrastructure and polices aimed at market. In developing country these uncertainties make farmers vulnerable to various risks such as loss of income and assets. Hence, it is difficult for them to shift entirely towards commercialized agriculture (Rogers and Everett, 1995).

In the case of smallholder farmers, it is very difficult to cope with the risks due to limited availability of resources and assets. As uncertainty is an important factor in household decision making, it enters the utility function of the farm household as a preference for security in the face of several risks such as the loss of investment, low income and shortage of food. The decision maker generally seeks medium solution among the several objectives in a satisfactory way decision of smallholder farmer is based on his/her behavior which in turn is affected by several factors (Romero, 1993).

The characteristics of the farmer that affect include education, gender, assets needed for production, external environment such as biophysical condition policies. The decision of the farmer to commercialize is affected by a variety of factors which are inter related such as biophysical, socioeconomic, institutional and policy factors (Fountas *et al*., 2006).

This study is undertaken in the context of the study area, where smallholder farmers are confronted with numerous issues. The core model shows the profit maximizing behavior of farm household over the goods consumed which is produced in the farm or purchased from the markets, keeping in view the constraints. Thus, the mentioned factors provide condition and underlay that facilitate commercialization process and commercialization realize

2.2.1.Overview of Sorghum Production

Sorghum (*Sorghum bicolor (L.) Moench*) is classified under the family Poaceae (grass family), tribe andropogoneae, genus bicolor, species bicolor (Fetene *et al*., 2010). It the fifth most important staple food crop after wheat, rice, maize and barley (Mcguire, 2005). The world average annual yield for sorghum was 1.37 tonnes per hectare in 2010. Food Aid organization (FAO) reported the United States of America as the top sorghum producer with a harvest of 9.7 million tones followed by India, Nigeria, Sudan, and Ethiopia. The productivity of sorghum varies across the different parts of the world.

Sorghum (*Sorghum bicolor (L.) Moench*) grows in a wide range of agro ecologies most importantly in the drought-prone parts where other crops can least survive (Adugna, 2007). This makes sorghum preferable by farmers in drought-prone areas due to its tolerance to drought and harsh environments. It is one of the important indigenous food crops and is only second to tef as injera (leavened local flatbread) making cereal.

The presence of wild and cultivated sorghums in Ethiopia reveals that Ethiopia is the primary center of origin and center of diversity (Mekbib, 2008).In Ethiopia, sorghum is the third most important cereal crop after tef and maize in terms of area coverage and total production (CSA, 2018). It accounts for 18.53% of the total area allocated to cereals and it also accounts for 19.3% of the area covered by cereals. Likewise, sorghum is the dominant crop in the low land areas of southern Ethiopia.

2.2.2.Sorghum growing area in Ethiopia

Sorghum is one of the major staple crops grown in the poorest and most food insecure regions of Ethiopia. The crop is typically produced under adverse conditions such as low input use and marginal lands. It is well adapted to a wide range of precipitation and temperature levels and is produced from sea level to above 2000 m.a.s.l (Fetene et al.,2010). Its drought tolerance and adaptation attributes have made it the favorite crop in drier and marginal areas. Ethiopian is often regarded as the center of domestication of sorghum because of the greatest genetic diversity in the country for both cultivated and wild forms (Fetene *et al*.,2010).

2.2.3.Production status economic significance of Sorghum in Ethiopia

Cereals are the most important food crops in the overall grain crop, according to the CSA (2020) data, both in terms of planted area and production size. Because they are the primary staple crops, they are produced in greater quantities than other crops. Cereals are grown in varying quantities in all places. Generally, in Ethiopia around 81.19% (10,538,341.91) hectares) was under cereals. From those sorghum took up 12.94% (1,679,277.06 hectares) and of the grain crop area. As to production, the Cereals contributed 88.36% (about 302,054,260.58 quintals) of the grain production. Sorghum made up 13.22% (45,173,502.18 quintals) of the grain production. It

is primarily produced in Oromia, Amhara and Tigray region with their area coverage of 676,075.00 ha, 597,440.83 ha, and 232,636.49 ha respectively.

According to the CSA (2020) data, sorghum is the third most important food cereal in Ethiopia, after maize and tef, in terms of the total number of growers, area coverage, and grain production. It is typically used to make Injera, a local bread, as well as tela and areke, the two local beverages. Sorghum is also used as feed for animals, construction, and raw material for industries.

2.2.4. Process of agricultural commercialization

Smallholder commercialization is part of an agricultural transformation process in which individual farms shift from a highly subsistence-oriented production towards more specialized production targeting markets both for their input procurement and output supply. In a broader sense, one could also see smallholder commercialization as a pathway to the overall economy's structural transformation in which larger proportions of economic output and employment are generated by the non-agricultural sectors.

However, there is an ongoing debate about targeting the process of smallholder commercialization. One issue of debate is whether smallholder commercialization should aim at increasing the productivity and marketed surplus of staple food crops or, alternatively, to focus on a newly introduced high value crops. The second issue is, given the targeted commodity types for commercialization, whether to produce these commodities for domestic or export markets (Dolan and Humphrey, 2000).

On the other hand, different modes of production targeting high-value non-traditional commodities could help farm households generate more income per unit of resources used on the

farm but at a higher production and market risk. In the latter case, out-grower schemes or contract farming are usually considered major risk-sharing strategies and means to link smallholders to the export markets (Dolan and Humphrey, 2000).

According to Pingali *et al*.(2005) argued that, for many farmers, the transition from subsistence to commercial staple crop production is far more pertinent than a complete shift to specialized high-value commodities. Through time, as the level of smallholder commercial orientation increases, however, one observes mixed staple and cash crop production systems giving way to specialized production units for the production of high-value crop and livestock products (Pingali *et al*.,2005). A critical issue to be answered by smallholders specializing in high-value outputs is whether their size, be it land or other resources, can profitably support such activities in the long term (Lerman, 2004; Pingali *et al*., 2005).

In conclusion, smallholders can commercialize in staple food commodities, in non-traditional high-value cash commodities, or combine the two types of commodities depending on the agro ecological circumstances, levels of production and price risks, and market conditions. However, one can certainly argue that smallholders will move towards more specialization in the process of commercial transformation in the long run. The choice of targeting either domestic or export markets in the process of smallholder commercialization is basically linked to the nature of the targeted commodities.

In targeting the export market for the process of smallholder commercialization, the issue of product quality, sanitary and phytosanitary standards, timely and regular supply, and volume need to be given emphasis in enabling the small-scale farmers to be part of the game (Henson and Loader, 1999). Apart from the intercontinental export markets for high-value cash crops,

there is a considerable potential demand for staple commodities in the domestic and intraregional food markets of developing countries (Diao, Dorosh, *et al*.,2007).

2.2.5. Measuring the level of commercialization

Focusing on commercialization in its static form, various authors have used different yardsticks in measuring the level of agricultural commercialization at household level. According to Govereh *et al*.(1999), "commercialization can be measured along a continuum from zero (total subsistence-oriented production) to unity (100% production is sold)". As study by suggested Strasberg *et al*.(1999), a measurement index called household Commercialization Index (HCI) which is computed as the ratio of gross value of all crop sales over gross value of all crop production multiplied by hundred. The advantage of using this approach is that it "avoids the use of crude distinctions as commercialized and non-commercialized farms" (Govereh *et al*.,1999).

However, this index had its limitations. For instance, consider the case when a farmer producing one quintal of any cereal crop and sales that all and another farmer producing ten quintals of the same cereal crop and sales only two quintals. The HCI will tell us that the first farmer is fully commercialized (100%) while the second is semi-commercialized (20%). This interpretation does not make sense in such circumstances.

Even though this limitation of using HCI is wrong nothing, there is still some room to use it in practice especially in the context of developing countries where it is less likely to get smallholders selling all of their output and very large farms selling none of their farm output. As can be understood from the preceding discussion, the degree of participation in the output market is the conventional way to measure commercialization.

However, von Braun *et al*.(1994), provide other dimensions to the measurement of commercialization. Commercialization is calculated as percentage of the total produce sold from a household or as a percentage of cash crops as compared to all crops cultivated by household (Von Braun et al.,1994).Accordingly, von Braun *et al*.(1994) specified three types of commercialization indices at household level: output and input side commercialization, commercialization of the rural economy, and degree of a household's integration into the cash economy. However, in measuring household-specific level of commercialization, *(Govereh et al.,*1999) and (Nyoro *et al.*,1999) used a household commercialization index (HCI), which is a ratio of the gross value of all crop sales per household per year to the gross value of all crop production with the following ratios:

(1a) Commercialization of agriculture (output side) $= \frac{value\ of\ agricultural\ sales\ in\ the\ market}{Agricultural\ production\ value}$

(1b) Commercialization of agriculture (input side) $= \frac{\text{Value of inputs acquired from market}}{\text{Agricultural production value}}$

(2)Commercialization of rural economy $= \frac{\text{Value of goods and services acquired through market transactio}}{\text{Total Income}}$

(3) Degree of integration into the cash economy $= \frac{\text{Value of goods and services acquiredby cash transactions}}{\text{Total income}}$

(4) HCI $= \frac{\text{Total violume of crop sales(hhi year j)}}{\text{Total volume of all crop production(hh i year j)}} \times 100$

Recently, Hagos used four approaches to measure the level of household commercialization: sales-to-output and sales-to-income ratios, net and absolute market positions (either as a net buyer, net seller or self-sufficient household), and income diversification or level of specialization in agricultural production. This ratio is similar to what has been developed earlier by von Von Govereh *et al*.(1999) as the percentage of agricultural output sold to total

agricultural production. The total sales-to-income ratio is the ratio of the gross value of total sales to total income from crop production. In this index, income from crop production is assumed as a proxy to total household income, and off- and non-farm sources. The market position of a household is evaluated using the ratio of volume of sales and volume of purchases to the total volume of stock: the sum of storage from the previous production year and production in the current year. Accordingly, based on the review of previous study household commercialization index (HCI) was used to measure commercialization from the output side following studies by (Govereh *et al*.,1999).

2.2.6. Commercialization Drivers and opportunities in Ethiopia

According to the reviewed work of Zhou *et al*.(2013) factors which trigger smallholder commercialization can be classified in to five categories based on the nature of their impact.

Factors promoting demand growth: The population increase is significantly higher in the urban areas of Ethiopia. Likewise, Land O'Lakes (2010) reported that Ethiopia is amongst the fastest urbanizing nations in Africa, with urbanizing growth rates of 4.3 percent per year. This growth helps for smallholder commercialization to produce more for satisfying the need of the population.

Environmental changes pushing for renewed approaches: Ethiopia is a country of an agrarian economy characterized by high population growth, huge dependence on erratic rainfall, low agricultural productivity, land degradation, drought and flood, increasing trends in temperature and a decreasing trend in precipitation (Thijssen et al., 2008). Droughts and floods are very common occurrences with significant events every 3 – 5 years (World Bank, 2006). Because of changes in the patterns of the local climate, this region is exposed to chronic food shortages, degradation of natural resources, unstable livelihoods and distress migration (Alebachew, 2011).

Operating environment more conducive for productivity: Ethiopia is the land of promise with great potential and a comparative advantage in agriculture. The country is endowed with large and diverse plant, animal genetic resources and great yet mostly untapped irrigation potential and agricultural land and highly diverse agro-ecological zone that are suitable for the production of a wide varieties of crops and for keeping different species of animals (Awulachew *et al*.,2010).

Factors making operations more efficient: According to Ravallion *et al*.(2007) many of the poor in SSA and South Asia are living in rural areas and they are farmers. In response to this, for many years, the government of Ethiopia working with extension program diffuses agricultural technologies to improve smallholders' crop productivity and farmer's income from surplus crop production. For example, there is a major policy shifts in Ethiopia since 1992 which has a substantial emphasis on improving the productivity of smallholder agriculture through increased use of a package of improved agricultural technologies.

Factors making individuals more committed to commercial activities: With regard to this, the Federal Democratic Republic of Ethiopia has devised Agricultural Development Led Industrialization (ADLI) strategy that could bring real change in the county's economy. Farmers' Training Centers are one of the implementations approaches to promote the rural development as mentioned in the policy and strategy document. Currently, there are about 8,500 FTCs established at the Kebele level, with roughly 2,500 of these FTCs reported to be fully functional Davis et al.(2010). Stationed at each FTC are three Development Agents (DAs) responsible for providing advisory services on livestock, crop production, and natural resource management (Davis *et al*.,2010).

2.2.7. Enablers of smallholder commercialization in Ethiopia

Policies, public goods and services, subsidies and investment incentives are some of the critical enablers to facilitate or promote the success of commercialization. As stated by Sharp *et al*.(2008), the government has prioritized commercialization of farming as a policy agenda since 2005 and this priority is demonstrated by the central place in the second five-year (2005/06-2009/10) Poverty Reduction Strategy Paper (PRSP) called the Plan for Accelerated and Sustainable Development to End Poverty (PASDEP).

Moreover, the Ethiopia's Growth and Transformation Plan I (GTP I) (2010/11-2014/15) retained agricultural sector growth as the prime driver of economic growth. The sector's strategy was further informed by the Agriculture Growth Program (AGP) and lessons drawn from implementation of the past development plans. The agricultural strategy directed on placing major effort to support the intensification of marketable farm products both for domestic and export markets, and by small and large farmers. Similarly, under current GTP II (2015/16 – 2019/2020) the same plan is made to mobilize all possible efforts to ensure adequate agricultural input supply and strengthen agricultural extension services, so as to boast productivity and then commercialization.

2.2.8. Benefits of Agricultural Commercialization

The benefits of commercialization are multifaceted. As Von Braun and Kennedy. (1994) state that commercialization plays a significant role in increasing incomes and stimulating rural growth, through improving employment opportunities; increasing agricultural rural productivity; and Leavy et al.(2008), direct income benefit for employees and employers; expanding food supply and potentially improving nutritional status. According to Bernard *et al*.(2007), smallholder agricultural commercialization is significantly related with higher productivity,

greater specialization and higher incomes. Bernard *et al*. (2007) further stated that the aforementioned outcomes give way to improvement in food security, poverty reduction and economy-wide growth.

Several researchers indicate that the outcomes of commercialization depend on whether efficient markets exist or not. If efficient markets do exist, then commercialization leads to separation of production from consumption, supporting food diversity and overall stability at household level (Bernard *et al*., 2007).But if markets remain inefficient and transaction costs are high, smallholders fail to exploit the blessings of commercialization.

As Gebreselassie and Sharp.(2008) pointed out that agricultural commercialization is a bridge through which smallholder farmers are able to achieve welfare goals. They describe farm household welfare to represent consumption of basic food (grains), high value foods (livestock products), expenditure on clothes and shoes, durable goods, education and health care. They also note that greater engagement in output markets would result in higher agricultural productivity which is, in itself, an intermediate outcome rather than a welfare goal.

2.3. Review of Empirical Studies

2.3.1. Empirical studies on determinants of commercialization of Subsistence Agriculture

These determinants of commercializing are broadly categorized as external and internal factors. The external factors beyond the smallholder's control like Population growth and demographic change, Technologies, Institutions, Markets and their integration, Transaction costs and Policy aspects affecting prices and other driving forces (Pingali and Rosegrant, 1995). In addition, development of input and output markets, institutions like property rights and land tenure, market regulations, cultural and social factors affecting consumption preferences, production and

market opportunities and constraints, agro-climatic conditions, production and market related risks are other external factors that could affect the commercialization process (Pender, 2007).

There are a number of empirical studies on factors affecting the marketable supply of agricultural commodities. For instance, Kabiti *et al*.(2016) examined the determinants of Agricultural Commercialization among Smallholder Farmers in Munyati Resettlement Area, Chikomba District, Zimbabwe using the Tobit model. Their findings indicated that that agricultural commercialization is determined by household size, irrigation availability, the farming experience of the household head, and nonfarm income.

On the other hand, Abu *et al*.(2014) analyzed determinants of smallholder farmers' maize commercialization in the Upper West region of Ghana using the Tobit model. Their result mentioned that the age of the household head, gender, household size, annual household income, access to market information, and off-farm income are major and significant variables to explain maize commercialization. Likewise, Stephen *et al*.(2017) also investigated factors influencing bean commercialization in Rwanda using the double hurdle model. The model results show that the age of the household head, market information, number of crops a household cultivates, and market distance influenced the level of bean commercialization. Also study by Martey *et al*.(2012),commercialization of smallholder agriculture in Ghana using a Tobit regression analysis. The model results observe, inter alia, that output price, farm size, households with access to extension services, distance to market and market information determine the extent of commercialization.

Moreover, Bekele and Alemu (2015) studied factors affecting the commercialization of smallholder farmers in the moisture-stress haricot bean-based farming systems of central Ethiopia. Their result indicated that family size, land size, age, livestock holding and dependency

ratio are the key determinants of crop commercialization. Similarly, the result by Tadele *et al*. (2017) indicated that the educational level of household head, livestock ownership, and credit access affect wheat commercialization positively and significantly, while the distance to the market and household size affect the commercialization of farmers negatively.

As Endalew *et al*.(2020) analyzed determinants of wheat commercialization among smallholder farmers in Debre Elias Woreda, Ethiopia by employing the beta regression model. Accordingly, the study found that educational status, number of oxen, land size allocated to wheat production, farming experience in wheat production, extension service, and market distance are major factors for smallholder farmer's wheat commercialization. Accordingly the study by Seyoum *et al*.(2011) on factors determining the degree of commercialization of smallholder agriculture in Kombolcha District, East Hararghe, Ethiopia using robust OLS model. The OLS results indicated that farm size allocated to potato, access to irrigation and access to market information were found to be significant in affecting extent of market participation (degree of commercialization) at 1 % probability level.

A study by Aman *et al*. (2014) on determinants of smallholder commercialization of horticultural crops in Gemechis District, West Hararghe Zone, Ethiopia also employing a double hurdle model. In first hurdle, the result of Probit Regression Model revealed that, gender, distance to the nearest market, and cultivated land played a significant role in smallholder commercialization decision. In the second hurdle, the result of truncated regression model revealed that, household education, household size, access to irrigation, cultivated land, livestock, and distance to the nearest market were the key determinants of the level of commercialization.

Belay *et al*.(2021) in their study of determinants of smallholder commercialization of livestock case study from Tigray, Ethiopia using econometric models of both concise and Heckman two-

step collections found that in the decision to sell, household head education level, family size, distance from the nearest market center, and the total livestock ownership played a significant role. Heckman second-step selection estimation indicated that the education level of the household head, the extension agents' visit, the total livestock owned and the owned land size significantly affected the level of commercialization measures.

Negesse Senbeta (2020) study on factors affecting level of potato commercialization in Kofale District, West Arsi Zone, Oromia Regional State, Ethiopia using truncated model. The results showed that Education status, land allocated for Potato production and Access to market information influenced level of potato commercialization positively and significantly. Moreover, Ejeta and Masresha (2020) study conducted on determinants of red bean commercialization by smallholder farmers in Shalla Districts, Oromia Regional State, Ethiopia by applying Heckman's two step sample selection model. The first-stage probit model estimation results revealed that age of household head, years of schooling, membership cooperative, family size, off-farm activities and active labor affected probability of market participation. Second-stage Heckman selection estimation indicated that age of household head, family size, farm size and years of schooling significantly determined volume of red bean supply.

2.4. Conceptual Frame Work of the Study

A conceptual framework is a structure linked with the concepts, empirical research, and important theories used in promoting and systemizing the knowledge espoused by the researcher (Peshkin, 2015). Also it is the researcher's explanation of how the research problem would be explored. According to Pender and Alemu (2007), it is explained that different internal and external factors influence commercialization by changing the conditions of demand and supply for commodities, including input-output prices, transaction costs, and risk that farmers, traders,

and others in the agricultural production and marketing system have to cope with. Accordingly, for this research study conceptual framework and its explanatory variables were hypothesized on sorghum commercialization based on the information extracted from the literature review of previous works.

Accordingly, here below based on the review of the previous studies which determine the smallholder sorghum market participations are presented in figure 1 below. Those interrelated factors are demographic, production input socio-economic factor, institutional, infrastructure, and market factors.

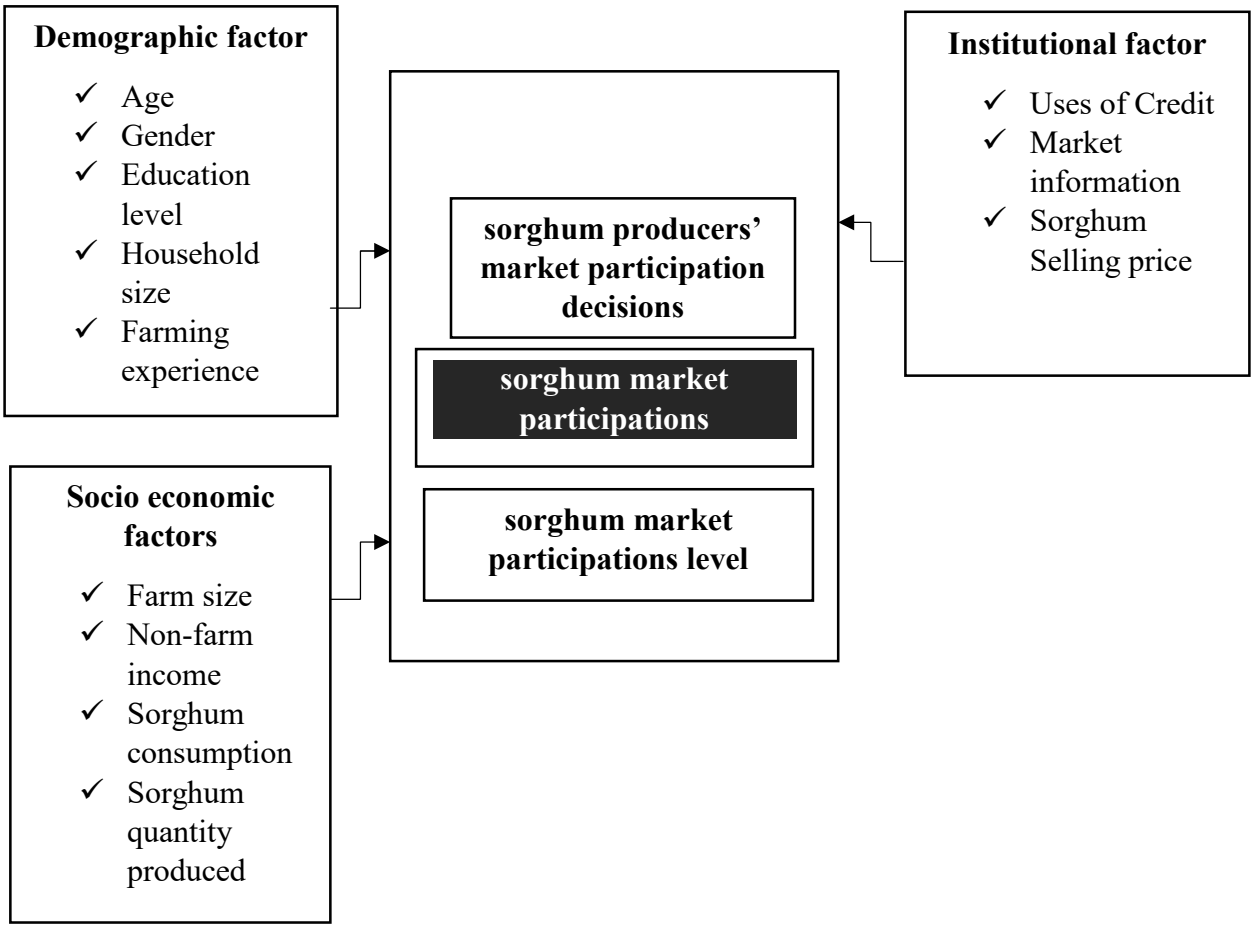

Figure 1: Conceptual Framework of the study

Source: Own, based on literature review, 2021/22

CHAPTER THREE: RESEARCH METHODOLOGY

3.1. Description of the Study Area

The study area Gololcha and Shene Kolu Districts is located in the Arsi Zone Oromia regional state of Ethiopia. The zone is found in the central part of the Oromia National Regional State. The Arsi zone astronomically lies between 60 45' N to 58'N and 38 32 E to 4050' E. It shares borderlines with the Regional State of Nations, Nationalities, and People of Southern Ethiopia, and also shares borderlines with East Shewa, Bale, and West Hararghe Zones. Accordingly, the Zone has the longest borderline of 450km with East Shewa Zone accounting for about 43 percent of its total boundary length. This Zone has the second longest line (350km) with Bale Zone. The Zone shares the least borderline (43km) with the Regional States of Nations, Nationalities and People of Southern Ethiopia. Asela is the capital town of the zone. Arsi Zone is located at 175 km from Finfinne on Finfinne-Adama-Bale Robe main road. Also Asela is located at 75 km south of Adama town (Abdi, 2017).

A brief description of study districts goes as follows. Shenen Kolu district is one of the districts among 26 districts which are found in Arsi zone Oromia regional state, Ethiopia. The district is located at about 316 km from Addis Ababa, the capital city of Ethiopia and 241 km from Asella, which is the capital town of Arsi zone. The district is situated at northeast of Aseko and Anchar, Seru district in the south, Daro Lebu district in the east and Gololcha district in the west. The altitude of the district ranges from 1400 to 2000 metres. Generally, the district has a total area of 112,101 hectares and is classified into three agro-ecologies, highland (2%) the midland (28%) and the lowland (70%). The average temperature of the district is 32 °C and the average rainfall is 800 mm/year. The districts main rainy season is in April, May, June, July, August and

September. The soil type of the district is clay soil and sandy soil. Major crops produced in the district are coffee, maize, sorghum, teff and groundnut (SKWoA, 2022).

The second study area (Gololcha district) is bordered by Aseko district in the north, Amigna district in the south, Shenan Kolu district in the east and Chole district in the west. Also the altitude of the district is ranging from 1400 and 2500 meters above sea level. The district has a total area of 178,102 hectares and is classified into two agro-ecologies, the midland and the lowland with a share of 25% and 75% respectively. Gololcha districts average temperature is 35˚C and the average rainfall is 900 mm/year. The main rainy season of the district is in April, May, June, July, August and September. The soil type of the district is silt and sandy soil. Major crops produced in the district include Coffee, Maize, Sorghum, Teff and Groundnut (GWoA, 2022).location of the study area is shown in figure 2.

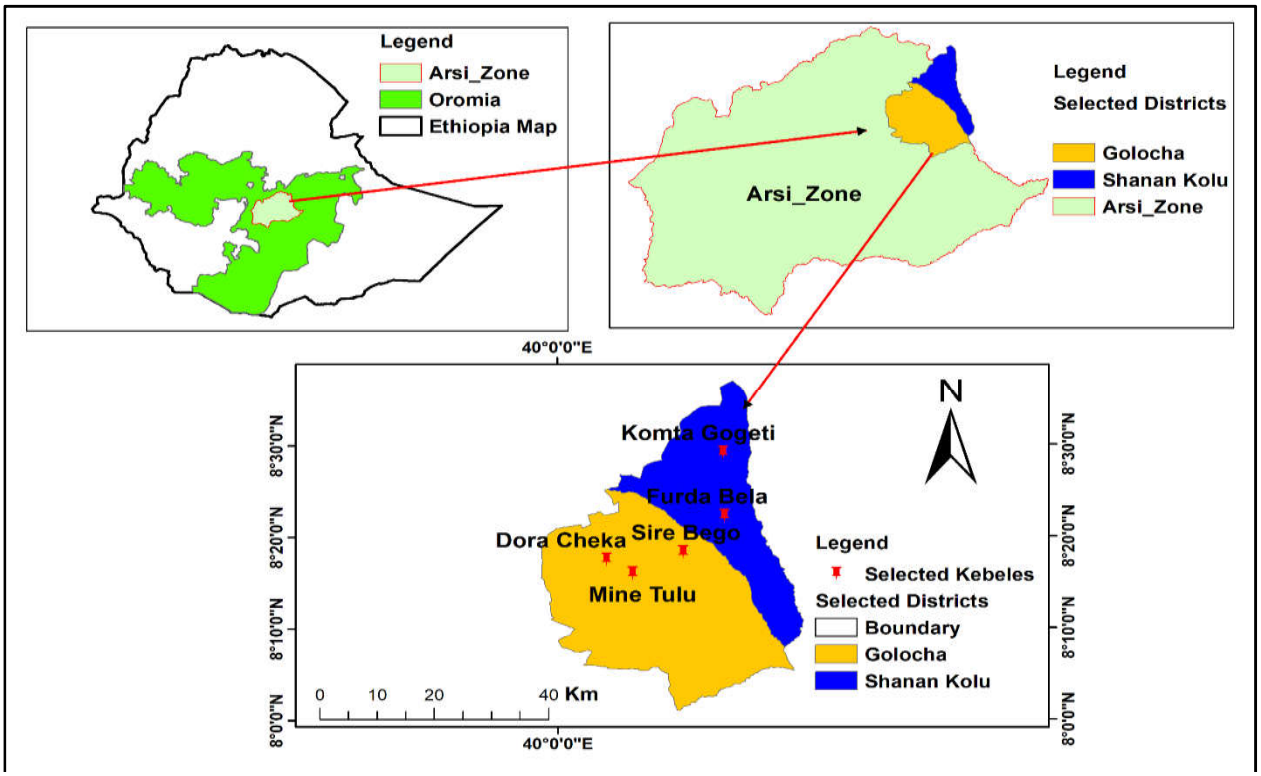

Figure 2.Geographic Map of study area

Source: GIS shape file of Ethiopian administrate map

3.2. Research Design

This research study is designed to analyze the determinants of smallholder sorghum market participations in the Arsi zone, Oromia regional states only at the time of the investigation. A cross-sectional research design, with quantitative and qualitative data components, was used in for this study. Because cross-sectional research design generally entails the collection of data at and concerning one point in time; it is also relatively inexpensive and takes little time to conduct data collection for research works. Therefore, this study employed a cross-sectional research design to collect data at a single point in time from a sample selected to represent the total population of the study area.

3.2.1 Sampling Technique and Procedures

Smallholder sorghum producers are the target population for this study. To draw a representative samples the research study has followed a purposive and three-stage random sampling technique to select the study area and representative sample households. In the first stage, Gololcha and Shene kolu districts were selected by using purposive sampling based on the potential of sorghum production and accessibility to the market among Arsi zone districts. In the second stage, three kebeles from Gololcha district and two kebeles from Shene Kolu district were selected purposively. Accordingly, Mine Tulu, Mine Adaye ,and Sire Bego kebeles were selected from Gololcha District while Furda Bela and Komtu Gogeti kebeles from Shenen Kolu district randomly were selected in collaboration with the Districts Agricultural Office.

From the selected kebeles, sorghum producer farm households were identified in collaboration with development agents. In the third stage, a total of 130 sorghum producer farm households during the 2021/22 production year were selected randomly from the selected sample kebeles by using a simple random sampling technique (SRS). Finally, the ultimate a sample size in each

kebele was determined probability proportional to the Size (PPS) of the identified sorghum producer households using sample frame from Districts Agricultural Office.

3.2.2. Sample Size Determination

A more population size results in more representativeness of the sample. Several factors limit the sample size of the study. According to Lenth (2001), constraints like resources, logistics, budget, and time limit the sample size of the study. Thus, taking an optimum and representative sample size is important for the inference of the population. There are several approaches to determine the sample size, out of them the one by Yamanes (1967) was used. Several authors used this sample size determination approach for instance (Haile *et al.*, 2018) and (Ahmed *et al*., 2016) used this sample size determination formula. The sample size for the study was determined based on the following Yamanes formula:

$$n = \frac{N}{1+N(e)2} = 129.54$$

Where; Where: n = is the desired sampled size, N = is the total population(N=) and e = is the desired level of precision(0.09) as suggested by (Haile et al., 2018) to get desired minimum sample size of households at 91% level of significance(confidence level) with the variability of 9%. Finally, a total of 130 sample households were selected for interview using probability proportional to size from each kebeles as presented in Table 1 below.

Table 1.Sample size determination of smallholder sorghum farmers

District	Sample Kebele	Total sorghum producing households	Number of sampled households	Proportion of sampled households (%)
Gololcha	Mine Tulu	987	23	18
	MineAdaye	1200	29	22
	Sire Bego	1019	24	18
Shenen Kolu	Furda Bela	1935	31	24
	KomtuGogt	1444	23	18
	Total	6583	130	100

Source: column 3 from agricultural office districts, (2021/22) and column 4 and 5, Authors own computation from the data.

3.3. Data Types and Sources

In this study, both qualitative and quantitative data were collected from different primary and secondary data sources to identify the important variables that affect market participations decisions and the level of market participations of sorghum crops. Primary data were the major data because it involves a larger number of respondents that were collected from primary sources. The sources of primary data of this study were collected mainly from household heads (130 sampled household heads) and focused group discussants. Primary data was collected through household surveys using structured interview schedules and Focus group discussions (FGDs) for both qualitative and quantitative data.

The data collected from sample households mainly focused on all institutional, demographic, socioeconomic, and production systems, the quantity of sorghum produced, the quantity of sorghum consumed and supplied to the market, market information, credit and extension access, non-farm income, input, and production constraints and other necessary information. Published and unpublished data including reports and kebeles records that are readily available in the study area were reviewed. Secondary data that are relevant to this study were collected from offices,

libraries, websites, books, journal articles, the district office of agriculture, and the central statistical authority (CSA).

3.4. Methods of Data Collection

For the conduct of this study, different data collection methods were used. The study was carried out using cross- sectional data taking the unit of analysis as smallholder sorghum producers. To collect primary data from the sampled household structured questionnaire for a face-face personal interview to collect data on household's demographic, socio-economic and institutional characteristics and smallholder market participations. To develop draft survey questionnaire checklists were prepared to conduct key informant interviews at Mine Tulu kebeles from Gololcha district for betterment incorporation of parameters to be included in the questionnaire. Then, the draft questionnaire was prepared.

Moreover, a pretest survey was conducted in Furda Bela kebeles of Shenen Kolu districts on six randomly selected households to test data collection instruments, assess the clarity of the questions for respondents, and revise the questionnaire accordingly. Accordingly, both open and close-ended questions in line with the objective of the study were included in the questionnaire. Then after, the survey questionnaire was tailored to the local conditions. Finally, three well-trained enumerators who have good experience in the household survey and are familiar with the culture and language (Afan Oromo) of the local communities were employed to gather the data required for this study. Then the primary data were collected from sample households of a representative random sample of household heads in selected kebeles by clearly explaining the objective of the survey for households. Moreover, focus group discussions and participant observation were employed to fill the gap observed during the structured interview schedule of the data collection method.

Accordingly, in addition to the structured questionnaire, three FGDs stratified into male-headed farmers, female-headed farmers' and youth-based were conducted in each Gololcha and Shenen Kolu districts. Finally, a total of six FGDs were carried out to collect primary qualitative data. For giving all participants enough time, the opportunity to share ideas, and easy management of the FGD the size of the FGD ranges from six to thirteen. The participants were farmers from male- headed FGD, Female-headed FGD, and Youth FGD from each district that are not included in the individual field interview.

3.5. Methods of Data Analysis

Suitable methods of data analysis were employed to analyze both qualitative and quantitative data collected through data collection methods. The data collected for achieving all objectives in the study were analyzed using appropriate statistical software, both SPSS (version 20) and STATA (version 15) software. After the required data collection was made with the appropriate method then data coding., entry, and cleaning by box plot were carried out using the software. Descriptive statistics, inferential statistics with appropriate statistical tests, and econometric models were used to analyze the quantitative data collected for the study. Likert scale ranking, narration, and interpretation were used to give meaningful information for ordinal qualitative data collected.

3.5.1. Descriptive Statistics

Descriptive statistics included the mean, minimum, maximum, percentages tabular presentation, figures, and standard deviation. Data on household demographic, socio-economic, and institutional characteristics that were collected through a structured questionnaire were summarized using descriptive statistics. The perceived input production and institutional challenges in smallholders' commercialization were measured using a Likert scale. Additionally,

inferential statistical methods tests like T-test for continuous and chi-square tests for discrete (dummy) explanatory variables were used to reveal, and to test the existence of any statistically verifiable differences among farmers participating in sorghum crop commercialization and their counterfactuals.

Moreover, the household commercialization index was used to measure both household and crop-specific level of sorghum market participations to answer the primary objective of this study. Following, Govere *et al*.(1999), the household commercialization index can be defined as the ratio of the volume of crops sold to the volume of crops produced by households multiplied by 100. Several authors adopted this definition and used it to calculate the commercialization index of different crops Among several authors (Berhanu and Moti,2010; Hichaambwa and Jayne, 2012;Mutabazi *et al*., 2013) are exemplary. Mathematically, it could be expressed as:

$$HC_{Ii} = \frac{Total\ volume\ sorghum\ \ sold\ by\ household\ i\ in\ i\ year}{Total\ volume\ of\ sorghum\ crops\ produced\ by\ household\ i\ in\ i\ year} \times 100\%$$

Where: i sold and i produced are the volume of sorghum sold and produced i^{th} farmer respectively. HCI_i=commercialization index of i^{th} farmer. The indices value of 0% and 100% indicate that the smallholder farmers are fully subsistence-oriented and highly commercial oriented respectively (Govereh *et al.*,1999).

3.5.2. Econometric Models

Descriptive and inferential statistics often fail to predict the combined effect of the explanatory variables on the dependent variable (Kmenta et al.,1988). Thus, this gap was bridged by selecting and running appropriate econometric models for inferential statistic purposes, for achieving the objective of this study analyzing determinants of smallholder sorghum market participations in the study area.

3.5.2.1. Econometric Model Specification of the Functional Form

The econometric model was used to identify factors that were hypothesized as determinants of smallholder sorghum farmers decision on whether or not to participate in the sorghum output market and the level of market participation. Different limited models having their positive and negative parts such as restrictive Tobit, double hurdle model, and Heckman two-stage selection model have been used to study crop market participation and level of participation. But the model specification mainly depends on the purpose of the study, the type of data available, and the underlying assumption of the model. For this study, dependent variables are market participation decisions and the level of market participation or proxy to the household's market participation index (HCI).

Since the factors affecting participation decisions and sales volume decisions in the output market were different and these two-decision were made differently first market participation was followed by a volume of sales decision choosing limited Tobit, Heckman sample selection, and double hurdle model was compulsory. As a result, factors affecting market participation decisions and level of participation become different, and in literature limited Tobit, Heckman selection, and double hurdle models are commonly used one such like decisions. Even after large production of farm products, smallholder farmers do not participate in the output market due to market price, low production, home consumption ,and other natural disasters.

The Tobit model was proposed by James James Tobin (1958). It assumes the factors explaining the decision to participate in the output market and the level of market participations have the same effect on these two decisions. Also, it cannot handle the situation in which participation decision to output market and level of market participations may be separate decisions, possibly influenced by different variables or by the same but in a different way.

This Tobit model is suitable for circumstances where the explanatory variables are fully observed for all sampling units but the response variable is incompletely observed due to censoring. Although Tobit has been extensively used to describe censored data, its application to data defined on the unit interval is not easy to justify. Because firstly, sample observations at the boundaries of a fractional variable are a natural consequence of individual choices and not of any type of censoring. Secondly, while the Tobit model assumes homoscedasticity in the latent model, the conditional variance of the fractional variable must be a function of the conditional mean since the former must change as the latter approaches either boundary (Ramalho E and Ramalho J,2009). Therefore, cannot suit such kinds of decisions and not be used in this study because recent empirical studies have shown its inadequacies stressing the relevance of alternative approaches.

In such cases, double hurdle and Heckman two stages models handle these two kinds of decisions. These two models are similar considering assuming that these two decision outcomes can be determined by different explanatory variables. The contradiction between these two models is double hurdle model assumes that zero values can be reported in both participation decision and level of market participations stages; the zero reported in this the first and second stages are arising from non-participation and non-sales respectively due to the respondents optimal decisions (Cragg, 1971).But in the Heckman sample selection model, however, there is no zero observation in the second stage once the first stage selection is passed so only non-participant respondents can report a zero level of market participations (Heckman, 1979).

In this research study, however, there are no respondents who made the decisions to participate in the market, but they did not sell and reported zero value means those who made decision to market participation supplied sorghum crops to the output market. In addition to this Heckman,

the two-step statical sample selection model offers means of correcting sample selection bias because of non-random selection process. Moreover, the model was carried and the result indicated a significant value of inverse mill ratio (lambda) conditional probability of the household's decision to participate which indicates selectivity bias in the sample when observation is selected in a process that is independent of the outcome interest.

However, because supply to the market is only observed for a subset of the sample population there exists a sample selection problem. This missing observation would cause incidental truncation (Greene, 2000). To address the selectivity bias, the study adopts Hackman two-stage model. From a review of the empirical literature different researchers used this model to determine factors affecting crop market participation decision and level of market participations. Among many studies by Tariku Ayele and Daka (2018),for analysis of market decisions and intensity of market participation of smallholder wheat farmers, a study by Kassa *et al*. (2017) to analyze determinants of smallholder market participation among banana growers in bench Maji Zone, Southwest Ethiopia, and study by Belay *et al*.(2021) for analysis of determinants of smallholder commercialization of livestock used Heckman two-stages model. Therefore, in this study Heckman sample selection model was chosen over the double hurdle model to analyze the sorghum market participation decision and level of market participations measured by kilograms.

In the first stage, sorghum farmers make a discrete decision about whether to participate or not in sorghum market. In the second stage, conditional on their participation decision in the sorghum market, farmers make continuous decisions on the level of market participation. Heckman's selectivity model consists of two steps. In the first, a selection equation is estimated using a probit model. This model predicts the probability that an individual household participates or does not in the sorghum output market, and the inverse Mills ratio is obtained

from this model. Then the second stage is estimated using the ordinary least square (OLS) regression equation by including the inverse Mills ratio (λ) from the first model as a regressor and produces consistent estimates, by eliminating selectivity bias (Greene, 2000).

With the above conditions, the binary probit model (first stage of the Heckman model) was used to identify factors that influence households' sorghum market participation decisions. The dependent variable (sorghum market participation) in this model has a value, of 1 if the households participate in the sorghum market; 0 if otherwise. The probit model is built on a latent variable with the following formula (Wooldridge, 2002):

$$Yi* = \beta iXi + ui \; Y = 1 \text{ if } Yi* > 0, Y = 0 \; if \; Yi* \leq 0$$

Where: Yi ∗= is a latent variable representing farmers discrete decision whether to participate in the sorghum market or not; Xi= is the explanatory variable hypothesized to affect farmers decision to participate in the sorghum market, βi= is a vector of parameters to be estimated which measure the effect of explanatory variables on household decision to participate in sorghum market. ui = is normally distributed disturbance term which captures all unmeasured variables that affect sorghum market participation decision of sample households. Y = is a dependent variable that takes the value of 1 if the farmers participate in the sorghum market and 0, if otherwise.

Since the probit parameter estimate does not show how much particular variable increases or decreases the likelihood of participating in the sorghum market, the average marginal effect of independent variables on the probability of a household to participating in the sorghum market was considered. Inverse mills ratio was estimated from probit (Frist stage of Heckman selection

model) and included in the second stage (OLS) an additional independent variable to estimate the parameters that determine the level of sorghum market participations consistently.

The inverse mills ratio was estimated as follows:

$$(\lambda i) = \phi\,(Zi)\ 1 - \Phi\,(Zi) = \phi(Zi)\ \Phi(-Zi)\ Zi = Xi\beta\ (\delta e)1/2.$$

Where: λi is the inverse Mills ratio; ϕ denotes the standards normal probability density function. Φ denotes the standard cumulative distribution function; β is a vector of regression parameters for variable X, and δe is the standard deviation of the error term which does not correlate with ui, vi ,and other independent variables. The Heckman second stage (OLS) model for observed volume sorghum sold is given by: $Y = \beta o + \beta 1x1i + \beta 2x2i + \beta 3x3i + \beta nxni + \mu\lambda i +$ vi Where: Y= represents the level of sorghum commercialization; X= represents the factors that affect the volume of sorghum crop sales; ßo and ß1-k are estimated parameters; μ= is a parameter that shows the impact of participation on the quantity sold, λ= an inverse mills ratio; vi= the error term.

3.6. Variable Definition, Measurement and working Hypothesis

To analyze determinants of smallholder sorghum market participations, exploring which factors significantly influence and how these factors are related to the dependent variables is required. Hence, the following dependent and independent variables were defined and hypothesized for this study in table 1. The hypothesis is made in line with the independent variables regressed in Heckman's two-stage selection model.

3.6.1. Dependent Variables

Households market participation decision and level of market participations proxy to households commercialization index (HCI), were dependent variables for this study and described as:

Market Participation Decision: The dependent variable for the first-stage probit Heckman two stages selection model has dichotomous nature, taking the value of 1 if the household supplied output of sorghum to market during the 2021/22 production year and the value of 0 if not supplied.

Level of market participations (HCI): It is a continuous dependent variable, which is measured as the ratio of the total volume of sorghum sales to the total volume of sorghum produced by the household in 2021/22 production year, expressed in percentage for the second stages Heckman estimation of OLS regression model.

3.6.2. Independent (explanatory) Variables and Hypothesis

Market participations related literature provides a list of factors that may determine smallholder market participations in the agricultural farming system. Households' decision to supply their output to the market and level of market participations in a given period of time is determined by a combined effect of various factors in which farmers operate. The independent variables used in this study are selected based on the previous study on determinants of crop market participations, theoretical explanation about commercialization, and the experience of the farming system of the study areas. Accordingly, the following independent variables were explained and hypothesized. The definition and explanation of the variables are presented below

Gender of the household head: This is a dummy independent variable indicating the gender of the household head. It was represented by 1 for male households and 0, otherwise. Gender difference is found to be one of the factors determining households' level of market participations and market participation decisions because of being male and female. Accordingly, male-headed households have better access to information that would provide them with a better ability to manage their farms and produce more output for the market as compared

to female-headed households (Taye *et al*., 2018).Accordingly to a study by Gebre *et al*.(2021) female-headed households are exposed to resource constraints that limit their agricultural production. Similarly, in the present study, gender of the household head is expected to affect the volume of sorghum sold and market participation decision positively.

Age of household head: Age is a continuous variable measured in a number of years and is one of the factors that affect households' market participations decisions and level of market participations in one of several ways. For the direction of influence, there are always mixed results from empirical analysis. That older households are believed to be wise in resource allocation, and risk management and have more contact which allows trading partners be find out at lower cost than younger households due to the experience they developed (Ejeta and Masresha, 2020).on the other hand younger households are generally more likely to participate in selling and market participation than their older counterparts. Because they may have more schooling than older farmers and have been exposed to new ideas and information (Abafita *et al*., 2016).Hence, the age of the household head may have a positive or negative effect on market participation decisions and the level of market participations.

Education level of the household head: Is a continuous variable measured based on formal years of schooling attended by the households. This variable reflects the ability of farmers to retrieve and interpret information. A study by von Broun *et al*.,(2017) revealed the key role of education to promote the commercialization of agriculture. Literate or households with higher grade education are expected to have better skills and better access to information and the ability to process information. Education increases the ability of farmers to gather and analyze relevant market information which would improve the managerial ability of the farmers in terms of better formulation and execution of farm plans and acquiring better information to improve their

marketing performance (Aman *et al*., 2014). Therefore, it is expected to be positively associated with the decision to market participation and level of market participations.

Household family size: It is a continuous explanatory variable that refers to the total number of people who lead their life in households without considering blood tidiness relationships or not. A study by, Samuel indicated that Keeping other factors constant, farmers participating in output markets follow more labor-intensive farming since, employing higher man-days per hectare is expected to affect both crop production and output markets participation. Similarly, a study by Alene *et al*. (2008) found a larger family of size provides cheaper labor and produces more output in absolute terms which in turn increases the quantity of output to be sold. However, the larger household size consumes more output of production, has a lower marketed surplus and less is available for sale (Efa *et al*., 2016).Therefore, household family size is hypothesized to have a positive or negative effect on market participation decisions and level of market participations.

Farm size: It is a continuous variable measured in hectares, cultivated farm size including self-owned, land rented in, and shared in and share-out . This factor is considered a critical production factor that determines sorghum production and the amount of sorghum harvested. land size cultivated hectare of land from self-owned, rented-in, or shared-in land has a positive significant outcome on being transition and commercial farmer and the larger area allocated to production increases the number of products available for sale (Efa *et al*., 2021). In addition to this, farm size is a critical production asset having a direct bearing on the production of surplus due to economies of scale if an additional plot of land of the household allocated for crops would increase the value of output sold (Aman *et al*., 2014) Therefore, it is hypothesized positively to affect sorghum market participation decision and level of market participations.

Farming experiences: It is a continuous variable measured in years of farming production and activities. It is expected that farmers who have adequate farm experience are more likely to be market participant than less experienced farmers. Smallholder farmers with longer farming experiences in agricultural production are supposed to have more knowledge and skill in intensive production. Moreover, they were expected to have better competence in assessing the characteristics and potential benefits of agricultural farming. The finding of Martey *et al*.(2012), reported farming experience positively affects the degree of commercialization. Because experienced farmers could have more trading partners' and this helps them to discover market information a lower cost. Hence, farming experience in this study was hypothesized to influence market participation decisions and level of market participations positively.

Use of credit: It is a dummy variable that takes a value of 1 if households have access to credit and 0, otherwise. Farmers who have access to credit may overcome their financial constraints and at the same time buy inputs. Those households who received farm credit have the possibility to invest in farming activities, which is an important component in small farm development programs (Mohammed Nasir *et al*., 2017). Accordingly, credit plays an important role in solving cash constraints needed in wheat production used to purchase inputs such as fertilizer, improved seed, and crop protection chemicals that are used to enhance wheat production and productivity which in turn has a positive effect on marketable surplus (Tadele *et al*., 2017). Therefore, this variable was hypothesized to influence market participation decisions and the level of market participations positively.

Access to market information: It's a dummy variable that takes values 1 if the household accessed market information and 0 otherwise. Farmers market decisions are based on market price information, poorly integrated markets may convey inaccurate price information, and

leading to inefficient product supply. Market information has a vital role in linking famers and buyers to the market. Farmers chose what best suited their position on market information from a scale of 'very satisfied' to 'not satisfied' about market information (Alene *et al*., 2008). A study by Abu *et al*. (2014),advanced that more information on marketing helps households to reduce transaction costs. Hence, access to market information by households is hypothesized to affect market participation decision's and level of market participations positively.

Non-farm income: It is a continuous variable measured as the household total income earned from wage employment, self-employment activities, and remittances in Ethiopian Birr. Income from non-farm activities is expected to supply the cash requirement of the households. A finding of wassihun *et al*. (2020) found that farmers who have extra income from non-farm income activities have more chance to commercialize than their counterparts. Therefore, it is expected that non-farm income is hypothesized that positively influence market participation decisions and the level of market participations.

Annual sorghum production: It is an economic factor and continuous variable that can determine the household level of sorghum marketed surplus and participation decisions and measured in quintals. Smallholder farmers who produce higher volume of sorghum for the whole year can participate in the market. Thus, this variable was expected to have a positive contribution to smallholder marketable participation and the level of commercialization of households. A study by Gebreselassie and Sharp (2008) found the volume of the total harvest was positively affect farmers market participation decisions and the level of household commercialization. Similarly, households those with relatively a large quantities of produce had a marketable surplus and with low output tended to have larger percentage of produce retained for household consumption (Stephen *et al*., 2017). Therefore, the volume of annual sorghum

production by households was hypothesized to affected positively both market participation decisions and the level of market participations.

Sorghum consumption: It was a continuous variable measured in kilograms. Households having large family size is negatively influenced household market participation decisions and the level of commercialization, since larger family sizes could potentially absorb a significant portion of the produce-to-home consumption (Mohammed *et al*., 2016). This is because households can participate in the market after satisfying their needs through consumption. Similarly, a study by Sendeku (2005) found consumption negatively and significantly affects rice supply when consumption has increased the rice quantity sold decreases. Therefore, the volume of sorghum consumption by households was hypothesized to affect negatively both market participation decisions and the level of market participations.

Sorghum market price: It was a continuous variable measured in monetary value in Ethiopian birr per quintal in 2021/22 production year . A household that have a high the production of sorghum can supply more to the market than a producer who had fewer yields. Households who receive high price of production are tied to market orientation strongly and positively influence both the probability of market participation (whether to sell or not) as well as the level of participation (quantity of sale) (Abafita *et al*., 2016). This is because the implication is that households who received higher market price are more likely to have a surplus volumes of production and sell more.

Accordingly, the higher price of produce, the volume of production and amount sold are positively related and production increases the level of commercialization index proxy to the level of market participations (Tadele *et al*., 2017). consequently, the price of sorghum sold by households was hypothesized to affect positively both market participation decisions and the

level of market participations. The following are a host of explanatory variables that are potentially expected to explain the variation in the dependent variables, households market participation decisions and the level of market participations (Table 2).

Table 2.Definition, Measurement and expected sign of the explanatory variables

Variable name	Definition of variables	Measurements	Expected sign
Dependent variables			
level of sorghum market participations	Ratio of sorghum sales to total sorghum produced in 2021/22 production year		
Market participation decision	If households sell sorghum its represented by 1,0 otherwise	1 if yes,0 otherwise	
Independent variables			
Age	Age of household head	Number of years	+/-ve
Gender	Gender of the household head	Male=1, Female=0	+ve
Education (EDU)	Level of education completed the household head	years	+ve
Family size (Fmlysz)	Number of people in the households	Number	+/-ve
Farming experiences (Farmexp)	Households Farming experience	year	+ve
Farm size (Farmsz)	Households total land holding	Hectare	+ve
Non-farm income (NFI)	Household access to non-farm income	ETB	+ve
sorghum production (Sprdn)	Total amount quantity produced	Kilogram	+ve
sorghum price(SMS)	Market sorghum prices	ETB	+ve
sorghum consumption (Scon)	Sorghum home consumed	Kilogram	-ve
Use of Credit (CREDT)	Household access to credit	1 if user, 0 otherwise	+ve
Market information (MKTINFO)	Household access to market information	1=yes 0=otherwise	+ve

ETB = Ethiopian Birr,
Source: Own, based on literature review, 2021/22

CHAPTER FOUR: RESULTS AND DISCUSSION

It is to be recalled from the previous chapter that qualitative and quantitative data was collected from structured questionaries and focus group discussion in selected Gololcha and Shenen Kolu districts. Based on the collected data this chapter of the thesis discusses the major findings of the study.

4.1. Results of Descriptive Statistics

4.1.1. Demographic and Socioeconomic characteristics of sample households

In this study for the purpose of descriptive analysis market participations of sorghum were seen based on categorizing smallholders farmers into market participant and non-market participants Accordingly, the result of descriptive analysis indicates, out of 130 households surveyed in selective districts in which 51.5% were supplying their sorghum from their production in the production season while the remaining 48.5.94% not supplied to market (used it for home consumption and gift for their relative).It can be concluded that farmers may supply some amount of their sorghum production to obtain more profits and to buy substitution goods (Table 3).

Table 3.Household market participation

Sorghum market participations	Frequency	Percent
Market participants	67	51.5
Non-participants	63	48.5
Total	130	100.0

Source: Own survey result, 2021/22

The demographic and socioeconomic characteristics of the sampled households considered in this study were classified into two group for the ease of presentation to analysis using t-test and chi-square test. Based on this before chi-square and t-test frequency and percentages of

categorical dummy variables in one group (Table 4) and continuous variables mean, a standard deviation, minimum and maximum presented in one group (Table 5).Accordingly, the dummy and categorical variables were incorporated in the same group and analyzed using chi-square to detect weather there is significant percentages difference or no difference among market participants and non-market participants.

On the other hand continuous variables were analyzed using independent sample t-test to identify weather there is significant mean or not between the market participant and non-market participants. The result of these tests were presented in the consecutive tables (Table 4,5,6,7,8). As indicated in the table 4, out of total sample respondents, 119 (91.5%) were male-headed and 11 (8.5%) were female-headed households. This may positively enhance the process of sorghum market participations in the study area, as male headed households are believed to have a higher chance to participate in the market than women headed due to higher social network (Samuel Gebreselassie and Ludi, 2008).

Regarding cooperative membership, 56 (43.1%) of the sample households were members of cooperatives and 74 (56.9%) were not organized under cooperatives whereas 39 (30%) of the sample households have access to credit and 91 (70%) don't have credit access. Farmers cooperatives, microfinance, and money lenders were the sources of credit in the study area. However, the sample respondents reported that collateral and bureaucracy of access to credit has been the most critical constraint in the start-up of Meher agriculture and expansion of the agricultural production. The use of or application of improved seed would enhance agricultural productivity and the chance of participating in the output markets. According to survey result, the majority of the households 117 (90%) bought and used improved sorghum seed while a small number of households 13 (10%) didn't buy and used improved sorghum seed. In the study area

from collected data majority number of households 83 (63.8%) of producers knew the price to be offered by the market outlets before selling sorghum.

In order to identify whether households have accessibility to extension services (training development agent contact, field day visit, field exchange, etc.) data collected from the study area. Accordingly, the data was collected revealed that 58 respondents which is equivalent to 44.6% were having access to the agriculture extension services while 72 respondents which is equivalent to 55.4% were not having access to the agriculture extension services. The survey sample consisted of people with diverse marital statuses. In this variable of the study, the researcher established three marital statuses modality where the respondents were asked to identify their marital status, the modalities were; Married, Divorced, and widowed.

The data collected revealed that 3 respondents which is equal to 2.3% were divorced, 121 household respondents which are equivalent to 93.1% were married, and 6 household respondents which are equal to 4.6% were widowed. The data collected in this area suggest that this study given for the variables in this study came from the married male group by 93% followed by widows who contributed by 4.6%. Table 4 shows the results.

Table 4.General characteristics of sample sorghum producers (dummy variables)

Variables	Frequency	Percent
Gender of the house hold head		
Male	119	91.5
Female	11	8.5
Cooperative membership		
Yes	56	43.1
No	74	56.9
Access to market information		
Yes	83	63.8
No	47	36.2
Access to extension services		
Yes	58	44.6
No	72	55.4
HH access to improved sorghum varieties		
Yes	117	90
No	13	10
Access to credit		
Yes	39	30
No	91	70
HH Marital status		
Married	121	93.1
Divorced	3	2.3
Widowed	6	4.6

Source: Own survey result, 2021/22

The statistical summary of continuous explanatory variables is provided in table 5 which describes sorghum farming households from the sample. According to survey results in the study area average age of the household head was 37.91 years with the youngest being 20 years and the oldest 65 years. This indicates that most of the household heads were within their productive age group. Regarding educational status, the average schooling of household is grade 4 formal education whereas the range goes from those who did not attend formal education at all to those who attended eleven years of schooling.

The average family size for the sample respondents was about 6.7 with a standard deviation of 2.6. Large household size may ensure an adequate supply of family labor force for crop production and could also absorb a significant portion of the product to home consumption. The mean landholding of the sample household is about 1.28 ha. Larger landholding could be seen as an incentive to produce a surplus for the market. Accordingly, as indicated the average annual sorghum production of the survey households is 1068.06-kilograms. A larger amount of sorghum production leads households to a higher amount of sorghum supply to the market. The average land allocated for sorghum per sample household heads was about 0.77ha while the mean livestock Owen was about 4.24 (TLU).

The average farming experience and sorghum farming experience of sample respondents that an individual continuously engaged in agricultural production was 16.97 years with a standard deviation of 9.48 and 13.8 and 9.9 respectively. The amount of output available in the stock and the marketed proportion of high-value crops could critically affect the overall household output supply to the market. Household in the study area has on average 1184.40 kg of sorghum supplied to the market before the beginning of the new harvest.

In the study districts, from the total volume of sorghum produced, on average 1184.40 kg of sorghum was supplied to market by ample households with a standard deviation of 147.00 kg. Additionally, the average amount of sorghum consumed by a sample household was 821.67 kg. From the total sorghum produced in those selected sample households, only 11.08% was supplied to the output sorghum market and the remaining large amount, 64.95% and 11.2% were used for home consumption and preserved for seed respectively.

The major non-farm income-generating activities in which sample households were participating in the study area include; sales of firewood, farm labor wages, sales of crop residues, Rental

property (other than land and oxen) and. Other business Net income (shops, trade, tailoring, sales of beverages, etc) from the total sample households 98 (75.4%) were participating in non-farm activities and 32 (24.6%) were not participating in non-farm income-generating activities. The mean cash income perceived/obtained from non-farm income by sample households was 3186.57 ET birr with a standard deviation of 3606.983 ET birr. Distance imposes transaction costs on households and determines the volume of output sold. For example, sample households on average 6.61 km and 20 km away from the nearest market and farmers' cooperative respectively (Table 5).

Table 5.General descriptive statistical characteristics of sampled households (continuous variables)

Explanatory Variable	Obs	Mean	Std. Dev.	Min	Max
HH family size	130	6.73	2.679	1.00	14.00
Sorghum quantity sold(kg)	130	118.40	147.003	0.00	600.00
Farming experience(year)	130	16.97	9.488	1.00	42.00
HH total land holding(ha)	130	1.28	0.643	0.25	3.00
Quantity of sorghum produced(kg)	130	1068.06	601.585	200.00	2950.00
Sorghum consumption(kg)	130	821.67	487.270	0.00	2100.00
Non-farm income(birr)	130	3186.57	3606.983	0.00	13050.00
HH education status(in year)	130	4.14	3.110	0.00	11.00
Distance to nearest market(km)	130	6.61	3.500	1.00	18.00
Distance to cooperative(km)	130	20.00	4.43	0.00	20.00
Land allocated for sorghum	130	0.77	0.77	0.00	2.00
livestock owned/TLU/	130	4.24	2.49	0.06	11.00
Household age in years	130	37.91	10.26	20.00	65.00
Sorghum farming experience	130	13.82	9.94	1.00	40.00

Source: Own survey result, 2021/22

4.1.2. Sorghum Production and Supply to Market in the study area

Crop production in the study area was not only for home consumption but also for meeting the cash requirements of the producers. Particularly sorghum was produced for the market and also used for home consumption in the study area. According to the survey result, in the study area, sorghum average production was 1171.8 kg for market participant households and 957.69 kg for

non-market participant households during the 2021/22 cropping year. From the volume of the sorghum produced on average 224.88 kg with a standard deviation of 134.06 kg sorghum was sold by market participant households and additionally on average 800.16 kg and 841.89 kg of sorghum were consumed by the market participant and non-participant households at home respectively. This shows as the production of sorghum is the major important source of food and income in the study area.

The t-test revealed that market participants and non-market participants had statistically significant differences with regard to sorghum production and sorghum quantity sold to the market by households in the study area. However, the t-test result depicts that household sorghum consumption by market participants and non-participant has no significant difference. The result shows that amount of sorghum produced and sorghum quantity sold was statistically significant at 5% and 1% probability level respectively signifying that the mean sorghum quantity produced by market participants was higher than that of non-market participants. The higher production of sorghum by households leads to higher market participation. (Table 6).

Table 6.Production and market supply of sorghum sampled households

Variable	Market participant		Non market participant			
	Mean	Std.	Mean	Std.	T-value	Sig.(2-tailed)
Sorghum produced(kg)	1171.8	552.76	957.69	635.39	2.054	0.042**
Sorghum quantity sold(kg)	224.88	134.06	0	0	12.822	0.000***
Sorghum consumption(kg)	800.16	479.828	841.89	496.92	0.487	0.627

Note: ***, **, represent significance of factors at 1 and 5%respectively
Source: Research field Survey result, 2021/22.

4.1.3. Farm Input use in Sorghum Production by sample households in 2021/22 cropping season

Smallholder farmers who used inputs for commercial production of crops and livestock products are better able to assess market opportunities, have more assets and/or income, and have better access to extension services and credit (Seife Ayele and Caroline Bosire, 2011).use of farm agricultural input increases the production and productivity of farming households at the same time increase households output supply to the market. The farm input used in the study area for the production of sorghum were; improved seed, NPS, and Urea fertilizer, herbicides, insecticides, and moisture conservation technology. The survey result shows that even if all the farmers do not use the recommendation rate from the sample households 90.76%,23.84 and 60% of the households in the study area use NPS, UREA fertilizer, and improved seed respectively.

Additionally, farmers in the study area used soil moisture conservations technology, herbicides and insecticides which are vital in the farming system. The result also revealed that the average amount of seed, NPS fertilizer and Urea fertilizer used per hectare by the market participant sample households was 25.95 kg, 55.77 kg, and 20.43 kg with standard deviations of 15.68,37 and 28.14 respectively. This mean result shows that non-market participants use lower farm input technology in the study area and there are notable differences in the application amount of fertilizer and seed by market participation category.

Together with land, capital, and management chemicals and soil moisture conservation methods are one of the most important factors of production (input) in any kind of production or farming activity. From sampled households, about 19.41% of market participants and 17.46% of non-market participants applied herbicides chemicals to fertilizer while about 80.59% of market participants and 82.54% of non-market participants did not apply herbicides chemical on their

sorghum farm activities. In addition to this 11.94% of market participants and 6.35% of non-market participant used insecticides chemical fertilizer while 88.06% of market participants and 93.66% of non-market participants did not used insecticides fertilizer to their sorghum farmlands during 2021/22 cropping year.

The t-test results of improved seed, inorganic fertilizer (NPS and Urea) used per hectare between the market-participant and the non-market participant is insignificant at a 1% level of significance indicating that there is no statistical mean difference between market participant and non-market participants in terms of improved seed, inorganic fertilizer (NPS and Urea). Also, the x^2 -test result of uses of moisture conservation, herbicides, and insecticides uses between market participants and non-market participants were found to be insignificant. That means there is no difference between market participants and non-market participant uses of moisture conservation, herbicides, and insecticides (Table 7).

Table 7.Farm input use of sample households for sorghum in 2021/22 production year

	Market participant		Non-market participant			
Input used	Mean	Std.	Mean	Std.	T-value	Sig.(2-tailed)
Improved seed(kg)	25.95	15.68	23.28	14.18	1.01	0.312
NPS fertilizer(kg)	55.77	37.00	62.71	37.28	-1.060	0.291
Urea fertilizer(kg)	20.43	28.14	26.91	34.22	-1.179	0.240
Moisture conservation	Response	N	%	N	%	Chi-Square(χ2)
	Yes	41	61.20	34	53.96	0.405
	No	26	38.80	29	46.04	
Herbicide (yes/no)	Yes	13	19.41	11	17.46	0.775
	No	54	80.59	52	82.54	
Insecticides(yes/no)	Yes	8	11.94	4	6.35	0.271
	No	59	88.06	59	93.66	

Source: Research field Survey result, 2021/22.

4.1.4. Institutional, economic and resource endowment of both market and non-market participants sample households.

This section presents the social, economic, and resource endowments of both households participating in the market and not participating in the study area. The characteristics of both market participants and non-participants of households who participated in sorghum out late status in the study area are presented in table 8 below. Having institutional services, economic and social are important factors that encourage the commercialization of smallholder farmers through a positive impact on technology transfer. The t-test result illustrates in table 7 below shows the significant mean difference for continuous variables among market participants and non-participants.

The value of the t-test shows that there is no significant difference between family size, household education in years of schooling, farming experiences, sorghum farming experiences, livestock owned (TLU), and household land holding of participants in sorghum market participants and non-participants. Therefore, it can be said that family size, household education in years of schooling, farming experiences, sorghum farming experiences, livestock owned (TLU), and the land holding size of the household will not affect the economy between the people involved in the commercialization process and the non-market participants. This result contradicts the findings of Kyaw *et al*.(2018).

The t-statistics value shows that the mean difference in the household age in years among the two groups, market participants and non-market participants, was statistically significant and positive at less than a 10% level of significance (Table 8). This reveals that there is an indirect relationship between the household and sorghum market participation decisions. Hence, this study can conclude that the mean household age in years of the household head for sorghum

market participants was lower than a non- market participants. This means the older the age of the household the lower to involve in the sorghum market.

Additionally, the T-test value shows that the mean difference in land allocated for sorghum among market participants and non-participant households was statistically significant and positive at a less than 10% significant level. Hence, this study can conclude that the mean land allocation by the household head for sorghum production for market participants was higher than for non-participants. This reveals that there is a direct relationship between the land allocation for sorghum production and market participation decisions (Table 8).

Table 8. Mean characteristics of sampled households by market participation status

	Market participant(N=67)		Non-market participant(N=63)		
Variable	Mean	Std	Mean	Std	T-test
Household age in years	36.43	9.409	39.48	10.96	0.091*
Family size	6.91	2.58	6.54	2.78	0.432
HH education status (in year)	4.46	3.11	3.79	3.09	0.22
Non-farm income(birr)	3362.99	3551.75	2998.9	3683.97	0.567
Farming experience(year)	17.48	10.14	16.49	8.87	0.557
Sorghum farming experience	14.16	10.48	13.44	9.39	0.68
Land allocated for sorghum	0.80	0.32	0.74	0.33	0.058*
livestock owned/TLU/	4.37	2.29	4.11	2.70	0.555
HH total land holding(ha)	1.30	0.626	1.246	0.664	0.583

Note: *, represent significance of factors at 10%.
Source: Research field Survey result, 2021/22.

In addition to the t-test chi-square test is used to determine that there are substantial variations between categorical variables among both market participants and non-market participants households in the study area (Table 8). The chi-square values of household head sex and household head status of categorical variables listed in the model of sorghum market participation indicate negligible variations in both groups. Male-headed households dominate surveyed households, both in supplying sorghum to output marketing. Females have traditionally

been heavily involved in agriculture, while men work off-farm to supplement the household income.

The table below shows that 65 (97%) of sorghum market participants were male, while 2 (3%) were female. And also, 54 (85.7) of non-market participants were male, while 9 (14.3%) were female. Regarding cooperatives membership, 31 (46.3%) of sorghum market participants were members of cooperative, while 36 (53.7%) were non-members. About 31 (49.2%) of non-market participants were members, while 32 (50.8%) were none-members. The distribution households for market information access of sorghum market participants were,62 (92.5%) for those who have market access and 5 (7.5%) household heads not have market information access, respectively. On the other hand, 21 (33.3%) of non-market participants have access to market information, while 42 (66.7%) do not have access to market information.

Furthermore, about 25 (37.3%) of sorghum market participants were trained and 42 (62.7%) not participating in training. This indicated that the use of communication mass media like radio, television, and printouts was lacking. Also, according to the survey results, they lack reliable information and the power of deciding on the price of sorghum, and the price of inputs. This is because local traders mainly focus on their profit and they deliver low market prices for sorghum and inputs that were not profitable for producers. The chi-square values for access to market information, gender, and categorical factors extension services (training access) included in the model for selling sorghum to the market suggest major variations in both groups.

Therefore, it can be said that market information access is one of the determining factors in market participation households in sorghum and its products. In other words, the more people have access to the market information, the more they are willing to participate in the sorghum output market and the more successful they will be. The chi-square statistics value shows that

there is a significant difference at less than 1 percent, in access to market information by a sorghum market participants and non-market participants households. Hence, as market information makes a difference in the decision to market participation.

The findings show that there is a statistically important gap in exposure to training by extension officers and other training providers at less than 10 percent, between those who participate and non-participants in the sorghum market. Therefore, it can be said that access to training by different training providers in the field of production can be very important in encouraging people to commercialize. The chi-square test of sex distribution between the market participant and non-participant was found to be significant at less than a five percent significance level with a chi- square value of 0. 021.Hence gender makes differences in the decision to market participation (Table 9).

Table 9. Proportion characteristics of sampled households by market status

Variables description	Market participant(N=67)		Non participants(N=63)	Total (%)	
	Category	N (%)	N (%)	N (%)	Chi-Square(χ2)
Gender	Male	65(97)	54(85.7)	119(91.5)	0.021**
	Female	2(3)	9(14.3)	11(8.5)	
Cooperative membership	Yes	31(46.3)	31(49.2)	62(74.7)	0.738
	No	36(53.7)	32(50.8)	68(81.9)	
Market information	Yes	62(92.5)	21(33.3)	83(63.8)	0.000***
	No	5(7.5)	42(66.7)	47(36.2)	
Extension services(training)	Yes	25 (37.3)	33(52.4)	58 (44.6)	0.084*
	No	42(62.7)	30(47.6)	72(55.4)	

Note: ***, **, *, represent significance of factors at 1,5 and 10% level respectively.
Source: Research field Survey result, 2021/22.

4.1.5. Infrastructural Services of sample households

Infrastructural factors are important factors that encourage the commercialization of smallholder households through a positive impact on technology suppliers to the market. The infrastructural

factors considered in this study that can affect commercialization are distance to the nearest market, farmers' cooperatives, extension offices, (FTC) and sources of input. In the study area, the average distance taken to travel from home to the nearest farmers' cooperative is 7.066 and 7.64 kilometers for sampled market participants and non-participants respectively.

Similarly sampled market participants and non-participant respondents traveled on average 7.30 and 8.54 kilometer to cover the distance between the residence and the sources of input (chemicals) respectively. More specifically market participants and non-participants were obligated to travel on average 2.64 and 1.29 kilometers respectively to reach the extension offices (FTC). Perhaps access to transport infrastructure is among the critical factors that affect the market participations of agriculture.

smallholder farmers with close proximity to roads are better integrated to the market than their counterparts. The value of the t-test shows that there is no significant difference between distance into the nearest farmers' cooperative, sources of input and extension offices (FTC) of participants in the sorghum market and non-participants. Therefore, it can be said that the distance to the cooperative, sources of input, and extension offices (FTC) will not affect the market decision between the people involved in the market participants and the non-participants (Table 10).

Table 10.Distribution of sample households by Distance to homestead

Variable	Market participant		Non-market participant		
	Mean	Std	Mean	Std	T-test
Distance to the nearest farmer cooperative	7.066	4.38	7.64	4.49	0.46
Distance to the nearest source of inputs	7.30	3.17	8.57	3.69	0.37
Distance to extension office (FTC)	2.64	1.29	2.68	1.39	0.86

Source: Research field Survey result, 2021/22.

4.1.6. Sorghum Production characteristics of sample household

Among the cereal crops grown in the study area sorghum is the major crop grown by the majority of farming families for home consumption and market supply. The mean area of land allocated for sorghum production by sample households was 0.80 hectares with a standard deviation of 0.320 for participants and 0.74 hectares with a standard deviation of 0.334 for non-participants respectively. In the study areas, sorghum is the dominant crop produced with a mean of 1171.20 kilograms for the market participants and 957.69 kilograms for non-market participants and it is the basis of livelihood in the study areas (table 11).

Table 11. Area coverage of sorghum crops with its production of sampled households

Crop cultivated	Market participation	Area allocated in 2021/22 cropping season in ha		Sorghum production in 2021/22 in kg	
		Mean	Std.Dev.	Mean	Std.Dev.
Sorghum	Market participant	0.80	0.320	1171.84	552.76
	Non-participant	0.74	0.334	957.69	635.392

Source: Research field Survey result, 2021/22.

4.1.7. Distribution of total sampled households' participation in different group by gender

The figure below shows the response of sample respondents to the question of their participation in different groups by gender. Of the total respondents, 54.6% of market participants are male and 18.2% of market participants are female. Accordingly, from the total respondents, 46.2% of male respondents are cooperative members while 63.2% of respondents are female who is members of the cooperative.

Additionally, the results showed that about 89.9 % of male respondents are improved seed users while 90.9% of female respondents are improved seed users. Regarding access to credit from the sampled households, 31.9% of male respondents have access to credit and 9.1% of female

respondents are noon credit users. This result indicates the majority of respondents in the study have low access to financial services (figure 3).

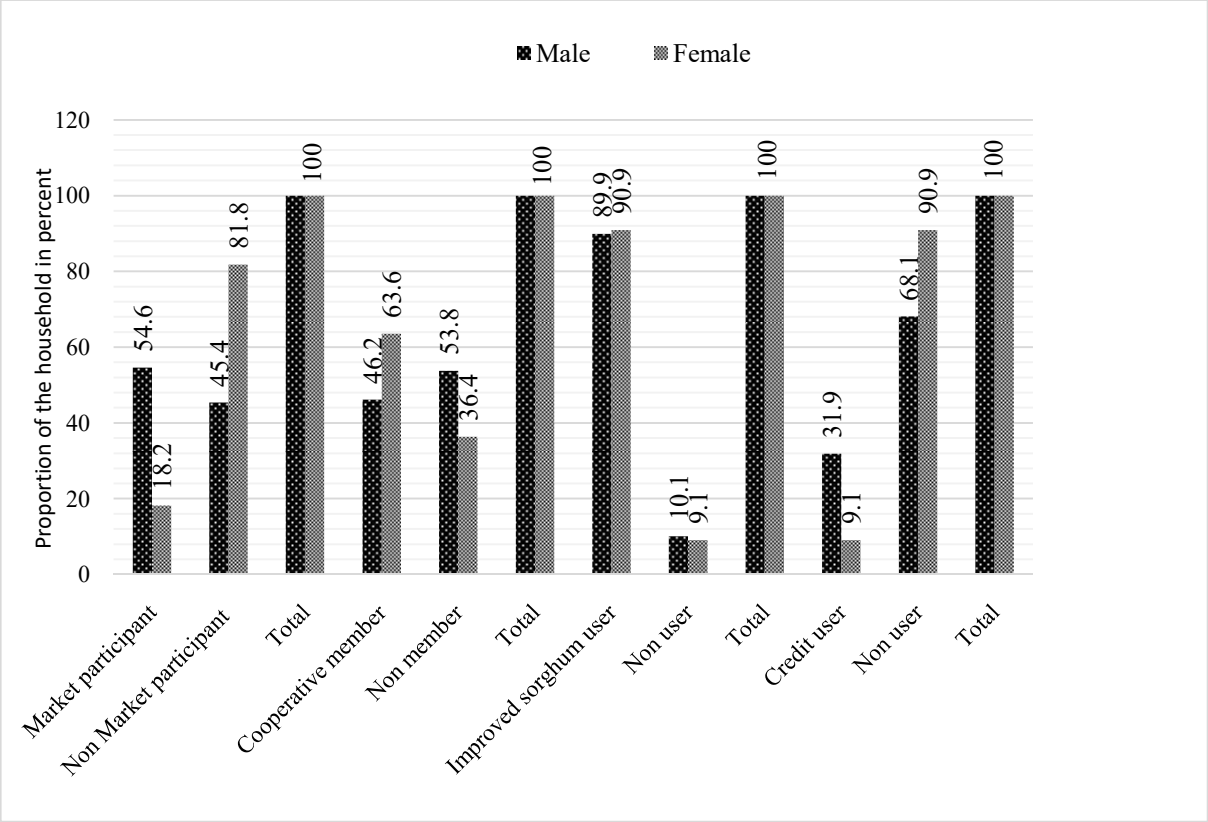

Figure 3. Gender based participation of sample household in different groups

Source: Own survey result, 2021/22

4.1.8. Major sources of sorghum seed used in 2021/22 cropping season in the study area

Several factors hinder farmers not to increase their agricultural production. Among the factors, one of the most important factors is the timely availability of seeds at the proper time and season to farmers. Delaying of this seeds and other inputs causes a reduction of the average yield which by default decreases the market participation of the households. According to the survey result household in the study area have several seed sources. Figure 5 shows percentages of sorghum farmers that used seeds other than owned or saved seeds. It was found that 23.08% of market

participants and 20.1% of non-market participants farmers used their own seed of sorghum during the 2021/22 cropping season respectively.

As the result of figure 5 below indicates about 6.92% and 1.54% of market participants and non-market participants used sorghum seed from a gift from family relatives which is predominantly for seed exchange in the study area especially for open-pollinated varieties (OPV) while about 4.62% market participants and 3.85% non-participants used seed from their extension demonstration plot respectively. Additionally, about 0.77% and 2.31%, and only 3.08% and 3.85% of market participants and non-participants used sorghum seed from buying from local seed producers and local traders respectively. The survey, result depicts farming households does not buy sorghum seed from seeds companies because of the high price and the majority of the farmers used seed from their own sources (figure 4).

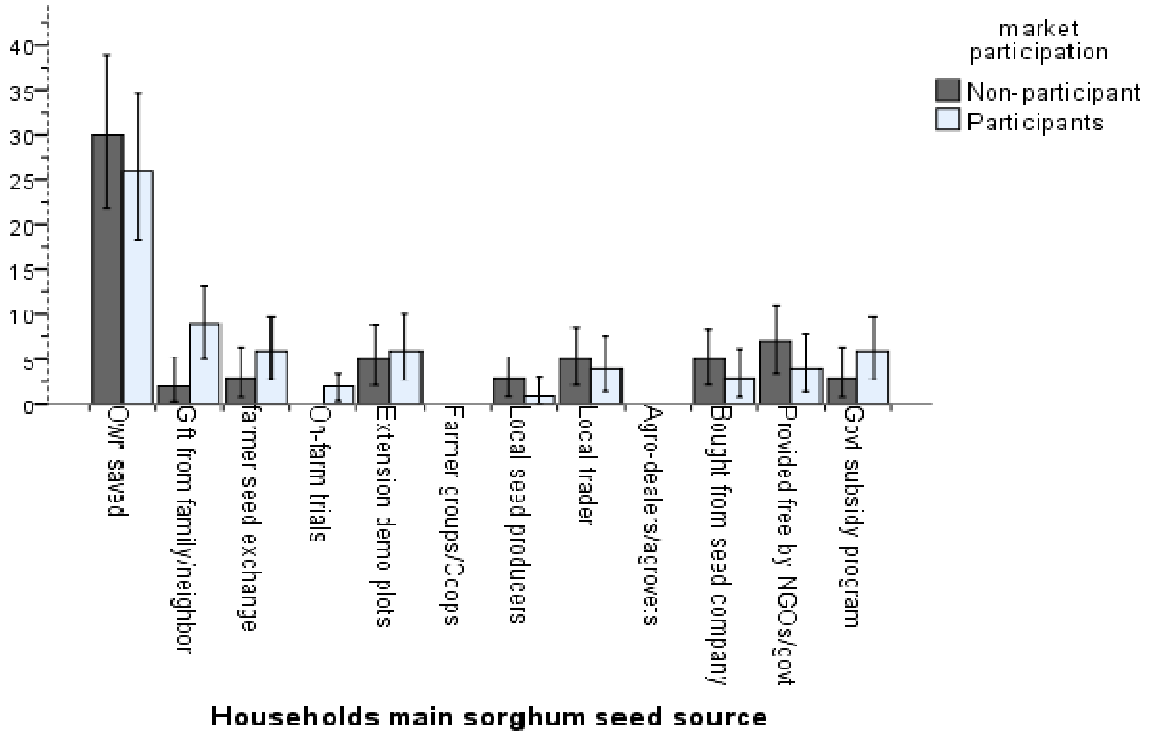

Figure 4. Sources of sorghum seed grown by households in the study area

Source: Research field Survey result, 2021/22.

4.1.9. Sorghum Variety traits as perceived by the farmers in the study areas

According to the survey result majority of households from sampled households, 65.39 percent of market participants, and 34.61 percent of non-market participants don't know the sorghum variety they were cultivating. OPV (open-pollinated variety) was the most grown in the study area cultivated by 59.64 percent of market participants and 40.36 percent of non-market participants while 57.15 percent of market participants and 42.85 percent of non-market participants households grow hybrid sorghum variety (table 12). Farmers in study area had maintained their traditional Open pollinated maize Varieties (OPVs) over the years. The use of

these varieties alleviated the problem of shortage of hybrid maize seed since these OPVs were readily and locally available.

Table 12.Sorghum varieties cultivated by the farmers in the study areas

Sorghum variety cultivated	Market participants		Non market participants		
	N	%	N	%	Total
OPV	34	59.64	23	40.36	57
Hybrid	12	57.15	9	42.85	21
Don't know	34	65.39	18	34.61	52

Source: Research field Survey result, 2021/22.

To gain an understanding of farmers' preferences for various sorghum variety attributes, they were asked their perceptions and rate the importance of different traits of varieties, and percentages of the households ranked accordingly as presented in figure 5. Farmers considered a wide range of attributes when selecting a variety for cultivation.

Hence, knowledge of respondent farmers' evaluative criteria with regard to technology attributes is needed. These include yield, drought resistance, early maturity, uniformity of maturity, marketability, disease resistance, insect pest tolerance, and grain color, price, and size, taste, palatability of stover, and water non-logging. Four descriptions, i.e., poor, average, good, and very good were used to facilitate the comparison by farmers of sorghum variety against their other seeds. For the sorghum cultivar they grow, 71 (54.60%) of respondents from the study area tended to emphasize yield more importance than another trait.

Similarly, marketability and grain color were highly valued attributes for farmers, both of which were generally importantly selected by 43.10 and 28.50 percent of the respondents respectively. Similarly, farmers showed high interest in feed attributes. Palatability of Stover yield and

digestibility to livestock are the most important attributes, with 22.30 percent of respondents showing as this attribute is very important.

The next most important group of attributes consists of early maturity, uniformity in maturity, the taste of sorghum, and grain size, all of which were selected by 22.60,20.80,21.50 and 19.20 percent of respondents in the selected study area . However, from the total households, 38.50,31.50 and 33.10 percent of the households raised that drought, water longing, and insect pest tolerance of the variety respectively were important attributes in the study area. Overall, respondents in the study area placed higher importance on many grain and field attributes (figure 5).

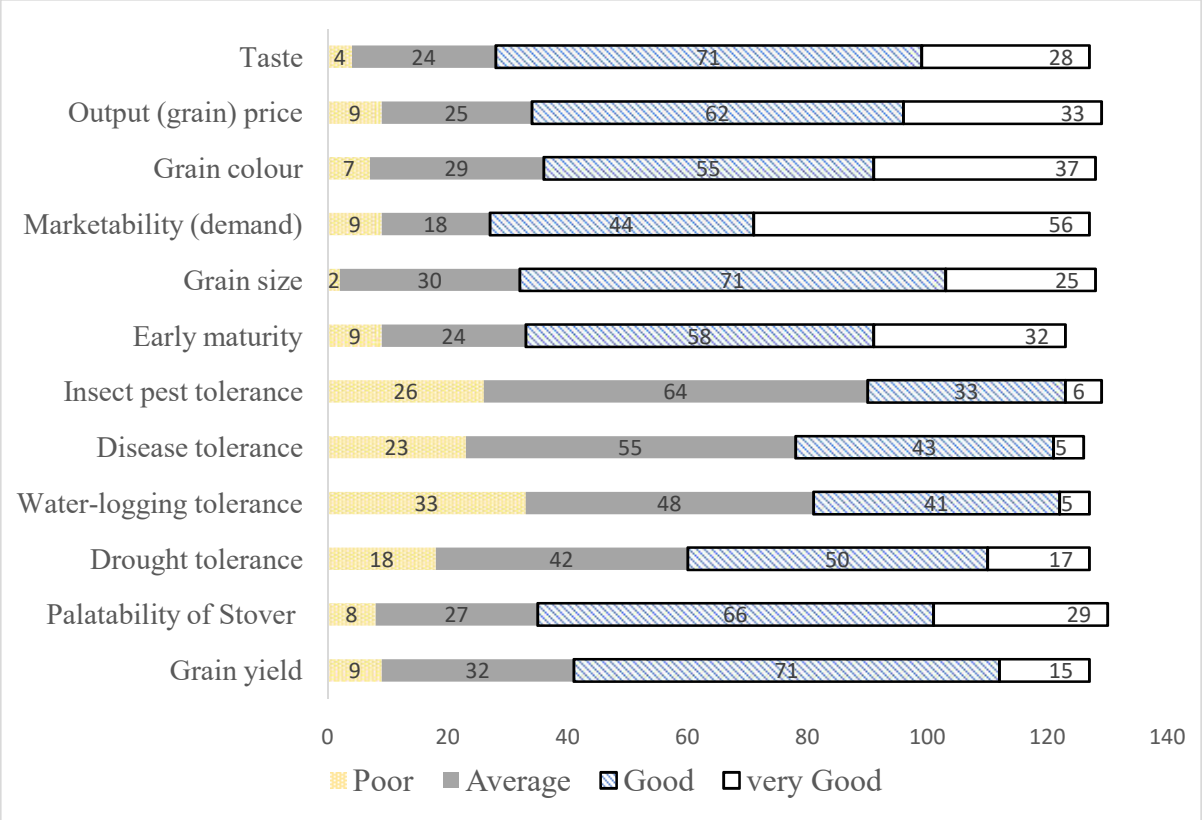

Figure 5. Households Sorghum variety characteristics in the study area

4.1.10. Physiographic soil characteristics of the households in the study area

Knowing the features of agricultural lands and soil management practices is pertinent to verify the potential and limitations of the soil resources and additionally to devise relevant land management strategies. The quality and physical features of the farmlands of the households determine the decision to invest in farm plot improvement. Based on the result of the survey from the total of household farm plots 25.4%, 56.2%, and 18.5% were considered as good, medium, and poor soil fertility types respectively. Also,24.6%,53.1% and 22.29% of soil were considered gentle, medium, and steep slopes respectively.

Accordingly, with regards to soil type from selected households 11.5%,29.2%,49.2% ,and 10% of the soil were black, brown, red, and grey respectively. Based on the result majority of the households soil fertility, and soil slope is medium followed by good for fertility while the majority of the households soil type is red indicating the presence of iron and less phosphorous available to the plant followed by brown indicating having high organic matter content soil type (Table 13).

Table 13.Household distribution by soil characteristics

Soil description		Frequency	Percent	Cumulative
Soil fertility	Good	33	25.4	25.4
	Medium	73	56.2	81.5
	Poor	24	18.5	100
Soil slope	Gently	32	24.6	24.6
	Medium	69	53.1	77.7
	Steep	29	22.29	100
Soil type	Black	15	11.5	11.5
	Brown	38	29.2	40.8
	Red	64	49.2	90
	Grey	13	10	100

Source: Research field Survey result, 2021/22.

4.1.11. Types of SWC practices that were implemented in the study area

Besides the application of manures, crop rotation and house residues for soil conservation farmers asked about soil conservation technologies. Most of the surveyed farmers believed that soil erosion could be controlled. In line with this result previous study, Alemu *et al*.(2019) reported that the majority of farmers confirmed soil erosion can be controlled. The result indicates soil conservation practices are relatively rare in general terms. The SWC practices have been implemented by the farmers and these were mostly physical and biological conservation technologies.

This soil conservation technology includes terraces, soil and stone bunds, grass strips, and mulching. Accordingly, the study showed that 33.85%,6.92%,0.80%,30%and 3.84% of the farmers in the study area respectively adopted terraces, mulching, grass strips, soil bunds, and stone bunds. As illustrated in the figure terraces and soil bunds soil erosion practices by sorghum farmers are better and relatively common practices (figure 6).

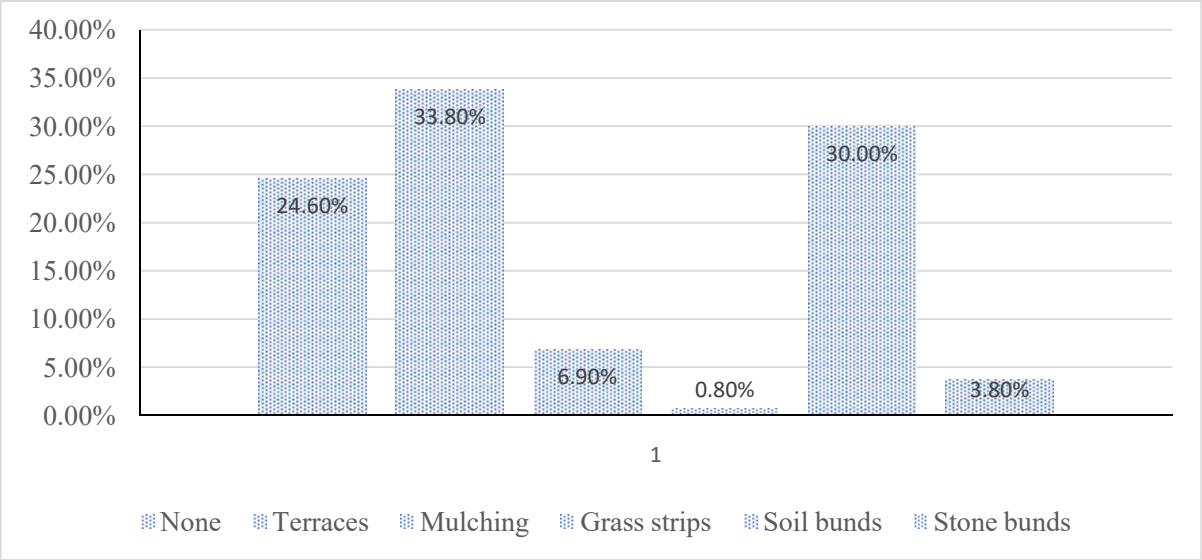

Figure 6. Soil and water conservation practices in the study area

Source: Research field Survey result, 2021/22

4.1.12. Social capital memberships and participation of households in the study area

This section consists of a discussion pertaining to the existing condition of social assets in the study area. As noted in below table 14 among the total respondents who were asked whether or not they participate in the cultural institutions of Idir 59 respondents 88% and 56 respondents 88.8% market participants and non-market participants reported that they are already participating. Similarly, 34 respondents 50.7% and, 24 respondents 38.1% market participants and non-market participants of households in the study area participate at informal Iqub institutions. Besides, from the total respondents, 34 respondents 50.7% and, 35 respondents 55.5% market participants and non-market participants respectively replied that they are participants of a church or mosque association.

And also, 30 (47.6%) of non-market participants were members of the savings and credit association, while 30 (44.7%) market participant respondents were members of saving and credit association. Regarding funeral membership, 30 (44.7%) of sorghum market participants were members of funeral associations, while 24 (38.1%) were non-members. The majority of respondents 52.2 percent and 76.2 percent of market participants and non-participants respectively in the study area indelicate that they are not farmers' cooperative members.

Similarly, the majority of respondents 73.2,98.5,91.1 and 79.4,84.1,85.7 percent of market participants and non-participants respondents were not members of local administration, women's associations and youth associations respectively. From this data it is possible to infer that Idir, Iqub, church or mosque, saving, and credit and funeral association is the main mechanism through which parts of the social and economic or livelihood life of people in the study area meet. This shows people of the study area made mutual help and strong social relationships within those associations that are not materialistic.

However, this strong social relationship would contribute to the people's livelihoods. Additionally, this study found the chi-square test result of members of Iqub, Idir, church or mosque, saving and credit, funeral, and local association memberships of respondents between market participants and non-market participants was found to be insignificant. That means there is no difference between market participants and non-market participants in the participation of these social groups.

There was also a statistically significant difference between the two groups in terms of memberships in the women association and farmers' cooperatives at a 5 percent level of significance. Therefore, it can be said that membership in farmers' cooperatives and women's associations can be very important in encouraging households to commercialize (Table 14).

Table 14.Membershipness of households in different social capitals

Social indicator	Market participant			Non participants		
	Category	N	%	N	%	Chi-Square(χ2)
Iqub	Yes	34	50.7	24	38.1	0.147
	No	33	49.3	39	61.9	
Idir	Yes	59	88	56	88.8	0.882
	No	8	12	7	11.2	
Church or mosque association	Yes	34	50.7	35	55.5	0.583
	No	33	49.3	28	44.5	
Saving and credit	Yes	30	44.7	30	47.6	0.745
	No	37	55.3	33	52.4	
Funeral association	Yes	30	44.7	24	38.1	0.440
	No	37	55.3	39	61.9	
Farmer cooperative	Yes	32	47.8	15	23.8	0.05**
	No	35	52.2	48	76.2	
Local administration	yes	18	26.8	13	20.6	0.405
	No	49	73.2	50	79.4	
Women association	Yes	1	1.5	10	15.9	0.03**
	No	66	98.5	53	84.1	
Youth association	Yes	6	8.9	9	14.3	0.342
	No	61	91.1	54	85.7	

Note: **, represent significance of factors at 5 % level.
Source: Research field Survey result, 2021/22.

4.1.13. Major actors and roles of sorghum market channel participants in the study area

This section discusses the sorghum market actors and their roles. As indicated in table 13 below the share of farmers selling their sorghum produce to the various types of buyers. The general picture that emerges is that the role played by local or villages traders in sorghum marketing is substantial- i.e. The vast majority of sorghum farmers (69.1%) sell their sorghum to villages markets while 30.9 % of farmers sell their surplus to main/districts market. Generally, sorghum producers in the study area are settled at the distance closer to the village market places This shows that the village market as the major market outlet somehow implies a longer value chain in sorghum in sorghum market. In addition to this sorghum, buyer types are also seen in this section.

The majority of sorghum buyers (61.2 %) in the study area are sorghum consumers. Urban wholesalers and rural assemblers/whole sellers are the second and third most important buyers from sorghum farmers. From sampled sorghum surplus suppliers to the market 16.4 and 7.5 % of sorghum-producing farmers sell their products directly to urban wholesalers and rural assemblers/wholesales respectively. From the total sample households, about 40.3% of female households decide sorghum be sold to the market and supplied by them whereas 26.9% and 32.8% of males and jointly sold it directly to buyers in the local market respectively. In general, women are responsible for bulk sales while men are charged with low percentages in the sale of sorghum.

In contrast, the role of urban grain traders and brokers in purchasing sorghum is limited and there is no role of cooperative in the study area. Of the sampled sorghum farmers 1.5% sell their sorghum to brokers. As indicated in table 11 below most sorghum farmers 70.1 percent in the sample don't have a relationship and the buyer is not a long-time buyer of the produce while 28.4 percent of the buyer have no relation to producers but they are long-term buyers of the sample households. Moreover, the seasonality of sorghum sales by month is also indicated in table 13.The result shows variation in the volume of sorghum sold by farmers across months.

For an instant, in the study area out of sample farmers 6%,43.3%,23.9%, and 9% of farmers sold their sorghum produce in January, February, March, April, and May respectively. Mainly farmers in the study area they sell their produces with high supply to market during March but low during May. Farmers sell their bulk sorghum produces at harvest time, because they fear storage losses and they need cash for supplementary goods. The dominant way of transporting produces to the local market as indicated in table 11 37.3 % of sample farmers using donkey followed by 19.4% of farmers by donkey cart and 14.9 % of farmers using back/head load respectively. This shows that transportation as is poorly developed in the study area (Table 15).

Table 15.Characteristics of major market participants

Statements	Farmers market decisions	N	%
Market type	Village	47	69.1
	main/district	20	30.9
who sold	female	27	40.3
	male	18	26.9
	Both	22	32.8
Buyer type	Consumer	41	61.2
	Rural assembler	5	7.5
	Broker/middlemen	1	1.5
	Rural grain trader	2	3
	Rural wholesaler	5	7.5
	Urban wholesaler	11	16.4
	Urban grain trader	2	3
Buyer relation to producer	No relation but not a long-time buyer	47	70.1
	No relation but a long-term buyer	19	28.4
	Friend	1	1.5
Mode of transport	Bicycle	4	6
	Hired truck	3	4.5
	Public transport	12	17.9
	Donkey	25	37.3
	Oxen/donkey/horse cart	13	19.4
	Back/head load	10	14.9
Month mainly sold	January	4	6
	February	12	17.9
	March	29	43.3
	April	16	23.9
	May	6	9.0

Source: Research field Survey result, 2021/22.

4.1.15. Households input and crop production constraints prevailed in the study area

The surveyed farmers faced numerous constraints with regard to input and agricultural production in the study area. The production challenges that the farmers faced were farm-level internal factors and external factors. The most input and production constraints prevailed in the study area are the availability of improved seed, price of improved seed, quality of seed, availability of credit to buy seed, availability of fertilizer, price of fertilizer, reasonable grain price, shortage of labor, drought, flood, and pest. Farmers also ranked the constraints according

to the number of households affected and the extent to which livelihoods were impaired by these constraints.

The survey result revealed that the timely unavailability of improved seed was the most common constraint faced by respondents (98.5%) of market participants and 95.2% of non-market participants, followed by the price of seed (94%) market participants and (90.5%) of non-market participants, drought (77.6%) and (84.1%),credit to seed (91%) and (85.7),pest (77.6) and (84.1%),quality of seed (82.1%) and (74.6%),and timely availability of fertilizer (85%) and (80.9%) both by market participants and non-market participants respectively (table 16).

Table 16.Production constraints by market participation in the study area

Constraints	Market participants			Non participants	
	Response	N	%	N	%
Timely availability of improved seed	Yes	66	98.5	60	95.2
	No	1	1.5	3	4.8
Prices of improved seed	Yes	63	94	57	90.5
	No	4	6	6	9.5
Quality of seed	Yes	55	82.1	47	74.6
	No	12	17.9	16	25.4
Availability of credit to buy seed	Yes	61	91	54	85.7
	No	6	8.9	9	14.3
Timely availability of fertilizer	Yes	57	85.1	51	80.9
	No	10	14.9	12	19.1
Price of fertilizer	Yes	57	85.1	52	82.5
	No	10	14.9	6	9.5
Reasonable grain prices	Yes	41	61.9	37	58.7
	No	26	38.1	26	41.3
Shortage of labor	Yes	28	41.8	23	36.5
	No	39	58.2	40	63.5
Drought	Yes	55	82.1	55	87.3
	No	12	17.9	8	12.7
Floods	yes	47	70.1	39	61.9
	No	20	29.9	29	38.1
Pest	Yes	52	77.6	53	84.1
	No	15	22.4	10	15.9

Source: Research field Survey result, 2021/22.

Lastly, the weighted mean of the constraints faced by farmers in the study area was done and ranked accordingly as presented in table 17. Among the major constraints that hinder input and crop production, which were raised by sample respondent household farmers, were the Drought, quality of seed, on-time improved seed unavailability, the problem of unavailability of credit to buy seed, and lack of reasonable grain price that ranks from one to five, respectively (Table 17).

Table 17.Input and crop production constraints in the study area

Constraints	Not important	Less important	Important	Very important	Weighted mean	Rank
On time improved seed	2(1.2)	5(3)	60(35.9)	63(37.7)	3.41	3
Prices of improved seed	4(2.4)	3(1.8)	64(38.3)	59(35.3)	3.36	6
Quality of seed	3(1.8)	6(3.6)	46(27.5)	75(44.9)	3.48	2
Availability of credit to buy seed	4(2.4)	10(6)	47(28.1)	69(41.3)	3.39	4
On time fertilizer access	6(3.6)	34(20.4)	60(35.9)	30(18)	2.8	11
Price of fertilizer	4(2.4)	14(8.4)	66(39.5)	46(27.5)	3.18	7
credit to buy fertilizer	1(0.6)	37(22.2)	58(34.7)	34(20.4)	2.96	9
Access to markets & information	10(6)	53(31.7)	30(18	37(22.2)	2.72	12
Reasonable grain prices	4(2.4)	9(5.4)	51(30.5)	66(39.5)	3.37	5
Shortage of labor	8(4.8)	32(19.2)	58(34.7)	32(19.2)	2.85	10
Drought	1(0.6)	3(1.8))	53(31.7)	73(43.7)	3.52	1
Floods	2(1.2)	20(12)	63(37.7)	45(26.9)	3.16	8

Note:1= Not important at all 2= less important 3= important 4=very important (in terms of level of importance), out off and in the bracket shows frequency and percentage respectively.

Source: Research field Survey result, 2021/22.

4.2. Major marketing constraints prevailing in the study area

Marketing constraints prevailed in the study area were market information, fluctuation of price, the unsuitable road to market, post-harvest loss, lack of improved storage, lack of market linkages, low quality of the grain, market transaction cost, distance to the main market, high cost of input and lack of appropriate market policy.

Moreover, a focus group discussion was carried out to identify and rank the prevailing marketing constraints in the study area. Three FGDs which were stratified into male-headed farmers', female-headed farmers, and youth-based were conducted in each district and a total of six FGDs were incorporated in the two potential sorghums-producing kebeles. Each of the male-headed consists of 10 and 13 members in mine Adaye kebele from Gololcha Districts and Furda Bela kebele from Shenen Kolu Districts respectively. Female-headed consists of 8 and 9 members in Mine Adaye and Furda Bela kebeles, respectively.

In addition to male and female-headed, Youth FGD which is composed of 6 members in Mine Adaye and 11 members in Furda Bela kebeles was conducted to envisage a good understanding of marketing constraints in the study area. The details of each FGD are given in appendix table 5. During the FGD participants were asked to list marketing constraints prevailing in the study area. Accordingly, the major marketing problems identified by the focus group participants in each kebeles were summarized using pairwise ranking techniques as shown in table 18.

The FGD result shows that market information access is the major problems followed by an unsuitable road, price fluctuation, and input cost in Mine Adaye kebele from Gololcha Districts. However, market linkages and price fluctuation are the problem next to Market information access in Furda Bela kebele from Shene Kolu Districts. Market information access is the major problem in both kebeles (table 18)

Table 18. Rank of marketing constraints prevailing in the study area

FGD	kebele	Market information	Road	Input cost	storage	Market linkages	Price fluctuation
MHHFGD	Mine	5(0.33)	4(0.26)	3(0.2)	2(0.13)	2(0.13)	5(0.33)
FHHFGD	Mine	5(0.33)	4(0.26)	3(0.2)	2(0.13)	1(0.07)	2(0.13)
YFGD	Mine	5(0.33)	4(0.26)	3(0.2)	2(0.13)	1(0.07)	2(0.13)
Weight		15(1)	12(0.8)	9(0.6)	6(0.4)	4(0.27)	9(0.6)
Rank	Mine	1	2	3	5	6	3
MHHFGD	Furda	5(0.33)	1(0.07)	3(0.2)	1(0.07)	4(0.27)	3(0.2)
FHHFGD	Furda	5(0.33)	1(0.07)	2(0.13)	1(0.07)	4(0.27)	3(0.2)
YFGD	Furda	5(0.33)	1(0.07)	2(0.13)	1(0.07)	4(0.27)	3(0.2)
Weight	Furda	15(1)	3(0.20)	7(0.46)	3(0.20)	12(0.8)	9(0.6)
Rank	Bela	1	5	4	5	2	3

Note:1= Not problem 2= less problem 3= medium problem 4= high problem 5= very high problem MHFGD= Male-headed FGD, FHFGD=Female headed FGD, YFGD= Youth-based FGD. The figure in the bracket shows weighted score

Source: Field data (FGD) 2021/22

4.3. Sorghum crops specific market participations level of households

Following the classification of commercialization by Tadele et al.(2017) smallholder level of commercialization is grouped into three categories; Less commercialized farmers (those who sold up to 25% of output), semi-commercialized farmers (those who sold between 25% and 50% of output they produce) and commercialized farmers (those farm households who sold more than 50% of what they have produced).

The results from the survey revealed that most of the sampled households 63(48.46%) of sample households' commercialization level is zero indicating that they are fully subsistent in terms of sorghum output supply to the market, 22 (16.92%) are less-commercialized, from market participants most of the sample households 28 (21.54%) fall in the medium-commercialization

category of output supply to market and a small number of households 6 (4.6%) are very highly commercialized farmers with the high commercialized sample households who supply equal or greater than 75% of the gross value of its sorghum output to the market.

According to the survey, result the overall degree of market participations of sorghum producers in the study area ranged from o to 0.84 across the sampled households in terms of the gross value of sorghum supplied to market-by-market participants. The average value of sorghum market participations for those who supplied their products to the market indicates that the level of market participations of sorghum producers in the study areas was at a medium commercial level. In general, the level of household sorghum market participations level in the study area was found to be 19%, which is significantly lower than the national commercialization average, of 35% (Getahun, 2020).This is because households in the study area use sorghum for home consumption than that of market supply (Table 19).

Table 19. Level of market participations of sorghum producers in 2021/22 production year

level of commercialization	Frequency	Percent
Fully Subsistent/ Non-commercial (0%)	63	48.46
less commercialized (1- 25%)	22	16.92
Medium commercialized (25.1- 50%)	28	21.54
Highly commercialized (50.1 -75%)	11	8.46
very Highly commercialized (=>75%)	6	4.6
Total	130	100

Source: Research field Survey result, 2021/22.

4.3.1. Households District specific level of market participations

Besides understanding the level of market participations at the household level, estimating the market participations level for each district is very important since the tendency of one district household to sell their products could vary according to the type of major crop produced and the

production and input constraints prevailed in the production year. Accordingly, from the survey result as shown in Table 20, the average household commercialization index of sorghum for Shene Kolu and Gololcha District were 0.2243, and 0.1656 respectively. This indicates that the household commercialization index is higher in Shene Kolu District than Gololcha districts of sorghum-producing households.

Table 20.Household level commercialization index by district

Zone	Name of District	N	Mean	Std	Variance
Arsi	Shenen kolu	46	0.2243	0.2425	0.0588
	Gololcha	84	0.1656	0.228	0.05199
	Market participations Mean		0.19495	0.23525	0.055395
	Total	130	0.3899	0.4705	0.1107

Source: Research field Survey result, 2021/22.

4.4. Econometrics Analysis and Results

This sub-section presents the model estimation results and their interpretations. Specifically, it will present the various factors that influence farmers market participation decision to participate or not and the level of participation in sorghum market supply to the market.

4.4.1. Model Specification and Test

Noting that determinants of a household's market participation decision and level of market participants may not necessarily be made jointly and that the factors affecting each decision may be different, this study estimated both Heckman's estimation of probit and OLS regression model separately. Prior to the econometric analysis, essential tests that verify the model to employ for the analysis were undertaken on hypothesized variables. Heckman's two-step is an econometric model developed to correct for sample-selection bias. In this study, the result from the Heckman two-step indicated that the inverse mills ratio (IMR)(mills lambda 0.000) was statistically significant. Hence, the Heckman two-step model needs to be used (Appendix figure 1).

While fitting important variables in the models a test for multicollinearity problems among all hypothesized explanatory variables was performed using VIF for each continuous variable were found to be less than ten thus, there is no multicollinearity problem among all the hypothesized continuous explanatory variables included in the model as indicated in Appendix Table 1.Also, the result of the contingency coefficient (CC) revealed that there was no serious problem of association among dummy explanatory variables as the contingency coefficient did not exceed 0.75 (Appendix 2).Consequently, the dummy variables are included in the model.

4.5. Determinants of household's sorghum Market participation and level of participation

About 11 variables were hypothesized to determine the household-level decision to participate in the sorghum market and the volume of marketed surplus. The Probit and Heckman selection model results are depicted in tables 21 and 22. The tables show the estimated coefficients and their standard errors. The mills lambda, Wald chi$^{\wedge 2}$, prob>ch$^{\wedge 2}$, Rho censored (selected) and uncensored (unselected) sample test results are presented at the bottom of the table (Tables 21 and 22). The analysis reveals that there are some differences in terms of the magnitude and direction of determinants significantly affecting the decision to participate and its level of participations.

4.5.1. Determinants of household's sorghum market participation decisions

To determine the determinants of market participation of sorghum in the study area, a probit model was estimated in the first step of the latent binary decision variable of whether or not a household has participated in the market as a seller or not (selection equation). As Kyaw *et al*.(2018) proposed utilizing the preference variable which is expected to have a significant effect on the marketing decision, but not the sum of promotion in the preferential equation which helps

to exactly estimate the inverse Mills ratio. This work has also used market information as selection variables in the probit model/selection equation, which has been shown to affect the decision on the marketing of sorghum to the market but has no major effect on the level proxy to the volume of sorghum supplied to the market in order to correctly estimate the lambda (inverse Mills ratio).

Based on the results of the first-stage probity model estimation of the determinants of the probabilities of the farmer's participation decisions in the sorghum market are given in table 21.This table also contains the values of marginal effects which are evaluated at the means of all other independent variables. The model chi-square tests applying appropriate degrees of freedom indicated that the overall goodness of fit of the probit model was statistically significant at a probability of less than 1% (Wald $chi^2(10) = 247.34$ with $Prob > chi^2 = 0.0000$) factor level. This showed that jointly the independent variables included in the probit model regression explain the variations in the farmer's probability to sorghum market participation decision.

The model result indicated that out of 11 explanatory variables (8 continuous and 3 dummy) included in the model, five were found to be significant in influencing farmers' decision to participate in the sorghum market or not at 1%, 5% ,and 10 % significant levels. These variables include the gender of the household, access to market information (MKTINFO), age of the household's head, sorghum production, and sorghum consumption of the households (Table 21).

Gender of the household head: Gender of the household head is one of the determinant factors of sorghum market participation decision. As was hypothesized the first stage Heckman probit estimation model indicates gender of household head was found to be a positive and significant factor in explaining the probability of sorghum crop market participations decisions at a 5% significant level. This positive marginal effect coefficient shows being male-headed households

are more likely to participate in the sorghum markets than a female ones. Male-headed households increase the probability of being to participate in sorghum marketing by 1.89% more than that female household heads. This can be due to male households having information access and more resource allocation i.e., labor, skill and, good contacts with farming community in sorghum production. The result is consistent with the findings of Leykun and Haji (2014) who found that male-headed households have better access to information that would provide them with a better ability to manage their farms and produce more output for the market as compared to female- headed households.

Access to market information (MKTINFO): As it was hypothesized access to market information has a positive and significant effect of on sorghum-producing households market participation decision at a 10% significant level. Households who have better market-related information have a better positions in marketing activities and supply their produce to market than households that have no or low market-related information access. Households who participate in marketing activities of their produce this marketing involvement may raise market information at the same time increases the probability of market participation of active market participants in their surplus market. This implies that access to market information both on input and out market could help farmers to make a production decision on the basis of market signal and this allows them to produce mostly for the market.

The result of first step of Heckman probit estimation coefficients of marginal effects confirms that if the probability of households to access to market information increases, the farmers intention to participate in the sorghum market increases by 2.28%.This result is in lines with the study made by Ahmed *et al*.(2016) who found access to market information positively determines potato market supply to market.

Age of the household head: The age of the household head is another important variable that was found important factor in determining households' market participations decisions. Age of the household head which was considered to have a positive or negative impact on households' market participations decision, has a negative sign and is significant. This result indicates that as the household ages increases, the probability of households to participate sorghum market decreases and the result is statistically significant at a 5% level of significance.

This may be due to younger households being more likely to take risks associated with the market and new technology than older households. In addition, younger households have more updated information, access to mobile phones for information sources, and have long planning that motivates them to invest in sorghum market participations decisions. The result of the model indicates one more unit increase in the age of the households decreases the probability of sorghum market participation by 1.61%.This result is in line with the study made by Workneh and Michael (2002).

volume of Sorghum production: Another explanatory variable that determines the market participation decision of the sorghum-producing households was the volume of annual sorghum production. As the hypothesized household volume of sorghum annual production shows that an increase in the volume of annual sorghum production increases the household's sorghum market participation's expected this variable had a positive significant effect on the decision of households to sorghum the market participation at a 10% significant level. The marginal effect model result indicates as the volume of annual sorghum production increases the probability of the households to market participation decisions increase by 1.29% quintal for each additional quintal of harvest, keeping all other variables constant.

This implied that Households with relatively large quantities of produce had not only more likely to participate in market, but also sell a higher proportion of their output. Therefore, generating and disseminating improved sorghum technologies would bring a positive effect on sorghum sector not only in the production sector but also in the marketing sector. This finding is Consistent with previous studies made by Ahmed *et al*. 2016;Oteh and Nwachukwu, (2014) volume of total potato and casava harvest positively affected the market participation decisions of households.

Volume of sorghum consumption: As expected volume of sorghum consumption was significantly and negatively associated with the probability to supply sorghum at a 10% significant level. This means that as the consumption of sorghum increases in households the probability of the farmers orientation toward market participations decision is reduced. This implication is that households' sorghum market participation decisions depend on households' annual sorghum consumption requirements this may be because of household size that could be fulfilled from the volume of sorghum production.

Those households participate after they satisfy the need for family home consumption. Thus, the first step of Heckman probity estimate of marginal effect result indicates that a unit increase in the consumption of sorghum by households decreases the probability of households to participate in the sorghum market by 1.10% remaining other factors constant. This result is in line with the findings of Hailua *et al*.(2015) who found family size increase decreases the participation of households to the market, since a larger family size could potentially absorb a significant portion of the product to home consumption.

Table 21.Probit Estimate of determinants of sorghum market participation decision

Variables	Coefficient	Standard error	Marginal effect (dy/dx)	z-value	p-value(P>z)
Gender	1.894233**	0.8645389	1.8942**	2.19	0.028
MKTINFO	2.28954***	0.3733718	2.2895***	6.13	0.000
Age	-1.611463**	0.8044799	-1.6115**	-2	0.045
Scon	-1.100257***	0.4048023	-1.1003***	-2.72	0.007
Farmsz	0.0525685	0.3143577	0.0526	0.17	0.867
Fmlysz	0.6088102	0.3851752	0.6088	1.58	0.114
CREDT	0.2558966	0.3383927	0.2559	0.76	0.450
Sprdn	1.598497***	0.454282	1.5985***	3.52	0.000
EDU	-0.1039277	0.2305216	-0.1039	-0.45	0.652
Farmexp	0.4584632	0.3155466	0.4585	1.45	0.146
None-farm	-0.0449764	0.0453552	-0.0450	-0.99	0.321
_cons	-3.251555	3.012306		-1.08	0.280
/Mills lambda	0.4129278	0.1151236		3.59	0.000
Rho	1.00000				

*=significant at 10% level of significance, **= Significant at 5% level of significance, ***=Significant at 1% level of significance, Total observation=130, Wald chi2(10) = 247.34, Prob > chi2 = 0.0000

Source: Model result of research field Survey, 2021/22.

4.5.2. Determinants of the level of market participations of sorghum

This section deals with the result of Heckman's estimation of the OLS regression model estimating determinants of level proxy to the volume of market supply of sorghum that was measured in sells value of sorghum. According to Gebremedhin *et al*.(2007), the sales-to-output ratio measures the value of all sales by a household as a percentage of the total gross value of its agricultural production.

Sorghum is produced by households mainly for consumption and income generation through supplying to the market in the study area. However, various variables were assumed to determine the marketed surplus of sorghum by sampled households. As to the survey result of this study, out of a total of 130 sample households,63 (48.46 %) of them didn't sell sorghum even if they produce in the 2021/2022 production year. The null hypothesis for the test assumed that all coefficients are jointly zero.

It is worth mentioning at this stage that only to include farm households who participated in the market as sellers are considered in this analysis since the objective is to identify determinants for a household to sell more or less of its sorghum in the market. In this stage inverse mills ratio (IMR is included to adjust for the selection bias. The result of Heckman's estimation of the OLS regression model in these stages showed that determinants of market participation decision and level of market participations as it is different. The model result indicated in Table 22 that, out of 10 independent variables used in the model, sorghum market prices (SMS), and household sorghum consumption (Scon), were found to determine significantly the level of sorghum market participations at 1% significant levels (Table 22).

Table 22.Determinants of sorghum level of market participations

Variables	Coefficient	Standard error	z	P>z
Gender	0.0706245	0.2943166	0.24	0.810
Age	-0.1141035	0.2503787	-0.46	0.649
Fmlysz	0.2321711	0.123267	1.88	0.060
SMS	0.8083816***	0.0733221	11.03	0.000
Farmsz	-0.0323086	0.101939	-0.32	0.751
Scon	-0.4834052***	0.0587708	-8.23	0.000
EDU	0.0321624	0.0725116	0.44	0.657
Farmexp	0.0653823	0.0947019	0.69	0.490
CREDT	0.1747372	0.1052914	1.66	0.097
NFI	-0.0236879	0.0142044	-1.67	0.095
_cons	1.434931	1.016983	1.41	0.158

Censored(selected) sample= 67, Uncensored(unselected)sample=63, Total sample=130,
***=Significant at 1% level of significance

Source: Model result of research field Survey, 2021/22.

Households' sorghum consumption (Scon): sorghum consumption by households from their production is another explanatory variable that influences the level of market participations of sorghum. As expected, it has a negative significant effect on the level of sorghum market participations at 1% significant level. This is because if households having large family size households tend to consume more at home at the same time this large amount of sorghum consumption from their production results in a low level of market participation. This means that the households with more sorghum consumption at home have a lower ability to sell a small volume of sorghum output to market. The model coefficient result indicates as increase in households' sorghum consumption at home by one unit decreases a level of sorghum market participations by 0.48 quintals, keeping all other variables constant. Due to this strong

relationship is expected, since a larger family size could potentially absorb a significant portion of the produce for home consumption (Mohammed *et al*., 2016).

Sorghum current market price (SMS): As was hypothesized sorghum market price has a positive and significant effect on the level of sorghum market participations at a 1% significant level. The positive coefficient indicated that an increase in sorghum market price will increase the level of household sorghum market participations. The result also implied that in one percent increasing in the price of sorghum in the market can increase the quantity of sorghum supply by 0.80 quintals of marketable sorghum. This denotes that farmers with higher sorghum production, are willing to supply more farm output in the market at the same time level of their market participations increases. This result is parallel with findings by Sendeku, (2005) in rice and Habtewold and Challa,(2017) in teff who's result have a positive relationship between the market price of rice and the level of commercialization.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

This chapters conclusion of the topics covered in this research thesis is described in this chapter including an important recommendation for concerned bodies and policymakers. The conclusion section briefly describes the key points discussed in the thesis. A necessary implication from the finding of this study was drawn in the recommendation section.

5.1. Conclusion

The study examined household-level factors determining smallholder farmers decision to participate in the output market and the level of marketed sorghum output in Gololcha and Shene Kolu Districts of Arsi zone. Results of descriptive analysis reveals 67 (51.1%) of the total households in the sample supplied sorghum to the market, while the remaining 63 (48.5) of them were non-market participants of sorghum output markets in 2021/22 production year. The results of household commercialization index of sampled households shows that 63 (48. 46%) of households in the sample were fully subsistent while 22 (16.92%) of them categorized as less,28 (21.54%) medium,11(8.46%) highly and 6 (4.6%) were very highly level of commercialized farmers.

The result showed that about 48.46 % of sampled households in the study area were found to be at fully subsistence level of commercialization followed by medium commercialization, selling on average about 25-50% of the annual sorghum crop produce. The level of market participations of the overall sample households in the study area is 0.19 but varies from District to District with the highest (0.224) in shenen Kolu and the lowest (0.165) in Gololcha. This result indicates the gap among households in sorghum market participations level is due to the

associated different factors which affect market participation decision and level of households in sorghum output market.

Furthermore, the result of Heckman's two-step selection model reveals among the explanatory variables hypothesized to determine sorghum market participations a significant number of variables were found to determine households market participation decision and level of market participations in output market signals of the study area. Accordingly the result from the first stage of Heckman's two-stage models shows that the gender of the household head, access to market information, and households annual sorghum production significantly and positively affect household sorghum market participations decision. This positive explanatory variables factor contribute to improve or increase sorghum production leading to households to supply more to the market. Therefore, the more sorghum production of the households as a result of the positive effects the explanatory variables factors in increasing sorghum production increases market participation decision of the households to the market.

On the other hand, age of household head and household sorghum consumption negatively and significantly affect household sorghum market participations decision in the study area. This implies younger households being more likely to take risks associated with the market, access to new technology information, and have more access to updated information than older households which leads to a decrease the probability of the households to participate in sorghum market. Similarly, households who consume more their sorghum market participation decisions depends on households annual sorghum consumption requirements this is may be because of household size that could be fulfilled from the volume of sorghum production. As a result the probability of households sorghum market participation decreases.

Moreover, the Heckman second stage model depicts that household sorghum current price were found to affect positively and significantly the level of market participations in sorghum crops. This implies households with access to higher market price of sorghum offers opportunity to solve cash constraints in solving cash constraints needed in sorghum production used to purchase inputs such as fertilizer, improved seed, crop protection chemicals from the supply of sorghum that used to enhance sorghum production and productivity. Thus, in mean time access to higher market price increases the households level of sorghum output market. Contrary to this household sorghum consumption affect negatively and significantly the level of market participations in sorghum crop output market. This implies households having large family size tend to consume more at home at the same time this large amount of sorghum consumption from their production results to low level of market participation. This means that the households with more sorghum consumption at home have lower ability sell small volume of sorghum output to market.

5.2. Recommendations

In general understanding, the factors affecting households market participation decisions and their extent are very important for policymaking to address the problem of market participation and the level of market participations of farm households. The following policy implications and interventions are forwarded based on the result of the study for the study area.

- Households Sorghum annual production affected positively and significantly smallholder market participation. This indicates that higher levels of crop production enhanced smallholders' market participation, implying that strategies that aim at improving household capacity to produce surplus production per unit area of land through optimal

allocation of resources like land, and oxen and enhancing productivity in the district, could have high returns in promoting smallholders' commercial transformations.

- Gender of the household head affected household market participation decisions positively and significantly. Therefore, policies should aim at supporting female-headed households by way of proving inputs, and knowledge about sorghum crops. As a result, increasing women's access to assets, institutional services, and market access market information is required to boost their production and productivity in sorghum crops and improve their market participation in sorghum crops.
- Access to market information was found positively affect the market participation decision by providing better information and thereby decreasing fixed transaction costs like searching and processing information etc. Commercialization requires a market-oriented production system and requires information about markets. However, smallholder farmers often face information asymmetry in the factor and product markets which forces them into production for subsistence. Therefore, the provision of market information facilities infrastructure to avoid information asymmetry should be given prior attention.
- Sorghums current market price affects the households' level of market participation positively. The output price is an incentive for farm households to supply more products for sale. Therefore, in order to increase the quantity supplied interventions by regional, zonal, or district-level marketing offices should focus in the form of establishing new farmers cooperatives and improving the existing farmers cooperatives to collect sorghum products and link farmers cooperatives with output markets required to reduce broker

interferences and transportation costs and also sustain farmers' benefits from their products.

- Age of the household affected households market participation decisions negatively and significantly. The implication is that as the household head of the family gets old, the productivity and efficiency of the head tend to decrease resulting in declining labor productivity and leading to a low marketable surplus. This could be due to the better educational level and source of market information of younger farmers Therefore, an intervention intended at raising the efficiency of youth to involve in sorghum agricultural production to obtain more agricultural production with the district is important.

REFERENCES

Abafita, J., Atkinson, J., & Kim, C. S. (2016). Smallholder commercialization in Ethiopia: Market orientation and participation. International Food Research Journal, 23(4), 1797–1807.

Abasiekong, E., & Oluwatoyin, J. (2021). Heliyon Agricultural commercialisation , poverty reduction and pro-poor growth : evidence from commercial agricultural development project in Nigeria. National Library of Medicine,7(5).

Abdi, R. D. (2017). Brucellosis and some reproductive problems of indigenous Arsi cattle in selected ArsiZone ' s of Oromia Regional State , Ethiopia. Global Veterinaria, 45-53.

Abu, B. M., Osei-Asare, Y. B., & Wayo, S. (2014). Market participation of smallholder maize farmers in the upper west region of Ghana. African Journal of Agricultural Research, 9(31), 2427–2435.

Adugna, A. (2007). The Role of Introduced Sorghum and Millets in Ethiopian Agriculture. Journal of SAT Agricultural Research, 3(1), 4.

Afework, H., & Endrias, G. (2016). Review on small holders agriculture commercialization in Ethiopia: What are the driving factors to focused on? Journal of Development and Agricultural Economics, 8(4), 65–76.

Ahmed, Y. E., Girma, A. B., & Aredo, M. K. (2016). Determinants of Smallholder Farmers Participation Decision in Potato Market in Kofele District , Oromia. International Journal of Agricultural Economics,1(2), 40–44.

Alemu, M. D., Kebede, A., & Moges, A. (2019). Farmers' Perception of Soil Erosion and

Adoption of Soil Conservation Technologies at Geshy Sub-Catchment, Gojeb River Catchment, Ethiopia. Agricultural Sciences, 10(01), 46–65.

Alene, A. D., Manyong, V. M., Omanya, G., Mignouna, H. D., Bokanga, M., & Odhiambo, G. (2008). Smallholder market participation under transactions costs : Maize supply and fertilizer demand in Kenya. 33, 318–328.

Allan, N. J. R. (2015). accessibility and altitudinal zonation models of mountains. 6(3), 185–194.

Aman, T., Adam, B., & Lemma, Z. (2014). Determinants of smallholder commercialization of horticultural crops in Gemechis District, West Hararghe Zone, Ethiopia. African Journal of Agricultural Research, 9(3), 310–319.

Amsalu Mitiku. (2014). Impact of Smallholder Farmers Agricultural Commercialization on Rural Households' Poverty. In The International Journal of Applied Economics and Finance (Vol. 8, Issue (2), pp. 51–61).

Asfaw, S., Shiferaw, B., & Simtowe, F. (2010). Does Technology Adoption Promote Commercialization ? Evidence from Chickpea Technologies in Ethiopia. Journal of Development and Agricultural Economics, 3(9): 436-447.

Bedaso, T., Wondwosen, T. & Mesfin, K. (2012). Commercialization of Ethiopian smallholder farmer's production: Factors and Challenges behind. Journal of Applied Agricultural Economics and Policy Analysis, 3(1), 15–19.

Bekele, A., & Alemu, D. (2015). Farm-Level Determinants of output Commercialization : In Haricot Bean based Farming Systems . Ethiop. J. Agric. Sci. 25 61-69.

Belay, G. H., Mengstu, K. A., Mehammedberhan Kahsay, H., Hosseininia, G., Işık Özgüven, A.,

Viira, A. H., & Azadi, H. (2021). Determinants of smallholder commercialization of livestock: A case study from Tigray, Ethiopia. Cogent Food and Agriculture, 7(1).

Berhanu G. and Moti J. (2010). Commercialization of Smallholders: Is Market Participation Enough? Working Paper Series N° 253, African Development Bank, Abidjan, Côte d'Ivoire, P22.

Berhanu Gebremedhin, & Moti Jaleta. (2010). Commercialization of smallholders: Does market orientation translate into market participation? 22, 1–30.

Bernard, T., Gabre-Madhin, E., & Taffesse, A. S. (2007). Smallholders' Commercialization through Cooperatives: A Diagnostic for Ethiopia. Historical Studies. RePEc, 33.

Ciniza. Romero, T. R. (1993). Application of Multiple Criteria Decision Making Methods to Farm Planning : A Case Study. 41, 305–319.

Central Statistics Agency (CSA) (2020). The Federal Democratic Republic of Ethiopia Central Statistical Agency Report on Area and Production of Major. Statistical Bulletin, 584(August), 121.

Central Statistics Agency (CSA) (2012). Population and Housing Results of for Oroimia,Vol.1(accessed 13 January 2007)

Chamberlin, J. (2008). It's a small world after all: Defining smallholder agriculture in Ghana. Development.IFPRI Discussion Paper 00823.

Cragg, J. G. (1971). This content downloaded from 77.103.16.28 on Wed. 39(5), 829–844.

Central Statistical Agency (CSA) (2020). Agricultural Sample Survey report on Area and Production of Major Crops (Private Peasant Holdings 'Meher' Season).

Csaki, C. (2001). Reaching the rural poor. In Development Policy Review (Vol. 19, Issue 4).

Davis, K., Swanson, B., Amudavi, D., Mekonnen, D. A., Flohrs, A., Riese, J., Lamb, C., & Zefru, E. (2010). In-Depth Assessment of the Public Agricultural Extension System of Ethiopia and Recommendations for Improvement. IFPRI Discussion Paper, 01041(December), 1–76.

Diao, X., Dorosh, P., & Rahman, S. M. (2007). Market Opportunities for African Agriculture: A General Equilibrium Examination of Demand-Side Constraints on Agricultural Growth in East and Southern Africa. International Food Policy Research Institute (IFPRI),154-161.

Dillon, S., Shapter, F., Henry, R., Cordeiro, G., Izquierdo, L., & Lee, S., (2007). Domestication to crop improvement: Genetic resources for Sorghum and Saccharum (Andropogoneae). Annals of Botany, 100(5), 975–989.

Dolan, C., & Humphrey, J. (2000). Governance and trade in fresh vegetables: The impact of UK supermarkets on the African horticulture industry. Journal of Development Studies, 37(2), 147–176.

Dube, L. and, & Guveya, E. (2016). Determinants of agriculture commercialization among smallholder farmers in Manicaland and Masvingo Provinces of Zimbabwe. Agricultural Science Research Journal, 6(8), 182–190.

Edosa, T. L. (2018). Determinants of commercialization of teff crop in Abay Chomen District, Horo Guduru wallaga zone, Oromia Regional State, Ethiopia. Journal of Agricultural Extension and Rural Development, 10(12), 251–259.

Ejeta, B., & Masresha, D. (2020). Determinants of Red Bean Commercialization by Smallholder

Farmers in Shalla Districts, Oromia Regional State, Ethiopia. Agriculture, Forestry and Fisheries, 9(6), 153.

Emerta, B., & Aragie, A. (2013). Climate change,Growth , and poverty in ethiopia. june.

Endalew, B., Aynalem, M., Assefa, F., & Ayalew, Z. (2020). Determinants of Wheat Commercialization among Smallholder Farmers in Debre Elias Woreda, Ethiopia. Advances in Agriculture, 2020, 1–12.

Enyew Muluken, Tileye Feyissa, Anderes S.Carlsson, K. (2022). Genetic Diversity and Population Structure of Sorghum [Sorghum Bicolor (L .) Moench] Accessions as Revealed by Single Nucleotide Polymorphism Markers. Plant Breeding, a Section of the Journal Frontiers in Plant Science, 12(January), 1–19.

FAO. (2013). Analysis of incentives and disincentives for sorghum in Ethiopia draft version January 2013. January, 1–34.

Federal, The., Republic, D., Agency, C. S., & Survey, A. S. (2012). the Federal democratic republic of ethiopia volume vii report on. 2012(january 2011).

Felix, K., Erick, C., Charles, M. M., Francis, N. W., & James, O. (2014). Biochemical quality indices of sorghum genotypes from east Africa for malting and brewing. African Journal of Biotechnology, 13(2), 313–321.

Fetene, M., Okori, P., Gudu, S., Mneney, E. E., & Tesfaye, K. (2010). Delivering new sorghum and finger millet innovations for food security and improving livelihoods in Eastern Africa. November 2010, 1–52.

Fountas, S., Wulfsohn, D., & Blackmore, B. S. (2006). A model of decision-making and

information flows for information-intensive agriculture. 87, 192–210.

Gebre, E., Workiye, A., & Haile, K. (2021). Heliyon Determinants of sorghum crop commercialization the case of Southwest Ethiopia. Heliyon, 7(June), e07453.

Gebremedhin, B., Hoekstra, D., & Jemaneh, S. (2007). Heading towards commercialization ? The case of live animal marketing in Ethiopia. International Livestock Research Institute, Improving Productivity and Market Success (IPMS) of Ethiopian Farmers. Journal of Service Science and Management, Vol.5 No.1, March 28, 2012, Nairobi, Kenya.

Gebreselassie, S, & Sharp, K. (2008). Commercialisation Of Smallholder Agriculture In Selected Tef-Growing Areas Of Ethiopia. Ethiopian Journal of Economics, 16(1), 55–86.

Gebreselassie, Samuel, & Ludi, E. (2008). Agricultural Commercialisation in Coff ee Growing Areas of Ethiopia . Ethiopian Journal of Economics, 005(1.

Getahun, A. (2019). Determinants of Commercialization of Tef : The Case of Smallholder Farmers in Dendi District of Oromia , Central Ethiopia. International Journal of Africa and Asia studies ,56-01.

Getahun, A. (2020). Smallholder Farmers Agricultural Commercialization in Ethiopia : A Review 2 . Notions on Smallholders and. 9(3), 67–74.

Govereh, J., Jayne, T. S., & Nyoro, J. (1999a). Smallholder Commercialization , Interlinked Markets and Food Crop Productivity : Cross-Country Evidence in Eastern and Southern Africa. International Livestock Research Institute, Nairobi, Kenya. 55 pp

Govereh, J., Jayne, T. S., & Nyoro, J. (1999b). smallholder commercialization , interlinked markets and food crop productivity : cross-country evidence in eastern and southern africa.

International Livestock Research Institute, Nairobi, Kenya. 55 pp.

Greene, W. H. (2000). Econometric Analysis, 4th Edition, Prentice Hall, Englewood Cliffs.

Gololcha woreda office of Agricultural (GWoA) (2022).Annual Report.Gololcha,Arsi.

Habtewold, A. B., & Challa, T. M. (2017). determinants of smallholder farmers in teff market supply in ambo district , west shoa zone of oromia , Ethiopia. International Journal of Advanced Research in Management and Social Sciences, 6(2), 133–140.

Haile, K. et al. (2018). Technical Efficiency of Sorghum Production : The Case of Smallholder Farmers in Konso District,Southern Ethiopa. Journal of Agricultural Economics, Extension and Rural Development: ISSN-2360-798X, Vol. 6(7): pp, 772-793.

Haile, K., & Gebre, E. (2022). Determinants of market participation among smallholder farmers in Southwest Ethiopia : double-hurdle model approach.Journal of Agriculture and Food Security, 1–13.

Hailua, G., Manjureb, K., & Aymutc, K. (2015). Crop commercialization and smallholder farmers ` livelihood in Tigray region , Ethiopia. Journal od Development and Agricultural Economics,7(9), 314–322.

Headey, D. D., & Jayne, T. S. (2014). Adaptation to land constraints: Is Africa different? Food Policy.Elsevier,*48*, 18–33.

Heckman, J. J. (1979). Sample Selection Bias as a Specification Error (with an application to the estimation of labor supply functions): The Econometric Society Stable *Econometrica*, *47*(1), 153–161.

Henson, S., & Loader, R. (1999). Impact of sanitary and phytosanitary standards on developing

countries and the role of the SPS Agreement. Agribusiness, *15*(3), 355–369.

Hichaambwa, M., & Jayne, T. S. (2012). Smallholder Commercialization Trends as Affected by Land Constraints in Zambia : What are the Policy Implications ? Poverty Reduction Potential of Increasing Smallholder Access to Land by Munguzwe Hichaambwa and T . S . Jayne Indaba Agricultural Policy Re. September 2014.

Horvath, R. J. (1967). Von thunen's isolated state and the area around addis ababa, ethiopia.Jstor, Vol. 59, No. 2 (Jun., 1969), pp. 308-323.

Johnston, R., & Jones, K. (2019). A classic that wasn't: Statistical Geography and paths only later taken.Sage Journals, Volume 44,113-129.

Joskow, J., & Yamane, T. (1965). Statistics, an Introductory Analysis. Journal of the American *Statistical Association*, *60*(310), 678.

Kabiti, H. M., Raidimi, N. E., Pfumayaramba, T. K., & Chauke1, P. K. (2016). Determinants of Agricultural Commercialization among Smallholder Farmers in Munyati Resettlement Area, Chikomba District, Zimbabwe. Journal of Human Ecology, 53(1), 10–19.

Kassa, G., Yigezu, E., & Alemayehu, D. (2017). Determinants of smallholder market participation among banana growers in bench Maji Zone, Southwest Ethiopia. International Journal of Agricultural Policy and Research, 5(11), 169–177.

Kinfe, H., & Tesfaye, A. (2018). Edelweiss Applied Science and Technology Yield Performance and Adoption of Released Sorghum Varieties in Ethiopia.Edelwess Publication, 2(1), 46–55.

Kmenta, J., Aldrich, J. H., Nelson, F. D., Newbold, P., & Bos, T. (1988). Linear Probability,

Logit, and Probit Models. In Journal of the American Statistical Association (Vol. 83, Issue 401).

Kyaw, N. N., Ahn, S., & Lee, S. H. (2018). Analysis of the Factors Influencing Market Participation among Smallholder Rice Farmers in Magway Region , Central Dry Zone of Myanma*r*.Sustainability, 10(12), 4441.

Land O'Lakes, I. P. O. (2010). The next stage in Dairy development. Usaid, November, 1–88.

Leavy J., Poulton, C., & Poulton, C. (2008). Commercialisations in Agriculture. Ethiopian Journal of Economics, 16(1).

Lenth R. V. (2001). Some Practical Guidelines for Effective Sample-Size Determination. International Journal of Behavioral Development, 1–11.

Lerman, Z. (2004). Policies and institutions for commercialization of subsistence farms in transition countries. Journal of Asian Economics, 15(3), 461–479.

Leykun, D., & Haji, L. (2014). Munich Personal RePEc Archive Econometric Analysis of Factors Affecting Market Participation of Smallholder Farming in Central Ethiopia Econometric Analysis of Factors Affecting Market. Munich Personal RePEc Archive, 77024.

Lipton, M. (2005). The family farm in a globalizing world the role of crop science in alleviating poverty. In Food, Agriculture, and the Environment Discussion Paper (Issue 40) ,Pages: 28.

Mahdi;, Tongdeelert, P., & Rangsipaht, S. (2010). Factors Influencing the Adoption of Improved Sorghum Varieties in Awbere District of. East African Journal of Sciences, 4, 41–47.

Marja H. Thijssen, Zewdie Bishaw, A. B. and W. S. de B. (2008). Farmers , seeds and varieties -

Supporting informal seed supply in Ethiopia (Issue January).

Martey, E., Al-hassan, R. M., & Kuwornu, J. K. M. (2012). Commercialization of smallholder agriculture in Ghana: A Tobit regression analysis. African Journal of Agricultural Research, 7(14), 2131–2141.

Mazengia, Y. (2018). Smallholders commercialization of maize production in Guangua district , northwestern Ethiopia.World Scientific News,58, 65–83.

Mcguire, S. (2005). Getting Genes *:* Rethinking seed system analysis and reform for sorghum in ethiopia. PH.D Thesis.Wageningen University ,October, 279.

McGuire, S. J. (2007). Vulnerability in farmer seed systems: Farmer practices for coping with seed insecurity for sorghum in eastern ethiopia. Economic Botany, 61(3), 211–222.

Mekbib, F. (2008). Farmers' breeding of sorghum in the center of diversity, ethiopia: I. socioecotype differentiation, varietal mixture and selection efficiency. Journal of New Seeds, 9(1), 43–67.

Meleaku T, Goshu, D., & Tegegne, B. (2020). Determinants Sorghum Market among Smallholder Farmers in Kafta Humera District Tigeray Ethiopia. South Asian Journal of Social Studies and Economics, 8(1), 1–13.

MoFED (Ministry of Finance and Economic Development).(2010).Growth and Transformation Plan (GTP 2010-2015).Addis Ababa.Ethiopia.

Mohammed A, Baze M, & Ahmed M. (2016). Smallholder Commercialization and Commercial Farming in Coffee-Spice Based Farming System of South West Ethiopia. International Journal of Research Studies in Agricultural Sciences, 2(5), 13–26.

Mohammed Nasir , Mulugeta W, & Kassa B. (2017). Impact of Commercialization on Rural Households' Food Security in Major Coffee Growing Areas of South West Ethiopia: The Case of Jimma Zone. International Journal of Economics & Management Sciences, 06(04).

Musah A. B. U. B. (2013). market participation of smallholder farmers in the upper west region of ghana. African Journal of Agricultural Research, 9(31):2427-2435

Mutabazi, K., Wiggins, S., & Mdoe, N. (2013). Commercialisation of African Smallholder Farming:The Case of Smallholder Farmers in Central Tanzania. Future Agricultures Working Paper 72.

Nagara, G. O. (2017). Genetic Diversity Analysis of Sorghum [Sorghum bicolor (L .) Moench] Races in Ethiopia Using SSR Markers. African Journal of Biotechnology, 20(11),431-439.

NBE. (2017). *Annual Report*. 138. www.nbe.gov.et

Negesse Senbeta, A. (2020). Factors Affecting Level of Potato Commercialization in Kofale District, West Arsi Zone, Oromia Regional State, Ethiopia. Journal of Investment and Management, 9(2), 56.

NPC (National Planning Commission) (2016). Federal Democratic Republic of Ethiopia Ethiopia Growth and Transformation Plan II(GTP II).(2015/16-2019/20) Volume I.NPC May,2016,Addis Ababa.

Nyoro, J., Karanja, D., & Strauss, J. (1999). Effects of Agricultural Commercialization on Food Crop Input Use and Productivity in Kenya. Security International Development ,1–4.

Ogutu, S. O., Gödecke, T., & Qaim, M. (2020). Agricultural Commercialisation and Nutrition in Smallholder Farm Households. Journal of Agricultural Economics, 71(2), 534–555.

Opondo, F. A., Dannenberg, P., & Willkomm, M. (2017). Characterization of the levels of cassava commercialization among smallholder farmers in Kenya : A multinomial regression approach. African Journal of Agricultural Research,12(41), 3024–3036.

Oteh, O. U., & Nwachukwu, I. N. (2014). efect of commercialization on productive capacity among cassava producing households in ikwuano local government area of abia state , nigeria. Management, Economic Engineering in Agriculture and Rural Development, 14(3), 213–220.

Pauw s. (2017). Agricultural Commercialization in Ethiopia: A Review of Warehouse Receipts in the Maize, Wheat, Sorghum and Tef Value Chains. USAID/Ethiopia Agriculture Knowledge, Learning, Documentation and Policy Project, Addis Ababa. June.

Pender, J. (2007). Determinants of smallholder commercialization of food crops : Theory and evidence from Ethiopia IFPRI Discussion Paper 00745 Determinants of Smallholder Commercialization of Food Crops Theory and Evidence from Ethiopia John Pender , International Food Pol. January.

Pender, J., & Alemu, D. (2007). Determinants of Smallholder Commercialization of Food Crops. IFPRI Discussion Papers, December, 88.

Pender, J. and D. A. (2007). Determinants of smallholder commercialization of food crops : Theory and evidence from Ethiopia IFPRI Discussion Paper 00745 Determinants of Smallholder Commercialization of Food Crops Theory and Evidence from Ethiopia John Pender , International Food Pol. August 2014.

Peshkin, A. (2015). Goodness.sage, 22(2), 23–29.

Pingali, P., Khwaja, Y., & Meijer, M. (2005). Commercializing Small Farms: Reducing Transaction Costs ESA Working Paper No . 05-08 Commercializing Small Farms : Reducing Transaction Costs. Ideas,05, 2–42.

Pingali, P. L. (1997). From Subsistence to Commercial Production Systems: The Transformation of Asian Agriculture. American Journal of Agricultural Economics, 79(2), 628–634.

Pingali, P. L., & Rosegrant, M. W. (1995). Agricultural commercialization and diversification: processes and policies. Food Policy, 20(3), 171–185.

Ramalho, E. A., & Ramalho, J. J. S. (2009). strategies for fractional regression models Alternative estimating and testing empirical strategies for fractional regression models.Economic Development, 19-68.

Ravallion, M., Chen, S., & Sangraula, P. (2007). New evidence on the urbanization of global poverty. Population and Development Review, 33(4), 667–701.

Rios, S. J. S. H. L. D. (2011). Smallholder Farmers , Emerging Standards , and Development Assistance Programs in Africa A Research Program Synthesis. The World Bank, 62324, 1–184.

Rogers, E. M., & Everett, M. (1995). diffusion of third edition .A Division of Macmillan Publishing Co., Inc.866 Third Avenue, New York, N. Y. 10022.

Schultz, T. W. (1964). Transforming Traditional Agriculture Redux .Theoretical Economics Letters,8,13.

Seife Ayele and Caroline Bosire. (2011). *F*armers ' use of improved agricultural inputs and practices : review and synthesis of research in Ethiopia. IPMS Information Resources , 1–

Sendeku, W. (2005). factors determining supply of rice;a study in fogera districts of ethiopa Agriculture Forestry and Fisheries, 8(5):95.

Seyoum, C., Lemma, T., & Karippai, R. S. (2011). Factors Determining the Degree of Commercialization of Smallholder Agriculture : The Case of Potato Growers in Kombolcha District , East Hararghe, Ethiopia. Jad, 2(1), 18–36.

Seyoum Taffesse, A., Dorosh, P., & Gemessa, S. A. (2013). Crop production in Ethiopia: Regional patterns and trends. *F*ood and Agriculture in Ethiopia: Progress and Policy Challenges.Agricultural Sciences, 53–83.

Sharp, K., Ludi, E., & Gebreselassie, S. (2008). Commercialisation Of Farming In Ethiopia: Which Pathways? Ethiopian Journal of Economics, 16(1), 41–55.

Silamana, & Nadembega, M. M. D. B. S. (2019). Determinant of Adoption of Improved Varieties of Sorghum in Center-north and Boucle du Mouhoun in Burkina Faso.Journal of Economics and Sustainable Development,10(4), 85–92.

Singh, I., Squire, L., & Strauss, J. (1986). *A* Survey of Agricultural Household Models : Recent Findings and Policy Implications.Jstor, 1,pp. 149-179.

Shenen Kolu Woreda Offices Agriculture (SKWoA). (2022). Annual Report.Shene Kolu,Arsi.

Stephen, K., Patience, M., & Eliud, B. (2017). Factors Influencing Commercialization of Beans among Smallholder Farmers in Rwanda. IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) 10(8), PP 30-34

Storck, H., Bezabih Emana, Berhanu Abebe, Borowiesck, A. (1991). Farming systems and resource economics in the tropics: farming system and farm management practices of

smallholders in the Hararghe Highland. Agris.Fao.Org Wissenschaftsverlag Vauk, Kiel, vol II(1), 116.

Strasberg, P. J., Jayne, T. S., Yamano, T., Nyoro, J., Karanja, D., & Strauss, J. (1999). MSU International Development Working Papers food crop input use and. Agricultural Economics. Department of Agricultural, Food, and Resource Economics,28 pp

Tadele, M., Wudineh, G., Agajie, T., Ali, C., Tesfaye, S., Aden, A.-H., Tolessa, D., & Solomon, A. (2017a). Analysis of wheat commercialization in Ethiopia: The case of SARD-SC wheat project innovation platform sites. African Journal of Agricultural Research, 12(10), 841–849.

Tadele, M., Wudineh, G., Agajie, T., Ali, C., Tesfaye, S., Aden, A.-H., Tolessa, D., & Solomon, A. (2017b). Analysis of wheat commercialization in Ethiopia: The case of SARD-SC wheat project innovation platform sites. African Journal of Agricultural Research, 12(10), 841–849.

Taffesse, A. S., Dorosh, P., & Asrat, S. (2017). Crop production in Ethiopia : Regional patterns and trends Crop Production in Ethiopia : Regional Patterns and Trends. essp ii research note, 2.

Taffesse, A. S., Dorosh, P., & Gemessa, S. A. (2012). Crop Production in Ethiopia: Regional Patterns and Trends. Summary of Report Ethiopian Strategy Support Program (ESSP II), Research Note 11, IFPRI and EDRI, Addis Ababa, Ethiopia.

Tariku Ayele, & Daka. (2018). Analysis of Market Decision and Level of Participation of Smallholder Wheat Farmers: The Case of Adola Rede District of Guji Zone, Oromia Regional State, Ethiopia. Biomass Chem Eng, 3(2), 1–11.

Taye, M., Abebe, B. D., & Tadie, M. A. (2018). Determinants of commercialization by smallholder onion farmers in Fogera district, South Gondar Zone, Amhara national regional State, Ethiopia. Journal of Development and Agricultural Economics, 10(10), 339–351.

Tesfaye, E. (2013). Marketing Channels and Transaction Costs for Sorghum Value Chains in Ethiopia. International Journal of Agricultural Economics and Extension ISSN: 2329-9797 Vol. 1(6), pp. 031-040.

Tobin, J. (1958). Liquidity preference as behavior towards risk. Review of Economic Studies, 25(2), 65–86.

Von Braun, J., Kennedy, E., 2017. (1994). Agricultural commercialization economic development and nutrition. Am. J. R. Dev. 1, 116–120.

von Braun, J., & Immink, M. (1994). Nontraditional vegetable crops and food security among smallholder farmers in Guatemala. The international food policy, 189–203.

wassihun, Agerie Nega, Fikeremaryam, Birara Feleke, Tadie, Mirie Abate, Gebrehiwot, A. B. (2020). Analysis of Maize Commercialization among Smallholder Farmers : Empirical Evidence from North Western Ethiopia. International Journal of Agricultural Marketing, 4 (2), 161–169.

Wooldridge. (2002). Wooldridge_Panel_Data_Chapters.pdf. In Econometric Analysis of Cross Section and Panel Data. Journal of Econometrics, 19 (2), 48–67.

Workneh Negatu, and M. R. (2002). Intensification and Crop Commercialization in Northeastern Ethiopia. Ethiopian Journal of Economics, 11(2), 84–107.

World Bank. (2006). Ethiopia: Managing Water Resources Managing Water Resources to

Maximize, Report No.36000-ET. 36000, 1–119.

World Bank. (2008).World Development Report 2008 : Agriculture for Development. Washington, DC 20433,USA.

Yan, Y., Trouvé, E., Bisserier, A., Mauris, G., Galichet, S., Pinel, V., & Pathier, E. (2010). Assimilation of D-InSAR and sub-pixel image correlation displacement measurements for coseismic fault parameter estimation. International Geoscience and Remote Sensing Symposium (IGARSS), 3664–3667.

Yoseph Wolebo, Beyene Fekadu, D. (2019). Adoption of improved sorghum varieties in fedis. hu-ir system, march, 74p.

Zerssa G, Feyssa D, Kim, D. G., & Eichler-Löbermann, B. (2021). Challenges of smallholder farming in Ethiopia and opportunities by adopting climate-smart agriculture. Agriculture (Switzerland), 11(3): 1–26.

Zhou S., Minde I. J., & Mtigwe B. (2013). Smallholder agricultural commercialization for income growth and poverty alleviation in southern Africa: A review. African Journal of Agricultural Research, 8(22): 2599–2608.

Appendices

Appendix I. List of tables in Appendices

Appendix Table 1. Multicollinearity test (VIF) for continuous explanatory variables (VIF) in the Heckman two step selection model

Variable	VIF	1/VIF
Age	1.19	0.849898
Famlysze	1.4	0.75713
lnSMS	1.41	0.60472
farmsz	1.34	0.657251
lnScon	1.36	0.788342
lnEDU	1.37	0.76787
Farmexp	1.23	0.684561
lnNFI	1.44	0.729327
Mean VIF	1.34	0.729887

Where: Age=Age of household's head, Famlysze=household family size, lnSMS=volume of sorghum supply, lnScon=household sorghum consumption, lnEDU=household head level of schooling, Farmexp=household head farm experience, lnNFI=households non-farm income.

Source: Owen computation-based model output

Appendix Table 2. Contingency coefficients among the dummy explanatory variables in the Heckman two step selection model

	Gender	MKTINFO	CREDT
Gender	1.00		
MKTINFO	0.116(0.185)	1.00	
CREDT	0.137(0.114)	0.031(0.720)	1.00

Where: Gender=sex of the household head, MKTINFO=household success to market information, CREDT=household access to credit

Source: Owen computation-based model output

Appendix Table 3. Result of correlation matrix between explanatory variables in the model

	Gende	MKTINF	lnAge	lnSco	lnFarms	lnFmlys	CRED	lnSprd	lnED	lnFarmex	lnNFI
Gender	1.0000										
MKTINFO	0.1164	1.0000									
lnAge	-0.1935	-0.1549	1.0000								
lnScon	0.2122	-0.1259	0.0076	1.0000							
lnFarmsz	0.1416	-0.0166	0.1607	0.3848	1.0000						
lnFmlysz	-0.002	0.0109	0.1411	0.2122	-0.0744	1.0000					
CREDT	0.1387	-0.0314	-0.0235	0.0945	0.0815	-0.0003	1.0000				
lnSprdn	0.2363	0.0414	-0.026	0.6264	0.3376	-0.0084	0.0057	1.0000			
lnEDU	0.3995	0.0451	-0.426	0.1018	0.1327	-0.0441	0.0771	0.0976	1.0000		
lnFarmexp	-0.0341	-0.0824	0.6532	0.0425	0.1761	0.1326	-0.1147	0.0912	-0.3525	1.0000	
lnNFI	0.0338	0.0872	0.0136	0.1005	0.1033	-0.0534	0.0967	0.2555	-0.0686	-0.0253	1.000

Where: Age=Age of household's head, Famlysze=household family size, lnSMS=volume of sorghum supply, lnScon=household sorghum consumption, lnEDU=household head level of schooling, Farmexp=household head farm experience, lnNFI=households non-farm income, Gender=sex of the household head, MKTINFO=household success to market information, CREDT=household access to credit

Source: Owen computation from survey data,2020/21

Appendix Table 4. Conversion factors used to estimate Tropical Livestock Unit equivalents

Livestock category	Tropical Livestock Unit (TLU)
Camel	1.25
Horse	1.10
Ox and Cow	1.00
Weaned Calf	0.34
Heifer	0.75
Calf	0.25
Donkey (adult)	0.70
Donkey (young)	0.35
Sheep and Goat (adult)	0.13
Sheep and Goat (young)	0.06
Chicken	0.013

Source:(Storck et al., 1991)

Appendix Table 5. Details of Focus Group Discussion (FGD) in each kebeles

Type of FGD	Mine Adaye kebeles		Furda Bela Kebeles	
	Number of FGD	Number of members	Number of FGD	Number of members
Male-headed farmers' FGD	1	10	1	13
Female-headed farmers' FGD	1	8	1	9
Youth-based FGD	1	6	1	11
Total	3	24	3	33

Source: field data of focus group Discussion 2021/22

Appendix II. Questionnaire for Sample Households

Introductory and consent statement:

"Dear Sir/Madam, we are conducting a survey to study Analysis of determinants of smallholder sorghum commercialization: the case of Arsi zone, Oromia region, Ethiopia. Your household response to these questions would remain **anonymous**. Taking part in this study is voluntary. If you choose not to take part, you have the right not to participate and there will be no consequences.

Do you and your family consent to provide information? **1**=Yes, **0**=No

"Thank you for your kind co-operation".

Dear enumerators, the objective of this study is Analysis determinants of smallholder sorghum commercialization: the case of Arsi zone in potential sorghum growing areas. The questionnaire is prepared to guide the data collection for the proposed study. The proposed study will be significant to farmers and government as it will provide more insights on the commercialization status and its determinants. It will also help in setting priorities to policy makers, researchers and other stakeholders and to bring better understanding on how to ensure a continuous production of sorghum and improve sorghum production to supply to market signals to improve the standard of living among the farming communities. Hence, the final result of the assessment will be very pertinent in giving direction for further research and measures on the issues. Thus, your contribution is very important in attaining the intended objectives of this study. Therefore, I kindly request your genuine work in filling the questionnaire.

KEY INSTRUCTIONS TO THE ENUMERATORS

Please,

- ☞ Introduce yourself (name, organization) clearly,
- ☞ Salute the respondent the traditional way,
- ☞ Explain the purpose of this study to the respondent and,
- ☞ Explain to the respondent that any information he/she provides will be confidential and used only for public benefit, then confirm his/her willingness to respond to the questionnaire

IDENTIFICATION

Name of the Enumerator_____ Date:_____Sign:_____
Starting time:_____ Questionnaire ID.no._____

PART 0. INTERVIEW BACKGROUND
General Information

No.	Question (*Instructions*)	Response
1.	Respondent's name	
2.	Mobile phone No	
3.	Date of interview (DD/MM/YYYY)	
4.	Enumerator's name	
5.	Region	
6.	Zone	
7.	District/Woreda	
8.	PA/Kebele	
9.	Latitude of the dwelling unit (N)	
10	Longitude of the dwelling unit (E)	
11	Altitude of the dwelling unit	

PART 1. HOUSEHOLDS DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS

1. Number of years the respondent has been living in this village.....
2. Experience in crop production (no of years): _____
3. Experience in sorghum farming (no of years): _____

4.Do you have any leadership position/ responsibility in your area (including official roles)
1. Yes 0. No

5.If Yes, Type of major leadership position/ responsibility ……

6.What means of transport do you use mainly to get to the village market? (**Codes A**) …

7.Average walking distance to the nearest main market ..... minutes of walking time

8.Distance to the nearest farmer cooperative from residence (km)…minutes of walking time ....

9.Distance to the nearest agricultural extension office from residence (km) minutes of walking time…

10.What is the source of income for your household (Codes **B:** more than one answer is possible)

Codes A: 1. Walking; 2. Bicycle; 3. Tractor; 4. Car; 5. Cart, 6. Other, specify

PART 2: CURRENT HOUSEHOLD COMPOSITION AND CHARACTERISTICS

Family code	Name of household member (start with respondent)	Sex Codes A	Marital status Codes B	Age (years)	Education (years) **Codes C**	Relation to HH Codes D	Occupation Codes E		Owen farm labour contribution **Codes F**
							Main	Secondary	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
01									
02									
03									
04									
05									
06									

Codes A	**Codes B**	**Codes C**	**Codes D**	**Codes E**	**Codes F**
0. Female 1. Male	1. Married living with spouse 2. Married but spouse away 3. Divorced/separated 4. Widow/widower 5. Never married 6. Other, specify……	0. None/Illiterate 1. Basic (read & write) * Give other education in years	1. Household head 2. Spouse 3. Son/daughter 4. Parent 5. Son/daughter in-law 6. Grand child 7. Other relative 8. Hired worker 9. Other, specify……	1. Farming (crop + livestock) 2. Salaried employment 3. Self-employed off-farm 4. Casual labourer on-farm 5. Casual labourer off-farm 6. School/college child 7. Non-school child 8. Herding 9. Household chores 10. Other, specify……	1. 100% 2. 75% 3. 50% 4. 25% 5. 10% 6. Not a worker

Part 3. HOUSEHOLDA RESOURCE OWNERSHIP AND OTHER SOURCE OF INCOME

1.Do you have your Owen farm land? 1.yes 2. No

2. What is the total arable land holding ……. ha/acres?

3.Hou is the land acquired?

Land holding (hectare) during the 20012-cropping year (last cropping year)

Land category	**Land tenure and use**	
	Cultivated (annual + permanent crops)	Uncultivated (e.g. grazing, homestead etc)
1. Own land used (A)		
2. Rented in land (B)		
3. Rented out land (C)		
4. Borrowed in land (D)		
5. Borrowed out land (E)		
6. Total owned land (A+C+E)		
7. Total operated land (A+B+D)		
10. Area allocated for sorghum crop		

4.Does the household own any of the following implements?

4.1Production equipment and major household furniture

Asset	Number (if no equipment put zero)	What would be the average price per item, if you would sell it now? (ETB)	Total current Value
1. Horse/mule cart			
2. Donkey cart			
3. Horse/Mule saddle			
4. Push cart			
5. Ox-plough			
6. Sickle			
7. Pick Axe			
8. Hoe/Jembe			
9. Knapsack sprayer			
10. Motor water pump			
11. Radio			
12.Other, specify			

5.Do you have livestock? 1.yes 2. No

Livestock production activities during 2021/22 cropping year

Livestock type	Number of livestock at end of 2021 cropping season (including bought ones)	If you would sell […], how much would you receive from the sale? (ETB) (If more than one livestock takes average price)	Total Value
1	**2**	**3**	
Cattle			
1. Indigenous milking cows			
2. Cross-bred milking cows			
3.Exotic milking cows			
4. Non milking cows (mature)			
5. Trained oxen for ploughing			
6. Bulls			
7. Heifers			
8. Calves			
9. Goats			
10. Sheep			
11. Donkeys			
12. Horses			
14. Chicken			
15. Local Bee hives			

6.Have you participated on non-farm income activities? 1.yes 2. No

7.If yes what is your source of income in during 2021 cropping year

Sources of income	Who earned/ received? 1=Women 2=Men; 3=Both	No. of units worked/	Unit (e.g., month, week, day, year, kg, no.)	Amount per unit (Cash & in-kind)		Total income (cash & in-kind)		Total income (ETB)
				Cash **(ETB)**	Payment in kind **Cash equivalent**	Cash **(ETB)**	Payment in kind	
1	**2**	**3**	**4**	**5**	**6**	**7= 4*6**	**8=4*7**	**9= 8+9**
1. Rented/sharecropped out land								
2. Rented out oxen								
3. Salaried employment								
4. Farm labour wages								
5. non-farm labour wages								
6. Other business (shops, trade, tailor, sales of beverages etc)								
7. Pension income								
8.Safety net or food for work								
9. Remittances								
20. Grand total								

Part 4. FARM INPUT USE RELATED IFORMATION (Fertilizer, Seed, Herbicides and Pesticides)-sorghum only

1.Do you have access to production input? 1.Yes 2. No

Serial number	**plot size (ha)**	Fertilizer									Seed					Herbicide			Insecticide			Fungicide		
		DAP used in (kg)	price per kg	Cost in Birr	Urea used in (kg)	price per kg	Cost in Birr	NPS used in (kg)	price per kg	Cost in Birr	Seed used in (kg)	price per kg	Cost in Birr	Seed Source in **kg (Codes A)**	Number of seasons own saved recycled	Amount used in (kg, lt, etc.)	Unit price	Cost in Birr	Amount used in (kg, lt, etc.)	Unit price	Cost in Birr	Amount (kg, lt, etc)	Unit price	Cost in Birr
1																								
2																								

Codes A

1. Own saved	5. Extension demo plots	9. Agro-dealers/agrovets	13. Other (specify)……
2. Gift from family/neighbor	6. Farmer groups/Coops	10. Bought from seed company	
3. Farmer to farmer seed exchange	7. Local seed producers	11. Provided free by NGOs/govt	
4. On-farm trials	8. Local trader	12. Govt subsidy program	

PART 5. SORGHUM CROP PRODUCTION AND BIO-PHYSICAL NATURE OF FARM LAND in 2021/22 crop calendar

Serial number	Season **Codes A**	(Sub)plot code	**(Sub)plot size (ha)**	**Crop(s) grown (Annex 1 codes)**	**Yield in Kg**	Soil fertility **Codes B**	Soil slope **Codes C**	Soil depth **Codes D**	Soil type **Codes E**	Soil & water conservation method – **Rank 3 Codes F**	Crop residue left on (sub)plot **1=Yes; 0=No**	Irrigation **(Codes G)**	

Codes A	**Codes B**	**Codes C**	**Codes D**	**Codes=E**		**Codes F**			**Codes G**
1. Belg (residual moisture) 2. Meher	1. Good 2.Medium 3. Poor	1. Gently slope (flat) 2. Medium slope 3. Steep slope	1. Shallow 2. Medium 3. Deep	1. Black 2. Brown 3. Red	4.Grey 5. Other, specify…	0. None 1. Terraces 2. Mulching	3. Grass strips 4. Trees on boundaries 5. No tillage	6.Minimum till 7.Soil bunds 8.Stone bunds 9. Other, specify…	1. Irrigated 2. Rainfed

5.1. Utilization of crop produced

Form **Codes A**	Stock before 2021 harvest (kg)	Production of 2021 (kg)	Total available stock after 2021 harvest (kg)	From the total available stock after 2021						
				Quantity sold after 2021 harvest (kg)	Average unit price after 2021 harvest (kg)	In-kind payments paid during 2021 cropping year (kg)	Seed used during 2021 cropping year (kg)	Gift, tithe, donations given out during 2021 cropping year (kg)	Consumption during 2021 cropping year (kg)	

Codes A:1. Fresh/green; 2. Dry

PART 6. SORGHUM VARIETY CHARACTERSTICS GROWIN IN 2020/21 OR IN THE PAST

Characteristics	Sorghum varieties						
Variety type according (1=OPV; 2=Hybrid; 3=don't know)							
Agronomic							
1. Grain yield							
3. Palatability of Stover							
4. Drought tolerance							
5. Water-logging tolerance							
6. Disease tolerance							
7. Insect pest tolerance							
8. Early maturity							
10. Grain size							
Market and economics							
15. Grain colour							
16. Output (grain) price							
Cooking & utilization							
18. Storability							
19. Cooking time							
20. Taste							

Code A 1. Very poor, 2. Poor, 3. Average 4. Good, 5. Very Good

PART 7. MARKETING RELATED INFORMATION

1.Have you participated in sorghum market? 1.Yes 2. No

2. Do you have market price information prior to selling your sorghum? 1.Yes 2. No

3.If you don't participate in sorghum market what is the reason?

1.low production 2.low market price 3. No market access 4. lack of transport

Crop	Market type **Codes A**	Month sold **Codes C**	Quantity sold (kg)	Who sold Codes B	Price (ETB /kg)	Buyer **Codes D**	Relation to buyer Codes E	Sales tax or charges (ETB)	Mode of transport Codes G	Actual transport cost (ETB)

Codes A	**Codes B**	**Codes C**	**Codes D**		**Codes E**	**Codes G**
1. Farmgate 2. Village 3.Main/district	0.Female 1. Male 2.both	1.January 2.February 3. March 4. April 5. May 6. June 7. July 8. August 9.September 10. October 11.November 12.December	1. Farmer group 2. Farmer Coop 3. Consumer 4. Rural assembler 5.Broker/middlemen 6. Rural grain trader	7. Rural wholesaler 8. Urban wholesaler 9. Urban grain trader 10.Exporter, 11. Other, specify…….	1. No relation but not a long-time buyer 2. No relation but a long-term buyer 3. Relative 4. Friend 5. Money lender 6. Other, specify……	1. Bicycle 2. Hired truck 3. Public transport 4. Donkey 5. Oxen/horse cart 6. Back/head load 7. Other, specify….

4.Do you store your produce to get better price? 1.Yes 2. No

Main storage structure **Codes A**	Reason of storage **Code B**	Reasons for preferring the storage structure **Codes D Rank 3**	Amount stored at the beginning **(Kg)**	If **NO Column 7,** Why **Codes F** Rank 3	If **YES column 6,** year first used **YYYY**	Length of storage **Months**	Amount at end of storage period **(kg)**	Amount lost due to pest (%) **(kg)**	Cause of storage loss **Codes G Rank 3**	Did quality deteriorate during storage **Codes E**

Codes A	**Code B**	**Codes D**	**Codes E**	**Codes F**	**Code G**
1. Traditional crib 2. Improved granary 3. Wooden store 4. Metal silo 5. Polythene bags (PICS Bags) 6. Well 7. Other, specify…….	1. Household Consumption 2. Sell at higher price 3. Seed for planting 4. Others, specify….	1. It is cheap 2. It dries well 3. Keeps off rodents 4. Keeps off other pests 5. Other, specify……	0. No 1. Yes	1. No idea/information 2. Lack of capital 3. not affordable 4. others/list…	1. Pest damage 2. Moisture loss 3. Rotting 4. Moulds 5. Theft 6. Other, specify….

8.INFRASTRUCTURAL RELATED INFORMATION

1.Do you have access to road? 1.Yes 2. No

2.Do you get transport services? 1.Yea 2. No

3.If yes how long travel to transport services? ----------hours-------distance in Km

4.Do you have access to all-weather road? 1.Yes 2. No

5.If yes what is the distance from your home to this all-weather road-------Km

PART 9. INSTITUTIONAL RELATED INFORMATION

9.1. Social capita network of the households

1.Have you and/or your spouse been member of formal and informal institutions in the last 5 years? 1= Yes; 0=No.
2.If yes please ask the following table and if no go to next section.

Type of group the husband/wife is/was a member of:(**codes A**)	Three most important group functions: **(codes B)**			Year joined (YYYY)	Role in the group **(codes C)**
	1st	**2nd**	**3rd**		

Codes A		**Codes B**		**Codes C**
1. Input supply/farmer coops/union 2. Crop/seed producer and marketing group/coops 3. Local administration 4. Farmers' Association 5. Women's Association 6. Youth Association 7. Church or mosque association/congregation	8. Saving and credit group 9. Funeral association 10. Government team 11. Water User's Association 12. Edir 13. Equb	1. Input access/marketing 2. Seed production 3. Farmer research group 4. Savings and credit 5. Funeral group 6. Tree planting 7. Soil & water conservation	9. Church group/congregation 10. Input credit 11. Other, specify……	1. Official 2. Ex-official 3. Ordinary member

10.2. Access to extension services

1.Do you get agricultural extension services? 1.Yes 2. No

Issue	Received training [….] in the last 5 years? (**Codes A**)	Main information source for 2021, Rank 3 (codes B)		
		Rank 1	Rank 2	Rank 3
1.Sorghum production & managements				
2. Field pest and disease control				
3. Soil and water management				
4. Crop rotation				
8. Crop storage pests				
9. Output markets and prices				
10. Input markets and prices				

Codes A	**Codes B**				
0. No 1. Yes	1. Government extension service 2. Farmer Coop or groups 3. Neighbour farmers	4. Seed traders/Agrovets 5. Relative farmers 6. NGOs	7. Another private trader 8. Private Company 9. Research centre	10. School 11. Radio/TV 12. Newspaper	11. Mobile phone 12. Other, specify……

11.3. Household credit need and sources over the last cropping season)

1.Do you perceived credit in 2021 cropping season? 1.Yes 2. No

Reason for loan	Needed credit? **0=no; 1=yes**	If **yes** in column 2, then did you get it?	If **Yes in column 4** Source of Credit, **Codes A**	Did you get the amount you requested **0=no; 1=yes**
1. Crop production				
2. Livestock production				
3. Invest in transport				
4. Non-farm business or trade				
5. Consumption needs (health/education)				

Codes A

1. Money lender	**4. Microfinance**	**7. Relative**
2. Farmer group/coop	**5. Bank**	**8. AFC**
3. Merry go round	**6. SACCO**	**9. Other, specify.**

2.If you don't received credit, what is the problem with? 1.lack of collateral 2. No access to financial services 3. high interest rate 4. Fear of credit

PART 9. CONSTRAINTS IN ACCESSING KEY INPUT AND CROP PRODUCTION TECKNOLOGY FRO SORGHUM CROP

1.Do you face any challenge in the access of improved sorghum technologypackages?1. Yes 2.No.

2.If your answer is Yes for Q#,1, what are the major challenges that affect the use recommended improved sorghum technology packages? _____ (Use **Code A**)

Code: 1. Lack of access to quality seed of improved sorghum variety, 2. Poor adaptability of the improved sorghum variety to our farming environment, 3. Difficulties in using the recommended spacing during planting, 4. Lack of adequate fertilizer to use the recommended amount, 5. lack of technical support regarding the use of the technology packages, 6. Others, specify

Input and production constraints	Sorghum	
	Constraint? 0. No; 1. Yes	**Level of importance:** 1=Not important at all; 2=Less important; 3=Important; 4=Vvery important
Socioeconomic		
1. Timely availability of improved seed		
2. Prices of improved seed		
3. Quality of seed		
4. Availability of credit to buy seed		
5. Timely availability of fertilizer		
6. Price of fertilizer		
7. Availability of credit to buy fertilizer		
8. Access to markets and information		
9. Reasonable grain prices		
Biophysical		
10. Drought		
11. Floods		
12. Pests		
13. Diseases		
14. Soil fertility		

Appendix III: List of figures in Appendices

Appendix figure 1. Result of Heckman two stage selection model output

```
Heckman selection model -- two-step estimates   Number of obs     =        130
(regression model with sample selection)              Selected    =         67
                                                      Nonselected =         63

                                                Wald chi2(10)     =     247.34
                                                Prob > chi2       =     0.0000
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnHCI						
Gender	.0706245	.2943166	0.24	0.810	-.5062255	.6474745
lnAge	-.1141035	.2503787	-0.46	0.649	-.6048368	.3766299
lnFmlysz	.2321711	.123267	1.88	0.060	-.0094277	.4737699
lnSMS	.8083816	.0733221	11.03	0.000	.6646729	.9520903
lnFarmsz	-.0323086	.101939	-0.32	0.751	-.2321053	.1674882
lnScon	-.4834052	.0587708	-8.23	0.000	-.5985938	-.3682166
lnEDU	.0321624	.0725116	0.44	0.657	-.1099577	.1742825
lnFarmexp	.0653823	.0947019	0.69	0.490	-.1202299	.2509946
CREDT	.1747372	.1052914	1.66	0.097	-.0316301	.3811045
lnNFI	-.0236879	.0142044	-1.67	0.095	-.051528	.0041522
_cons	1.434931	1.016983	1.41	0.158	-.5583195	3.428181
MRKTPART						
Gender	1.894233	.8645389	2.19	0.028	.1997682	3.588698
MKTINFO	2.28954	.3733718	6.13	0.000	1.557745	3.021336
lnAge	-1.611463	.8044799	-2.00	0.045	-3.188214	-.0347112
lnScon	-1.100257	.4048023	-2.72	0.007	-1.893655	-.3068596
lnFarmsz	.0525685	.3143577	0.17	0.867	-.5635612	.6686982
lnFmlysz	.6088102	.3851752	1.58	0.114	-.1461193	1.36374
CREDT	.2558966	.3383927	0.76	0.450	-.4073409	.9191341
lnSprdn	1.598497	.454282	3.52	0.000	.7081212	2.488874
lnEDU	-.1039277	.2305216	-0.45	0.652	-.5557417	.3478864
lnFarmexp	.4584632	.3155466	1.45	0.146	-.1599968	1.076923
lnNFI	-.0449764	.0453552	-0.99	0.321	-.133871	.0439183
_cons	-3.251555	3.012306	-1.08	0.280	-9.155566	2.652456
/mills						
lambda	.4129278	.1151236	3.59	0.000	.1872898	.6385659
rho	1.00000					
sigma	.41292784					

.

BIOGRAPHICAL SKETECH

The author was born in West Arsi zone of Oromia National Regional State, Ethiopia, Dodola district, Dodola town, on June 10, 1984, from his mother Yeshi Bekele, and father Roba Tadesse. He attended his primary school education at Tulu Dodola primary School, high school education at Dodola secondary school, and preparatory education at Dodola preparatory school. After completing his preparatory school education in 2003 he joined the then Jimma University in October 2004 and graduated with B.Sc. Degree in Rural development and Agricultural Extension in 2006. Immediately after graduation, he was employed by Ethiopian institute of agricultural research (EIAR) based at melkassa research center in September 2009, as a junior Researcher until author got the chance to join Hawassa University in January 2013 to purse his MSc Degree study at Hawassa University in college of agriculture school of environment, Gender and development studies in Rural Development Department.