

**PRODUCTION EFFICIENCY, POST-HARVEST LOSSES AND
MARKETING OF SESAME: THE CASE OF KAFTA HUMERA
DISTRICT, WESTERN ZONE OF TIGRAY, ETHIOPIA**

**MSc THESIS
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Haramaya University, Haramaya

APPROVAL SHEET

HARAMAYA UNIVERSITY

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Final approval and acceptance of the Thesis is contingent up on the submission of its final copy to the Council of Graduate Studies (CGS) through the candidate’s department or school graduate committee (DGC or SGC).

DEDICATION

I dedicated this thesis to my beloved father Gebretsadik Gebrealif for his unpreserved patience, lovely advice and sacrifice for my accomplishment during my academic study and in all aspects of the research.

STATEMENT OF THE AUTHOR

By my signature below, I declare and affirm that this Thesis is my own work. I have followed all ethical and technical principles of scholarship in the preparation, data collection, data analysis and compilation of this Thesis. Any scholarly matter that is included in the Thesis has been given recognition through citation.

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BIOGRAPHICAL SKETCH

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ACRONYMS AND ABBREVIATIONS

AE	Allocative Efficiency
AGP	Agricultural Growth Program
AGTP	Agricultural Growth and Transformation Plan
APHL	African Post-harvest Losses
ATA	Agricultural Transformation Agency
CAII	Center of Agribusiness Innovation and Incubation
CEXC	Commodity Exchange Export Center
CR	Concentration Ratio
CRS	Constant Returns to Scale
CSA	Central Statistical Agency
DEA	Data Envelopment Analysis
ECX	Exchange Commodity Export
EE	Economic Efficiency
EIXCC	Ethiopian Import Export Commodity Control
FAO	Food and Agricultural Organization
FAOSTAT	Food and Agricultural Organization Statistics
FOB	Fright On Board
GDP	Gross Domestic Product
GMM	Gross Marketing Margin
GOs	Governmental Organizations
GTP	Growth and Transformation Plan
ha	Hectare
HuARC	Humera Agricultural Research Center
KHARDO	Kafta Humera Agriculture and Rural Development Office
KHCRO	Kafta Humera Custom and Revenue Office
KHLAdO	Kafta Humera Land Administration Office
MoARD	Ministry of Agriculture and Rural Development
NGOs	Non- Governmental Organizations
Mt	Metric Tone

ACRONYMS AND ABBREVIATIONS (CONTINIUED...)

NMM	Net Marketing Margin
OLS	Ordinary Least Squares
Qt	Quintal
RMA	Rapped Market Appraisal
SBN	Sesame Business Network
S-C-P	Structure Conduct and Performance
SFA	Stochastic Frontier Approach
SNNP	Southern Nations and Nationalities Peoples
TE	Technical Efficiency
WB	World Bank
WTZAO	Western Tigray Zone Agricultural Office

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PRODUCTION EFFICIENCY, POST-HARVEST LOSS AND MARKETING OF SESAME: THE CASE OF KAFTA HUMERA DISTRICT, WESTERN ZONE OF TIGRAY, ETHIOPIA

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ABSTRACT

This study analyzed production efficiency, post-harvest loss and marketing of sesame in Kafta Humera district of Tigray region, Ethiopia. It was specifically aimed to address the research gaps by measuring technical, allocative and economic efficiencies and their determinants, measuring post-harvest loss and analyzing its determinants and market performance of sesame in Kafta Humera District. For addressing these objectives the study used primary and secondary data obtained from field survey and desk review. Multistage random sampling technique was used to draw 128 and 126 small and large-scale sesame producers respectively. Besides, a total of 44 assemblers, 5 cooperatives, 13 exporters and one processor were interviewed. Applying the Cobb-Douglas functional form of one step procedure the average, technical, allocative and economic efficiencies found are 62%, 84% and 52% for small-scale and 71%, 90% and 64% for large-scale producers, respectively. Regarding the small-scale producers, education level, farm distance, frequency of farm visit, training and credited amount obtained are found to be significant sources of technical, allocative and economic inefficiencies. Besides, membership in cooperative and number of extension contact are significant sources of technical and economic inefficiencies. Household age for allocative inefficiency and sesame production experience in technical inefficiency are also significant variables. Regarding large-scale producers; education level, frequency off-arm visit, sesame production experience, type of road and amount of credited received are found to be significant sources of technical, allocative and economic inefficiencies. Farm distance, ownership of living home, livestock and membership in cooperative are also significant sources of technical and economic inefficiencies. The percentages of sesame grain post-harvest loss were during harvesting (16.41%, 13.5%), drying (50.44%, 51.5%), un-threshed left over (11.55%, 17.4%), piles transportation (9.9%, 7%), storage (6.73%, 4.62%), cleaning (3.2%, 1.8%) that leads to the total loss of 23.7% and 24.6% of total production by small and large-scale producers respectively. The significant determinants of post-harvest loss for small and large-scale farms were total sesame produced, weather condition, mode of transportation, distance of piles transported, stacking days, educational level, distance of farm and sesame land size. Extension contact for small-scale; while amount of credit obtained, off-sesame farm income, road access, storage weeks and harvesting and threshing management for large-scale producers had significant effect on post-harvest loss. The major sesame market chain actors are producers, assemblers, cooperatives, exporters and processors. The concentration ratios of the first four large traders indicated weak oligopoly market structure. It is also found that there are entry barriers, information asymmetry and collusion in price setting; indicating that sesame market deviating from competitive market structure norms. Considering free on board of hulled sesame price; gross marketing

ABSTRACT (CONTINUED...)

margins of 5%, 12% and 45% and net marketing margins of 1%, 3% and 17% obtained by assemblers, exporters and processors, respectively. All these are indicating that the sesame market being inefficient. Depending on the results found this study recommend strengthening the introduction of improved seed, mechanized labor substituting technologies and fertility enhancing inputs. For improving efficiency and reducing post-harvest loss capacitating small and large-scale producers through strengthening education, strengthening credit access at affordable interest rate, nearby farm follow up and frequently visiting of their farm with effective farm management are better. Strengthening extension service so as to improve efficiency and reduce post-harvest loss for small-scale producers. For improving the farm level efficiency of large-scale producers, it is also important to hire certified managerial experts, strengthening different utilities of livestock and livestock products and house ownership. For minimizing post-harvest loss it is also better if harvesting and drying technologies are introduced. Regarding the market performance, it will be better if focus is given to value added product export, securing competitive market through minimizing entry barriers, strengthening timely updated market information and formal credit access, hiring marketing experts at market centers to control collusion of traders in price setting.

Key words: Efficiency, Kafta Humera, Large-Scale, Market performance, Post-harvest loss, Sesame, Small-scale

1. INTRODUCTION

1.1. Background of the Study

Agriculture is the most important sector of Ethiopia's economy where about 95% of the total arable area is cultivated by small-scale farmers that produce more than 95% of the total output obtained from the sector (CSA, 2015; Mahelet, 2007; Seyoum *et al.*, 2007; MoARD, 2010). It has contributed to livelihoods of about 85%, employing about 85% of labor force, accounts for about 45% of GDP and for foreign exchange currency of about 86% (FDRE, 2016). Accordingly the government of Ethiopia has taken initiatives such as AGP, ATA that are meant to support successful achievement of GTP that can be assured by improving efficiency through reducing losses and improving performance of the market.

Sesame is one of the important oilseed crops well adapted to semi-arid tropical regions. It performs best on well drained, moderately fertile soils of light to medium texture with temperature ranging between 20-35°C (Wijnands *et al.*, 2007). Sesame is one of the six priority crops in the AGP of Ethiopia (SBN, 2013_b). In Ethiopia, sesame is being produced as cash crop by more than 867,347 small-scale farmers who cultivate 0.42 million ha and produce 0.29 million tone and by large-scale producers who cultivate 0.28 million ha of land and produced more than 0.22 million tones (CAS, 2015). Nationally, sesame accounts for 3.35% of total area and 1.1% of total grain production (CSA, 2015). It is produced in North Gondar and Western Tigray lowlands, Welega, Benishangul Gumuz and South-Omo; in which North Gondar and Western Tigray lowlands contributed more than 68% of the national product (CSA, 2015). Nationally Amhara, Tigray and Oromia scored 39%, 29% and 21% with productivity of 6.6, 7.04, and 7.35 Qt/ha, respectively for the national yield of 6.87 Qt/ha (CSA, 2015).

Over the past years, sesame production has shown greater increase in area and production but decreasing in yield. Looking at its trend, nationally sesame covered 0.14 million ha area where 0.12 million tons was produced in 2004/5 (Kindie, 2007) increased to 0.29 million ton production over 0.42 million ha of land in 2014/15 (CSA, 2015). But, its productivity declined from 8.47 Qt/ha in 2004/5 (Kindie, 2007) to 7.35 Qt/ha in 2013/14 (CSA, 2014) and further to 6.87 Qt/ha in 2014/15 (CSA, 2015). More than 70% of the national sesame harvest (accounting for over 90% of the values of oil seed export) was marketed at the international market generating about 427 million USD (FAOSTAT, 2012). It was also observed that in

2013/14 production season from the total production, 59% in Amhara and 88.7% in Tigray were supplied to international market that shown as sesame was mainly produced cash crop (CSA, 2014).

In Tigray region, more than 176,030 small-scale (CSA, 2015) and more than 1130 large-scale producers (KHLAdO, 2015) were engaged in sesame production that supplied 88.7% of the total production in the region (CSA, 2014). In the Western zone of Tigray particularly Kafta Humera district, sesame own majority and the leading economic importance (KHARDO, 2015). It also provided employment for 370,000 seasonal laborers coming from other zones of Tigray, Amhara, Oromia and SNNP regions (WTZAO, 2014). According to CSA (2014), Tigray region ranked second in sesame area coverage and production. The study area took the lion share in the region's sesame area (76.33%) and total production (76%) for the average productivity estimated to be 7 Qt/ha (CSA, 2015). Cultivation of sesame in Western zone Tigray is labor intensive especially during land preparation, weeding and harvesting with the casual labor cost for weeding and harvesting 3,150 and 1,600 birr/ha respectively (AIIC, 2014).

Post-harvest loss is the loss of grain between the moments of harvest and consumption. It occurs at all stages of post-harvest handling; pre-processing, transportation, storage, packaging, and marketing. The stage such as harvesting, drying, threshing and storage losses were high that was totally estimated to 15-26% (Kahsu *et al.*, 2014).

Sesame market in Ethiopia particularly in Kafta Humera is characterized by the chain from production, local collectors and exporters. The sector's market chain was faced the challenges of information asymmetry, barriers to entry resulted from different sides and imperfection in the interaction of the market actors (SBN, 2013a) The commodity was exported to China, Israel, Jordan, Turkey, Saudi Arabia, Greece, Yemen, United Arab Emirates, Japan, UK, Egypt and others (Haile, 2009).

Given the agriculture based economy as backbone of the nation's food security, it is imperative to conduct a study that focuses on measuring production efficiency with its sources of inefficiency, amount of grain losses during and after harvest with its determining factors and on measuring of the market performance. Thus, the study on production efficiency, post-harvest loss and marketing of sesame the case of Kafta Humera district in both small and large-scale producers was designed to address the gaps in measuring the efficiency and identifying sources of inefficiency, measuring post-harvest loss amount and its determinants and market performance of sesame in its market chain.

1.2. Statement of the Problem

Sesame is the second agricultural product that earns foreign exchange currency for Ethiopia's economy (CSA, 2015). Similarly, it is the major crop grown in the study area; but, it suffers by low productivity by far lower than the FAO estimated potential (which is about 16 Qt/ha) (Wijnands *et al.*, 2007). Also, through farmer's practice the productivity was ranging from 2 to 13.75 Qt/ha (WTZAO, 2014; HuARC, 2014). This all shows there was wider gap of inefficiency (inefficiency differentials) in sesame production in the study area. So, this study was aimed to measure production efficiency level and its sources of inefficiency differentials; which could help producers in achieving their goal of food security.

Even though sesame is an important cash crop in western zone of Tigray which is supplied to international market, its post-harvest loss is high estimated at 15%-26% of the total production (Kahsu *et al.*, 2014). As far as the researcher's knowledge, except estimation of the sesame post-harvest loss amount (that was done in fewer fields) there was no study conducted on the major sources of post-harvest loss. So, it is crucial to identify the major sources of loss during and after harvest to export.

The Humera type sesame had considerable international market demand, but it was constrained by many factors such as lower price and lack of market information (SBN, 2013a). So, analysis of sesame marketing provides knowledge on identifying the actors of sesame market chain and their role, conducting behavior of market participants and structure and performance of the market.

Hence, this study was designed to assess production efficiency, post-harvest loss and marketing performance of sesame for small and large-scale producers in Kafta Humera district, Western zone of Tigray region. Mainly the levels of production efficiency and the sources of inefficiency differentials, the amount of sesame post-harvest loss and its determinants, actors participating in sesame markets, their roles and marketing structure, conduct and performance were analyzed.

1.3. Research Questions

This study attempted to answer the following research questions:

1. What are the levels of technical, allocative and economic efficiencies of sesame production by small and large-scale producers in Kafta Humera district?

2. What are the major sources of production inefficiency differentials among small and large-scale sesame producers in the district?
3. How much sesame is lost at the market chain and what are its sources in the district?
4. Who are the major sesame market actors and what are their roles?
5. What looks like the sesame market chain and market structure, conduct and performance?

1.4. Objectives of the Study

The general objective of the study was to analyze production efficiency, post-harvest loss of small and large-scale sesame producers and marketing of sesame in Kafta Humera district, western zone of Tigray.

The specific objectives of the study were:

1. To analyze the levels of technical, allocative and economic efficiencies of sesame production for small and large-scale sesame producers in Kafta Humera district;
2. To identify the major sources of inefficiency differentials among small and large-scale sesame producers in the district;
3. To estimate post-harvest loss and its sources at each stage of the market chain in the study area;
4. To identify market actors and their roles in the sesame market chain of the district;
5. To analyze market performance of sesame market chain in the district

1.5. Significances of the Study

The study aimed at analyzing production efficiency, post-harvest loss and marketing of sesame in the study area. The study addressed its objectives by analyzing the efficiency levels and identifying the sources of inefficiency differentials, measuring the post-harvest loss and its determinants, identifying market actors and their relationships, analyzing sesame market structure and conduct of pricing strategies, and how marketing surplus is shared among actors. Therefore, the information obtained in this study will contribute to make an informed decision for the improvement in production and productivity of sesame and for optimum input allocation and efficient utilization of produce. This study would also contribute in minimization of sesame post-harvest loss by identifying its sources and setting solutions.

Through identification of the major sesame market actors, the role each actor in the market chain plays, the margin each actor obtains, and market structure, conduct and performance; government can improve the sesame marketing policies.

The study result would also provide scientific information for decision makers, planners, policy makers, input suppliers, supporting institutions, and other development actors involved directly or indirectly in sesame production and marketing. This study would also help as reference for other similar studies.

1.6. Scope and Limitations of the Study

The scope of this study was limited to lowlands of Kafta Humera district, in both small and large-scale sesame producers; focusing on production efficiency, post-harvest loss and marketing of sesame. Production efficiency analyses focused on measuring technical, allocative and economic efficiencies and the inefficiency sources. The scope of this study was also focused to measure the sesame post-harvest loss amount and the major determinants of this loss, identifying the major sesame market actors and their role and sesame market structure, conduct and performance in Kafta Humera district.

The scope of this study is limited only to Kafta Humera district. So that, it will be better for future if all the potential areas could be studied as the commodity is exportable cash crop. Secondly, the data was cross-sectional data collected during one production season. So, for future it will be better if the focus is to study based on panel data to evaluate across time periods for understanding the production efficiency trends and its inefficiency differentials, amount of post-harvest loss and their determinates across time and the improvements in the market performances across time periods. The other limitation is that, efficiency is the relative measure that considers the one with highest point as efficient whereas the others are compared with that point taking as base reference or boundary.

1.7. Organization of the Thesis

This thesis contains five chapters. The first chapter gives background, the way of the study, objectives, significance and scope and limitations of the study. Following, chapter two is devoted to relevant literature review. Description of the study area and the research methodology are subjects of the third chapter. Chapter four is where the findings of the study are presented and discussed. The fifth chapter summarizes the main findings and draw conclusions and policy implications.

2. LITERATURE REVIEW

In this chapter definitions of basic concepts related to production efficiency, post-harvest loss and marketing; theories related to production efficiency, post-harvest loss and marketing; the methodological and analytical frameworks; review of empirical studies and conceptual framework of the study are presented.

2.1. Definition and Concepts

2.1.1. Small and Large Scale Producers

There are many definitions provided to scale of producers; but most consider common basic indicators such as size of land holding, market orientation, labor input used, farm management responsibility, income level and type of farming system (Calcaterra, 2013; CSA, 2015). These indicators show that, small-scale producers allocating most of these inputs from their own source; while large-scale producers used almost all of these inputs from market. Specifically, small-scale producers produce for their own family consumption with smaller remain supplied to market that prevents them not to take risk in adopting newly innovated technologies. This category also have lower amount of capital to be allocated for undertaking production and mostly the household head acts both as farm manager and owner.

Large-scale producers in the other context; operate by hired managers and laborers, are relatively mechanized, take risk of adopting newly innovated production technologies and produce market oriented product (Calcaterra, 2013). Generally, this category is identified as profit motive/oriented that operate every aspect in the profit maximization way regardless of own consumption. However, the size of land holding differs from region to region and even from district to district depending on the availability of cultivable land and population density in the locality (ADB, 2010).

Taking the case of western zone Tigray; small-scale farmers are those who have allocated land size lower than 20 ha, whereas large-scale producers are those who have provided greater than 20 ha (KHLAdO, 2015). Large-scale producers who are profit oriented/motive firms also produce sesame with larger size/share of their cultivable land. Further, the government of Ethiopia categorizes large-scale sesame producers in Western zone Tigray as; large investors (allocated > 300 ha), medium investors (allocated 151-300 ha) and small investors (allocated 20-150 ha) (KHLAdO, 2015).

2.1.2. Definitions of Production Efficiency and Related Terms

Production function: It can be defined as the technological relationship between alternative combinations of inputs used during a production process and the maximum possible quantity of output associated with each of these input combinations; so indicate the average level of outputs that can be produced from a given level of inputs (Schmidt, 1986). Therefore, production function describes a boundary or frontier attained by best performing firms representing the limit of output obtainable from each feasible combination of inputs. Alternatively, a production function can be defined as the specification of the minimum input requirements needed to produce designated quantities of output.

Production efficiency: It is the point where there is no possibility of producing more output from the same level of input use or producing the same output from reduced level of input use as necessary condition and making best use or allocation of the productive resources in the activity that optimizes the objectives designed. Koopmans (1951) defined efficient point as a point in which an increase in net output of one good can be achieved only at the expense of other good's net output. So that efficiency is a relative concept and is measured by comparing the actual ratio of outputs to inputs with the optimal ratio of outputs to inputs. The most common types of efficiency such as: technical efficiency (TE), allocative efficiency (AE) and economic efficiency (EE) (Coelli *et al.*, 1998) are primarily distinguished by Farrell (1957) through the use of frontier production function.

Production inefficiency: It is the failure to operate on production frontier for the amount, timing and method of application of production inputs (Liewlyn and Jeffery, 1996). The more the distance from the efficient point of production function indicates the more the producer is inefficient. This deviation from the efficient point can be raised generally by different sources such as physical and natural, socioeconomic and institutional factors. That is the difference in these factors across producers lead to inefficiency differentials.

Technical efficiency (TE): It measures the ability of a producer or decision maker to achieve maximum output possible for a specified set of inputs, given the existing technologies at a given time period (Farrell, 1957 and Coelli, *et al.*, 1998). Its measurement is calculated relative to production function of fully efficient farm or unit, represented by the frontier function. Alternatively, technical inefficiency is the deviation from the frontier isoquant. This deviation can be happened due to the difference in producers performing capacity and natural factors which are beyond the control of the producers.

Allocative efficiency (AE): It refers to the producer's ability to respond to economic signals and choose optimal input combinations (proportions) given relative input prices (Farrell, 1957). AE shows the firm's ability to maximize profits by equating marginal revenue product of the factors of production to their respective marginal costs (Farrell, 1957; Abay and Assefa, 1997). It measures the extent to which a firm uses various factors in their best proportion given inputs and output prices. As a result technically efficient farms may not necessarily be allocatively efficient (Coelli *et al.*, 1998). In the other case allocative inefficiency is the deviation from the minimum cost input point/frontier.

Economic efficiency (EE): It is also called as the overall efficiency (Farrell, 1957). It refers to the combination of the two efficiency legs (TE and AE) (Farrell, 1957 and Coelli *et al.*, 1998). It is the point at which the producer obtains optimal level of output while minimizing his production costs; beyond which output optimization and cost minimization from the same inputs and specified price could not be achieved.

2.1.3. Definitions of Post-harvest and Post-harvest Loss

Post-harvest: According to FAO (2011), it is the period between crop maturity and time of its final consumption; that is, the period starting from the time in which crop in field is to be harvested (matured) to end time its product is consumed. According to the study conducted by WB (2011), post-harvest (post production and marketing system) is a chain of interconnected activities from the time of harvest to the delivery of food to consumer. In grain value chains, the familiar activities associated are: harvesting, assembling, drying, threshing/shelling, milling, storage, packaging, transportation and marketing.

Post-harvest grain loss: Grains may be lost in the pre-harvest and post-harvest stages. Pre-harvest losses occur before the process of harvesting begins, and may be due to insects, weeds and rusts. Harvest losses occur between the beginning and completion of harvesting, and are primarily caused by losses due to. Post-harvest losses is loss of grains (quality and/or quantity) between the moments of harvesting and consumption which could induce measurable reduction in foodstuffs that affect quantity (weight) and/or quality that reduce benefits obtained from the chain (Tyler and Gilman, 1979; WB, 2011). It occurs between the moment of harvesting and human consumption. This loss include on-farm losses, such as as grain is shattering, poor harvesting performances (gain drop, unharvest left), threshing, drying and winnowing, as well as losses along the chain during transportation, storage and processing.

2.1.4. Definitions of Market and Related Terms

Market: It is an arena of organizing and facilitating business activities and answering the basic economic questions such as what to produce, how much to produce, how to produce and how to distribute it (Kohls and Uhl, 1985). According to Pindyck and Rubinfeld (1995) market is a collection of buyers and sellers that interact for exchange of goods and services. Mmarket is an atmosphere or a mechanism that facilitate price fixation and exchange of goods and services (McNair and Harry, 1956).

Marketing: It is a social and managerial process by which individuals and groups obtain what they need and exchanging products and values with others (Kotler, 2003). According to Abbott and Makeham (1981) and Kohls and Uhl (1985) marketing is the flow of goods and services from their point of production to their consumers through the routes. The same word, Mendoza (1995), defines marketing as system which comprises several and usually stable and interrelated structures along with production, distribution and consumption that has basic productive value, in that it adds time, form, place and possession utilities to products and commodities. Usually, marketing of agricultural products begins at farm when the farmer plans his production to meet specific demand and market prospects (Abbott and Makeham, 1981 and Kohls and Uhl 1985).

Marketable Surplus: It is the residual production of agricultural produce left with the producer after meeting his requirements of family consumption, farm needs (seed and feed), kind payments, etc. (Atteri and Bisaria, 2003). It is the amount that could be sold but not yet actually sold.

Marketed Surplus: It is the amount of supply that is actually taken to the market irrespective of the needs for home consumption and other requirements which affected by the production level further determined by producers' decision making and furnishing weather condition especially for the cash crops like that of sesame. Supply refers to the willing of producers to transfer his ownership that offered for sale at different prices at a given time and place (Kohls and Uhl, 1985).

Marketing System: It is defined as the sequential set of kinds or types of business firms through which a product passes during the marketing process (Robert and Norvell, 1983). It is usually seen as a system because it comprises several, usually stable, interrelated structures that, along with production, distribution, and consumption, underpin the economic process (Mendoza, 1995).

Market structure: This is the feature of environment that influences the behavior and rivalry action among the buyers and sellers operating in the market (Scott, 1995; Pomeroy and Trinidad, 1995). Some examples of market structure include: the number and size distribution (size of their business) of buyers and sellers of commodities in the market; barriers to entry into the market, and the nature of trading relations (vertical coordination mechanisms) among market participants (Scott, 1995; Mendoza, 1995). According to Bain (1968) structural characteristics can be used as a basis for classifying markets as either; Perfect competition, Oligopoly or Monopoly. This analyses the structural arrangement and relationships of market participants in the chain.

Market conduct: It refers to patterns of behavior that firms or traders and other market participants adopt to affect or adjust the markets where they sell or buy; these include behaviors such as: pricing strategies on buying and selling (Price setting, Predatory pricing, and Price discrimination), collusive behavior, and mergers (vertical, horizontal and conglomerate), transport, storage, information and finance of traders or firms to maximize their market gain (Scott, 1995; Pomeroy and Trinidad, 1995). It is to indicate the characteristics that how the market actors behave so that they could affect the price of the commodity.

Market performance: The extent to by which the market results outcomes thought good or preferred by society. Price levels and stability (long run, short run), profits, margins and costs, volumes, product quality and variety and distributions within the market are some indicators of market performance (Cubbin, 1988). The principle behind structure-conduct-performance approach, mostly used in industrial organizations, is that there exists a relationship between the structural organization of a market and the competitive behaviors of market participants and this would influence the performance of the market (Scott, 1995; Pomeroy and Trinidad, 1995; Cubbin, 1988).

Thoroughly factors accounting for market efficiency can be evaluated through examining enterprises for S-C-P approach by measuring the extent of deviation from the perfectly competitive norm. The larger in deviation, the more imperfectly competitive is the market; if an extreme case it would be monopoly (Abbott and Makeham, 1981). According to Bain (1968), markets fail to follow perfect competition conditions, depending basically in the degree of: supply concentration, demand concentration, product differentiation and market entrance barriers. The dynamic behaviors of buyers and sellers have an effect on the markets, making it harder to predict and establish fixed structures.

Market chain: It describes the various links that connect all actors and transactions involved in the movement of goods from producer to consumer (CIAT, 2004). Commodity chain is the chain that connects small-scale farmers to technologies that they need on one side of the chain and to product markets of the commodity on the other side (Mankiw, 2003). Market chain is the path one good follow from their source of original production to ultimate destination for final use. According to Kotler and Armstrong (2003) supply chain is a longer channel stretching from raw materials to final products that are carried to final buyer value-delivery network.

Value chain: It is a group of companies working together to satisfy market demands which involves a chain of activities that are associated with adding value to a product. It encompasses issues such as organizational, coordination, power relationship between actors, linkages, and governance aspects. Value chain analyses allow examining the consequence of empowering one group on the other and identifying how to link them. It also enables analysis of the implication of who does what, at which stage in the chain, capital needed and margins obtained (Verina, 2009). Value chain actors are those who directly involved/deal with the product. But value chain supporters are those who do not directly deal with the product rather provide support services that add value to the product. The interaction of these value chain participants affects the performance of the market.

Marketing margin: It is defined alternatively as the difference between the price paid by consumers and that obtained by producers or the price of marketing services (Mankiw, 2003). It is the share obtained by the respective actor for its contribution in the market chain relative to the price paid by consumer.

2.2. The Origin, Nature and Uses of Sesame

Sesame seed (*Sesamum Indicum*) is one of the oldest seeds known to mankind. It is an ancient oil crop that has been used for thousands of years and is still an oil seed of worldwide significance (Haile, 2009). According to the study conducted by several researchers, two possible centers of origin have been proposed; East Africa (Ethiopia) or India; that later goes either east ward from Africa or west ward from India (Nayar, 1984; Hiltebrandt, 1932; Nayar; Mehra, 1970: cited in Uzun *et al.*, 2008). In the out ward spreading of sesame, Turkey played an important role since it was a major crossroads of East and West trade in ancient times (Uzun *et al.*, 2008).

2. 2.1. Sesame Production Requirement, Natural Suitability and Uses of Sesame Seed

Sesame requires warmth climate ranging from 26-40°C; altitudes up to 1600 m; rainfall of 300-600 mm and a soil type of well-drained, loose, fertile and sandy alluvial soils that have a PH value between 5.4 and 6.7 (Naturlande, 2002). So, sesame performs best on fertile and well-drained soil such as silt loams and is adapted to sandy loam soils provided adequate moisture during seedling establishment and grown well on silt clay loam soils with planting the most critical phase of its management (Zerihun, 2012).

Sesame seed and their oil have long been used for human nutrition and industrial uses such as pharmaceuticals, cosmetics, perfumery, soaps, paints and insecticides and it has still worldwide significance as an oilseed crop and the seeds contain 40-60% oil and 17-29% protein (Naturlande, 2002; Uzun *et al.*, 2008; Bedigian, 2004). Most of the world's sesame seed production is used for extracting oil which is used mainly for cooking, as culinary oil; which is free of unwanted odors, flavorful, very stable and resistant to oxidative deterioration (Uzun *et al.*, 2008).

2.2.2. World Sesame Production and Marketing

The estimated world production of sesame grain grown on 19.09 million ha was about 3.73 million tones, of which, about 70% is consumed in the producing countries themselves (FAO, 2007; cited in Haile, 2009). The world leading sesame producers were India, China, Myanmar in Asia (produced 64%) and Sudan, Uganda, Ethiopia, Nigeria and Tanzania in Africa (produced 31%) (Haile, 2009). According to Haile (2009) in the world market of sesame, 16 countries have a share of 80-90% of both export volume and value. These countries are India, Sudan, China, Myanmar, Ethiopia, Mexico, Netherlands, Venezuela, Guatemala, Japan, Nigeria, Tanzania, Pakistan, Thailand, Burkina Faso, and England.

2.2.3. Trends of Sesame Production and Marketing in Ethiopia

Though there was debate on the origin of sesame, Ethiopia is considered to be the origin and center of sesame (Mehra, 1967; Weiss, 1983; Mahajan *et al.*, 2007). According to Brar and Ahuja (1979), Bedigian (1981) and Ram *et al.* (1990), the origin would be in Africa. Internationally Ethiopia's share of 1.5% in export volume and 1.9% in value in 1997 had grown to 8.9% and 8.3% in 2004, respectively (FAOSTAT, 2012). Comparatively, from 2005-2015 sesame production had increased from 0.12 to 0.29 million tons (Kindie, 2007; CSA, 2015).

Regarding the area coverage, in 2000 it was 16 000 ha total area cultivated for sesame that later after ten years (up to 2010); increased by more than twentyfold (FAOSTAT, 2012). According to this organization over the past decade (2002-2012), earnings from sesame exports increased from 66 to 427 million US\$ with its increased contribution to national export earnings from 6.7 to 13.8 percent in the same period. The quantity of sesame produced for export also increased from 0.026 million ton in 2000 to about 0.318 million tons in 2012 (FAOSTAT, 2012).

2.3. Theoretical Framework

2.3.1. Production Efficiency

In micro-economic theory, production of output is represented either by production or cost function. Production function illustrates the maximum attainable outputs from given quantities of inputs at given time for the existing technology keeping other inputs constant. Cost function also targets to attain minimum cost subject to given output and at given inputs and outputs market price. For these functional forms, maximization and minimization becomes important explained by frontier (Forsund *et al.*, 1980).

According to Kokkinou (2010) economic theory assumes that producers are both technically and economically optimal. But, practically not all producers equally solve their optimization problems due to difference in technology used, differences in environmental conditions and production performances (Korres, 2007). Production decision is so done considering the main concern of production theory as in choosing the amount, type to produce and method of production (Colman and Young, 1989). Production function is so complex that includes inputs classified as: land, labor, capital, raw materials, technology, and time. These variables form the firm's actual production function as: $Q = f(L_d, L, K, M, T, t)$ (Cobb and Douglas, 1928). But, additionally entrepreneurship (human capital) is production input that contributes for managerial expertise in all production process.

Production function represents maximum possible output obtained from any given set of inputs which is a limit or frontier on the observed value (Hazarika and Subramanian, 1999). They added that technically efficient firm produces maximum possible output from inputs used, given locational and environmental constraints. However, production process might be technically inefficient in the sense that it fails to

produce a maximum output from a given input. It may also arise because of excessive input usage, which prevents cost minimization (Liewlyn, and Jeffery, 1996).

Depending on the inputs available and their share, the producers' performance in achieving the potential level differ. Taking land resource as one major determining factor, Schultz (1964) proposed the inverse relationship theory that indicates as small-scale producers in developing countries use factors of production more efficient than large-scale producers. This is because their labor operational share to manage other production inputs is higher than producers with higher farm size. Guarantying with the idea that, the share of labor operator has greater contribution to the production performance; education determines producer's stock of human capital to manage the operation (Lockheed *et al.*, 1980) that enables an individual to organize factors of production for maximum efficiency (Huffman, 1980).

Allocative efficiency is said to exist if the marginal product of each resource used in the production is the same in all alternative allocations. Thus, price efficiency is so one aspect of allocative efficiency as it is concerned with resource allocation given to their respective prices and further the resource allocation is an aspect of AE (Hazarika and Subramanian, 1999). According to the same source, production process could be allocatively inefficient in the sense that marginal revenue product of an input might not be equal to marginal cost of that input.

Allocative inefficiency might arise from the absence of perfect competition in market that leads producers to misallocate their factors of production keeping their survival in the long run (Carlsson, 1972). So that, for profit maximization the combination is chosen by equating marginal cost with relative prices. Generally, it is observable that one sector's production system is said to be technically and allocatively efficient decision if the production and cost minimization level reaches its optimum.

According to Forsund *et al.* (1980), the amount above production cost function frontier or below the production maximization function frontier or the profit function frontier is taken as an indication of inefficiency with its magnitude depends on the distance from the frontier point. All types of inefficiency may rise from the miss matching of production resources and their factor prices that adversely affects the resource allocation and then efficiency (Carlsson, 1972). According to him, in the absence of competitive pressure producers are free to pursue other goals than maximizing profit; so that, they may hire inputs for aspects differentiated from others that enable to produce at different production points.

2.3.2. Post-harvest Loss

If grain markets are demand constrained or supply is price elastic; as it is true in the case of grains, instant sale of grains immediately after harvest will have a price reducing effect. So, majority of farmers decide to store even perceived an imminent risk of grain loss due to attack by storage pests and/or other factors; if they stored for longer period of time. The study conducted by Affognon *et al.* (2015) proved that there is greater absolute post-harvest loss during plentiful harvest resulting from a sharper fall in market prices that calls for longer storage. Low prices and surplus production may result in a slower flow to the market, leading to longer storage periods so loss due to insect attacks. Post-harvest loss at storage could be associated with both poor storage conditions and/or lack of storage capacity.

Agricultural development technologies for which the farmer is not pre-adapted could also result serious losses at farm level which was proved by the study conducted by WB (2011). These technologies include introduction of high-yielding varieties more susceptible to pest damage, need for timely harvesting and drying even when weather is damp or cloudy, increased climate variability or farmers producing significant surplus grain that must be stored on the farm in larger quantities and for longer periods. Poor management performance also contributes huge loss starting from farm to marketing and still consumption.

Modes of transport lead to high post-harvest loss, as the grain is not properly protected from exposure to the elements such as insects and birds consume, tear and wear of packaging materials. Poor condition of roads and the fact that majority of villages do not have access to all-weather roads may also cause extended delays or even prevent transport to market. So that, poor road conditions contribute to physical post-harvest loss as they increase the shocks to which grains are subjected during transport (WB, 2011).

2.3.3. Market Performance

According to Pindyck and Rubinfeld (1995) equilibrium market mechanism is the tendency in a free market for the price to change until the market clears. The supply and demand sides of market intersect at equilibrium or market clearing price in which at this price quantity supplied and quantity demanded are equal. But, as supply and demand might not always be in equilibrium that is if one of the market wings changed the whole equilibrium has changed that latter forms new equilibrium level.

Marketers always think and decide on choice of right market segment spot, differentiating their offering, method of competing against lower cost while keeping customers loyal so that they could grow their business (Kotler, 2002; Fetter, 1905). These indicate as structure and conduct of actors further affect market performance. When markets fail to perfectly compete; it is possible to observe more concentrated industries, greater barrier to enter in to market, easier ways for enterprises to collude in output and pricing practices. Similarly, according to Pindyck and Rubinfeld (1995) in imperfectly competitive markets different firms charge different prices for the same product. By analyzing the level of market concentration of the different market actors, the margins they obtained and their cost components; it is possible to evaluate the impact of structure and conduct characteristics on market performance (Bain, 1968).

2.4. Methodological Framework

This includes review of the data required, data sources and methods of data collection for production efficiency, post-harvest loss and marketing.

2.4.1. Production Efficiency

In analyzing the level of efficiency the type of data required is better if panel (Battese and Coelli, 1995); otherwise it could be cross-sectional type (Huang and Liu, 1994). However, due to its constraints to obtain panel data it is also possible to use cross-sectional data with homogeneity nature in similar geographic locations and faces similar external influence (Coelli *et al.*, 1998). The data sources could be primary and/or secondary. The primary data is collected from field survey, while secondary source is obtained from formerly recorded sources. Some of the studies such as conducted by Jema (2008), Chimai (2011), Abu *et al.* (2012), Taptuk (2012), Wutyi *et al.* (2013), Abebe (2014), Asad *et al.* (2014), Berhan (2015), Chakwera (2015) and Ermiyas *et al.* (2015) used cross-sectional data collected from randomly selected respondents applying questionnaires.

This study is so used the primary data sources of cross-sectional type through directly collected by field survey from producers applying the semi-structured questionnaires. The sample respondents were randomly selected from the sesame producers who have homogenous nature in their specific category.

2.4.2. Post-harvest Loss

The panel or cross-sectional data type could be used for studying post-harvest loss. According to the study of Basavaraja *et al.* (2007), Kumar *et al.* (2011), WB (2011) and Kwami *et al.* (2014) the required data could be obtained from field measurement or field survey. Even though; the data obtained from field measurement is relatively accurate compared to the data obtained from survey, it has difficulty in its requirement of huge time and budget.

Because of its resource requirement, most studies such as Basavaraja *et al.* (2007), Kumar *et al.* (2011), Kwami *et al.* (2014) and Affognon *et al.* (2015) used the survey data collected from sampled respondents. But, the study conducted by WB (2011) used direct measured data recorded on the fields of the selected respondents. This study also used both the field direct measurement and the survey methods on the randomly selected sesame market chain actors in the study area.

2.4.3. Market Performance

The data type required for studying marketing performance is either time series, panel or cross-sectional. Time series and panel data are mostly used by studies which conduct market integration studies. But; in measuring the market chain actors and their role, market structure, conduct, the market margin obtained by each actor in the chain the studies conducted by Kindie (2007), Bosena (2008) and Geremew (2012) used cross-sectional data collected from randomly selected respondents. In this study also the cross sectional data used due to absence of panel data and considering the time and budget constraints. The data is collected from randomly selected market participants by semi-structured questionnaires.

2.5. Analytical Framework

This is to review on the methods of analysis used by the formerly conducted studies regarding the analysis of efficiency and inefficiency differential, post-harvest loss with its sources and marketing.

2. 5.1. Production Efficiency Analysis

This is to review the methods of analysis used on measuring TE, AE and EE and their sources of inefficiency differentials. The two widely used methods of efficiency measurement methods are the non-

parametric Data Envelopment Analysis (DEA) and parametric Stochastic Frontier Analysis (SFA) (Farrell, 1957). DEA is the mathematical programming approach, while SFA is an econometric method (Coelli *et al.*, 1998). The non-parametric method was initiated as DEA by Charnes *et al.* (1978). DEA has the merits of no specification of functional form are required, it also used for multi-output situations. But, it has limitations in its assumption of CRS, no consideration of external effects and susceptibility to extreme observation (Forsund *et al.*, 1980). As the selected method for this study is SFA, its detailed explanation will be as follows:

2.5.1.1. The stochastic production frontier Analysis

The concept of plotting inputs per-unit of output observations as points in a space of suitable dimension (Farrell, 1957) was not applied until the introduction of SFA. The SFA was independently proposed by Aigner *et al.* (1968) and Meeusen and Vanden Broeck (1977) that further improved by Schmidt (1986). Furthermore, Bravo-Ureta and Rieger (1991) used SFA to remove random elements from efficiency component before deriving the various efficiency indices.

The SFA fits data to production or cost function using specific functional forms such as linear, translog, Cobb-Douglas, logarithmic, or quadratic (Coelli *et al.*, 1998). It is used to estimate stochastic best-practice frontier function where observations are allowed to depart from the frontier due to random shocks and/or inefficiency (Kumbhakar and Lovell, 2000). Among the functional forms an appropriate functional form to be used for the data at hand would be selected based on maximum likelihood ratio tests. Duality of production cost takes cost of the production inputs used in production process to estimate cost efficiency and sources of inefficiency. It was formerly used by Kumbhakar *et al.* (1991) and Reifschneider and Stevenson (1991) then latter by so money studies.

Once inefficiency scores have been estimated by gamma (γ), factors that determine inefficiencies can be studied using two main procedures called a one-step and two-step procedures. The two-step method is simple in which firstly, efficiency terms should be obtained by using one of the models discussed in earlier sections. Secondly, the obtained efficiency terms should be regressed on variables that are expected to influence efficiency with OLS or with Tobit model. The main advantage of two-step is its simplicity. But it has major drawbacks of assuming efficiency is dependent, while SFA model assume that efficiency is independently and identically distributed. Also the two-step could render biased

estimates with little evidence on severity of this bias (Caudill and Ford, 1993; Wang and Schmidt, 2002). One-step procedure estimates efficiency scores and its sources of inefficiency simultaneously and overcomes the problem of normality and biased estimates which could be committed by two-step that has been considered by Caudill and Ford (1993) and Caudill *et al.* (1995).

Reifschneider and Stevenson (1991) extend the inefficiency model assuming that the inefficiency term is composed of two factors; the firm specific disturbances and unexplained disturbances with its drawbacks of random errors around the efficiency term. This is improved by Kumbhakar *et al.* (1991) and then by Huang and Liu (1994). Latter, Battese and Coelli (1995) used it for panel data.

The SFA enables one to measure farm specific efficiency, assumes an error term with two additive asymmetric components that accounts for pure random factors (v), and inefficiency relative to stochastic frontier (u). it is also argued that SFA is preferable to DEA for estimating total factor productivity growth rate when there is relatively high degree of noise and measurement error in the input and output data (Headey *et al.*, 2010) as efficiency measure is highly sensitive to the choice of functional forms and distributional assumptions (Brovo-Ureta and Pinherro, 1993). Unlike DEA, SFA measures productive efficiency by the ratio of observed output to the stochastic production frontier which simply distinguishes productive efficiency from other source of disturbance (Aigner *et al.*, 1977). However, it requires a prior specification of functional form and needs distributional assumptions for the estimation of inefficiency (Coelli *et al.*, 1998).

Taking the merits and demerits, most of the formerly conducted studies used the Cobb-Douglas functional form of the SFA to measure production efficiency for different crops such as studies conducted by Coelli *et al.* (1998), Nguyễn *et al.* (2009), Amaza *et al.* (2010), Zalkuwi *et al.* (2010), Chimai (2011), Abu *et al.* (2012), Taptuk, (2012), Hidayah *et al.* (2013), Abebe (2014), Asad *et al.* (2014), Berhan (2015), Chakwera (2015) and Ermiyas *et al.* (2015). But other studies conducted by Jema (2008), Abu *et al.* (2011), Myo (2012) and Wutyi *et al.* (2013) used DEA to measure efficiency. They applied it for its no requirement of functional form, ability to provide new insights and additional information and its ability to handle multiple-output-input situations simultaneously.

Generally, the trade-offs between SFA and DEA approaches suggest the choice among models depends up on the objective of the research, the type of data and the choice of functional forms considered. After

identifying the efficiency level it is necessary to determine the sources of inefficiency. Regarding this, many studies used a two-step procedure, i. e., determining the sources of inefficiency after identifying the level of efficiency.

The objectives and type of data secured for this study would best fit the SFA, but differ from those who employed DEA that won't capture the external noises facing the sesame producers in the study area. This is because both sesame producers in Kafta Humera district face different external noises such as rainfall, fertility of soil etc. So other than the farm specific errors there could also be external factors that affects production efficiency. Taking these in to considerations this study used the SFA for estimating sesame production efficiency. The test to use either the Cobb Douglas or translog functional form was preserved to the maximum likelihood ratio test results. In estimating the sources of sesame production inefficiency (second objective), this study used the one-stage procedure. This was because the one-step procedure addresses the problem of normality and biased estimates which could be committed by two-step procedure.

2.5.1.2. Approaches of measuring production efficiency

Koopmans (1951) and Debreu (1951) determined and used the concept of distance between the produced output and the output that could have been produced given the inputs best allocation. In similar context Shepherd (1953) applied distance idea to explain the concept that producer uses too many inputs to produce certain amount of outputs. The concept of production frontier, allows the idea that inefficient input use leads to deviations from frontier production level. Extending some producers did not respond to input prices in an optimal manner that they do not used cost-minimizing combinations of inputs (allocatively inefficient). The efficiency concepts can be measured in either input or output oriented procedure which is stated as follows:

Input oriented approaches of measuring production efficiency

Original idea of representing the technology in a convex isoquant is an input oriented measure of efficiency. Farrell (1957) illustrated the idea of input oriented efficiency using a simple example of a given firm, which uses two factors of production, capital (K) and labor (L), to produce a single output (Y), and face a production function, $y = F(K, L)$, under the assumption of constant returns to scale. The

isoquant Y^0Y^1 (Fig.1) represents various combinations of two input variables (K, L) that at least a firm might use to produce a unit output (Y). In an input-oriented measure of efficiency both AE and TE of a firm fall on or above the unit isoquant of the input-per-unit of output space and cannot be below or to the left of it. A departure from the unit isoquant indicates technical inefficiency and the more a firm is far from unit isoquant the greater it is inefficient. This concept is depicted graphically as in Fig 1 (Coelli *et al.*, 2005):

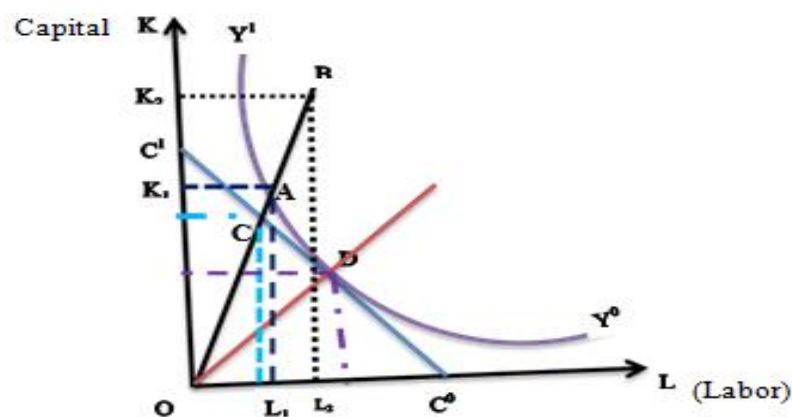


Figure 1. Input-oriented illustration of Technical and allocative efficiency

In Fig 1, the curve Y^0Y^1 represents technically efficient combinations of two inputs (K, L) in producing output level Y (i.e., efficient isoquant). The C^0C^1 represents input combinations (K, L) having an aggregate cost of C_0 (iso-cost line). Point D on the efficient isoquant is also allocatively efficient; point D is termed as the point of EE production. For instance, as illustrated in Fig 1 a firm producing at B uses inputs K_2 and L_2 to produce a unit output and firm A uses K_1 and L_1 amounts of inputs to produce unit output given by the isoquant curve Y^0Y^1 . The ratio $(K_2 - K_1)/K_2$ which is equal to $(L_2 - L_1)/L_2$ is the proportion by which firm B has over used inputs compared to A and this measures the level of technical inefficiency of firm B.

It may not be necessarily that technically efficient farms operating at the isoquant to become allocatively efficient. Despite a relatively high level of production, a producer that follows this strategy will not minimize cost (Jeffery and Richards, 1996). Departure from the line C^0C^1 represents the degree of allocative inefficiency and the value for point A is given by the ratio CA/OA . Also suppose that point B represents an observed combination of inputs used to produce Y. At this point, production is neither technically or allocatively efficient. The degree of technical inefficiency for this producer is given by the ratio AB/OB ; that is, the ratio of the distance between potential and actual input use. The degree of

allocative inefficiency for this producer is given by the ratio CA/OA ; that is, the distance between the isoquant and iso-cost line.

Mathematically we can represent the TE and AE of a firm operating at 'B' as follows

$$TE(B) = OA/OB \quad (2.1)$$

$$AE(B) = OC/OA \quad (2.2)$$

Economic efficiency (EE) is therefore the product of the two efficiencies.

$$\begin{aligned} EE(B) &= AE(B) \times TE(B) \\ &= (OC/OA) \times (OA/OB) \\ &= OC/OB \end{aligned} \quad (2.3)$$

Output oriented approaches of measuring production efficiency

Output oriented concept of efficiency is in which output is maximized and cost is minimized for given inputs level. On the other hand it is minimizing the level of inputs used for given level of output. The concept of output oriented efficiency evaluation was emerged by Koopmans (1951), and then used by Debreu (1951) to determine the level of efficiency through the application of distance between real output level from potential level for the predetermined level of input application. In the output oriented approach one can alternatively answer the question by how much can output be increased without increasing the amount of inputs used (Coelli *et al.*, 1998).

As it is shown in Fig 2, suppose that two inputs (X_1 and X_2) are needed to produce one output (Y) of the isoquant by a certain production process. The x-axis denotes input X_1 and the y-axis denotes input X_2 . The curve S'S represents the amounts of X_1 and X_2 combination to produce an identical amount of Y . This means that in an ideal situation every producer that wants to produce certain amount of output Y needs the amount of inputs represented by the frontier. In a less ideal situation it is possible that a producer needs X_1^* and X_2^* for the production of Y amount represented by point P. The line C_1C_2 represents iso-cost line.

To determine efficiency, a full efficient point is necessary that is located on the curve S'S. Taking the ration Just as in the input oriented case, the proportion of X_1 and X_2 should be equal to the proportion of X_1^* and X_2^* represented by point Q. TE at point Q can then be determined by the ratio of distance OP to

OQ. This measure gives value of one if P is equal to Q. The cost of inputs used in production process is also depicted by point A in which AE is obtained by the distance from OQ to OA. This is the case if the amount of inputs that are needed for the production lay on the $S'S$ curve and thus is fully efficient. So that as lines C_1C_2 and S_1S' tangent (at point D) then EE is the distance ratio of OP to OA (Coilie *et al.*, 1998).

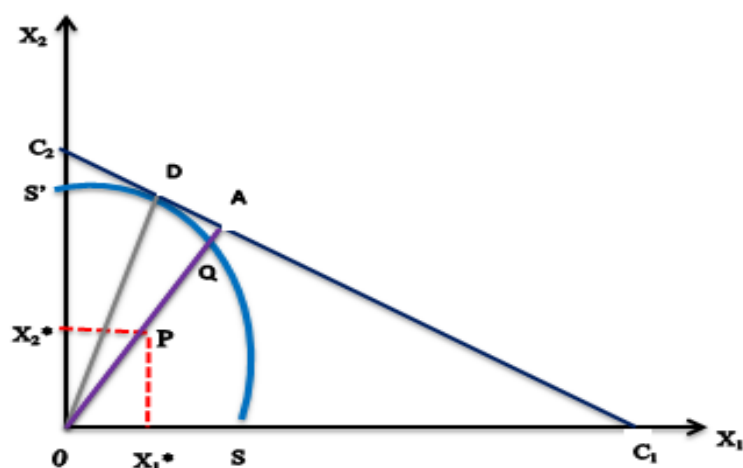


Figure 2. The output oriented concept of technical efficiency

2.5.2. Post-harvest Loss and Its Determinants

Most of the studies conducted on post-harvest loss had used averages and percentages to compute the quantity of post-harvest loss indicating that these studies did not go beyond describing the quantity lost. However, it is important to identify the determinants of the post-harvest loss. Regarding sources of post-harvest loss few studies conducted by Nag *et al.* (2000) and Basavaraja *et al.* (2007) used multiple linear regression model by obtaining information from chain actors. This study applied the multiple linear regression model given that post-harvest loss is a continuous variable. The result was also tested for validity of OLS assumption; heteroskedasticity, multicollinearity, omitted variable and endogeneity.

2.5.3. Market Performance

The methods applied in analyzing the objectives related to marketing aspect; the approaches followed, while analyzing market performance would be reviewed.

Approaches to analyze market performance

For the study of market efficiency important approaches were employed because of the reason that the role of market and marketing firms is explained based on these approaches. These approaches are functional, institutional, commodity, behavioral system and the structure-conduct-performance approaches (Robert and Norvell, 1983; Mendoza, 1995). The mostly used approaches are Functional, institutional, commodity and SCP that would be discussed one by one as follows:

Functional approach: It studies different activities performed in changing the farm products in to the product required/desired by the consumers. Based on the arguments developed by (Robert and Norvell, 1983; Kohls and Uhl, 1985) which had used by so many researchers, three types of functions which incorporate different chief activities were specified such as: Exchange function (buying, selling and pricing); Physical function (transportation, handling and packaging, assembly, storage and grading); Facilitative functions (standardization, financing, risk bearing, market intelligence)

Institutional approach: It is mainly focusing on the study of the various institutions, middlemen and other agencies which add utility to the product. It is interesting because of the reason that the number, level of competition, pricing behavior, relationship, etc. of various marketing agents or institutions is crucial in analyzing a given market. Marketing institutions that are analyzed in this approach include: merchant middlemen (supermarket chains retailers and whole sellers with their networks), agent middlemen (commission-men and brokers), facilitative organizations (market stabilization agencies, board of foreign trade, and different GOs and NGOs), processors and manufacturers (millers), a town's central market, or agreements between producers and millers and speculative middlemen.

Commodity approach: This is the individual approach which combines both functional and institutional approach and make in depth analysis of only one product/commodity or certain commodity groups, such as grain marketing, food marketing. This is used to deal with list of products and detail analysis including products classification, products characteristics, source of supply, persons engaged in the exchange process, its financing, storage, and advertisement (Robert and Norvell, 1983). In this approach institutional analysis for major marketing channels, marketing costs and margins is possible to done.

S-C-P Approach: It is the analytical approach how the structure of the market and the behavior of sellers affect the performance of market. As explained by Plaskas and Harris (1993) markets are complex

institutions that encompass different hierarchies and interlinked transactions involving various commodities. Performance and integration of different markets are the results of actions done by different traders and the environment under which they operate. The basic achievements of S-C-P is that, given certain basic conditions, the performance of a particular industry depends on the conduct of its sellers and buyers, which in turn is strongly influenced by the structure of the relevant market.

It is possible to understand that the more concentrated an industry is the greater the barrier to enter into the market, the easier it is for firms to collude in their output and pricing practices resulting in an inefficient allocation of resources. The basic achievements of S-C-P is that, the performance of a particular industry depends on the conduct of its sellers and buyers, which in turn is strongly influenced by structure of the relevant market so that the structure of the market determines its performance (Maria and Clemens, 1994).

The studies conducted by Kindie (2007), Bosenia (2008), Sripruetkiat (2010), Amare and Dawit (2013) and Ndubuto (2014) applied S-C-P methods. They applied the concentration ratio (CR) for analyzing the structure of the market. In their analyzing the conduct of the market these studies used the theoretical justification on physical observation for the barriers to entry and exit, price making decisions and integration of the market participants. These studies had also applied the market margin to estimate the market performance by evaluating the share of profit for the market participants.

In this study, the fourth & fifth objective was analyzed by S-C-P approach and descriptive statistics. The descriptive statistics was used for estimating the major market actors and their roles in the sesame market chain. The market structure was analyzed by employing the concentration ratio (CR₄ and CR₈) and Herfindahl-Hirschman Index (HHI). The market conduct of sesame markets was also analyzed through physical observations on the barriers to market entry and exit, price making decisions and coordination of the market participants. Further the share of market margins obtained by each market participants was used to analyze the market performance.

2.6. Empirical Studies

This section presents previous empirical studies on production efficiency and sources of inefficiency, post-harvest loss and its determinants and marketing performance.

2.6.1. Production Efficiency

In this sub-section, studies conducted on production function with its determinants, production efficiency and sources of inefficiencies are reviewed.

2.6.1.1. Production function and its determinants

An output is the result of physical and conceptual thinking of inputs entered to the production process. These inputs determine production of a commodity either by upgrading or by lowering its productivity. Regarding the relationship between inputs and outputs, different studies identified those factors which could determine production of crops in different locations. According to the study conducted by Zalkuwi *et al.* (2010), Abu *et al.* (2012), Wassie (2014), Ermiyas *et al.* (2015) the major determinant factors of crop production were improved seed, labor and fertilizer. Beside to the explained factors other studies done by Ogundari and Ojo (2006), Baten *et al.* (2009), Ibrahim *et al.* (2014), Wassie (2014), Ermiyas *et al.* (2015), Chakwera (2015) found farm size as significant factor; and also in the study conducted by Ermiyas *et al.* (2015) plough power was also significant determinant input. Generally this study took improved seed, labor, farm size, plough power and fertilizer as major determinant factors of production function considering the miss matching of these factors results to inefficiency.

After obtaining the determinants of production function; so further the level of technical, allocative and economic efficiencies were estimated by many researchers at different time and location applying the SFA in Cobb-Douglas production functional form. Besides the likelihood ratio (λ) and gamma (γ) results were used to evaluate the total deviation from efficient point and its inefficiency share respectively. When reviewing those studies which conducted in Africa; such as studies conducted by Ogundari and Ojo (2006, 2007), Zalkuwi *et al.* (2010), Abu *et al.* (2012), Hidayah *et al.* (2013), Dawit *et al.* (2013), Alboghdady (2014), Chepng'etich *et al.* (2014), Getachew and Bamlak (2014), Berhan (2015), Chakwera (2015) and Ermiyas *et al.* (2015) the mean TE, AE, and EE were ranging from 40-67%, 51-89% and 29-45%, respectively. Their study also shown the gamma (γ) estimates ranges from 0.91 to 0.95.

2.6.1.2. Sources of production inefficiency

Measuring production efficiency is not enough (is necessary but not sufficient) rather it may be embarking with no solution. So it is better and productive if followed by identifying the sources of

inefficiency. Taking this concept there were so many studies conducted. The studies conducted by Zalkuwi *et al.* (2010), Abu, *et al.* (2012), Myo *et al.* (2012), Hidayah *et al.* (2013), Asad *et al.* (2014) and Ermiyas *et al.* (2015), detected that the sources of inefficiency were both socio economic, institutional and farm specific sources.

The study conducted by Ermiyas *et al.* (2015), on estimation of the production efficiency of sesame in Selamago district South Omo zone of South Ethiopia revealed that soil fertility, non-farm income and credit access positively and significantly affected TE and EE. Their study also revealed that, soil fertility had positive and significant effect on AE. On the other hand experience, distance of sesame farm, non-farm income and extension contact affected AE significantly and negatively. However, extension contact affects EE significantly and negatively. The study result of Abu *et al.* (2012) in analyzing Productive efficiency among sesame farmers in Nasarawa State of Nigeria found seed, labor and fertilizer were significant production inputs. They also revealed that factors such as experience, educational level and access to credit were all positively while age, off-farm income, training significantly and negatively related to efficiency.

The study conducted by Nyiatagher and Ocholi (2015) on analysis of gross margin and resource use efficiency in sesame production among small-scale farmers in Benue state, Nigeria found Farm size, seed and labor significantly influenced sesame production. They also revealed that the socioeconomic factors determining TE included age, access to credit and extension visit. According to their report also the variables extension visit and price were the significant determinants of AE; while sex, access to credit and price were determinants of EE.

2.6.2. Post-harvest Loss

According to WB (2011), in Eastern and Southern Africa the average crops weight loss was about 13.5% that is valued approximately for US\$11 billion. Extrapolating this to Central and Western Africa the total value loss during post-harvest in SSA, reach nearly US\$4 billion a year, out of an estimated annual value of grain production value of US\$27 billion in 2005/ 07 (WB, 2011).

Results of the study done by Kahsu *et al.* (2014) also indicated that, the total loss of sesame as measured during different stages was 55.56 kg/ ha from the average productivity of 4.5 Qt/ha in which most of the

loss was during drying at piles (5.54%), followed by pre-harvest plant shattering (3.25%), piles transport to threshing sites (1.85%) and re-bagging at market centers (1.12%). The study conducted by Rani (2011) also found 14.43 kg/Qt loss which encompassed 1.2 kg/Qt during maturity stage, 4 kg/Qt due to weather impact, 0.5 kg/Qt during harvesting, 1 kg/Qt during threshing, 1.5 kg/Qt due to labor unavailability, 0.03 kg/Qt during drying, 5 kg/Qt during storage, 0.2 kg/Qt on storage, and 1 kg/Qt during processing. He further specified that 75% of the total loss occurring at farm level and about 25% at market level.

In determining causes of post-harvest loss, the study conducted by Basavaraja *et al.* (2007) found the factors such as harvesting at incorrect maturity stage, excessive exposure to rain, extreme temperature, contamination by microorganisms and physical damage as the major determinants of post-harvest loss. According to Kumar *et al.* (2011), also the main reasons for post-harvest losses were higher productivity, improper storage conditions, lack of knowledge on recently released seeds and poor technical guidance.

According to WB (2011), loss could be mitigated by appropriate handling and management of the product along the chain to minimize the effect of biological and environmental factors on product deterioration and avoid product contamination by the choice of grain variety (critical initial step), harvesting properly at the right time, use of mechanical dryers and mechanical thresher.

2.6.3. Market Performance

There were many researches conducted on market structure, conduct and performance. The studies mostly focused on concentration of the commodity, actors participated and their linkage, margins obtained by each actor. So finally identify market characteristics and its performance. On the study conducted by Kindie (2007), applying CR₄ measures found oligopoly sesame market structure. Unlikely the study conducted by Bosena (2008) found competitive cotton market structure.

In measuring the market performance through market margin, the study results of Kindie (2007), Bosena (2008) and Sripruetkiat (2010) found that, the total gross market margin obtained in the complete distribution ranges from 21-41%. The study by Kindie (2007) also found that the gross market margins obtained by producers, whole sellers and exporters of sesame were about 63.12, 8.34 and 12.79, respectively. Similarly the study result of Sripruetkiat (2010) shows that, the GMM obtained by producers, whole sellers and exporters of sesame were about 78.88%, 11.67% and 28.54% respectively.

2.7. Conceptual Framework of Production Efficiency, Post-harvest Losses and Marketing Channel of Sesame.

It is the section in which objectives of the study were graphically represented. As it is presented in Figure 3, the flow includes from the production inputs up to export market (fob). It includes the production inputs and its determinants, post-harvest loss and its determinants and market chain and its actors.

The arrows and colors in Figure 3; have meanings, red color with the arrow header out ward from the chain is to indicate the reduction of quantity by loss in opposite direction to the chain direction. Whereas, the lines with arrow head towards the chain indicates positive contribution of support service.

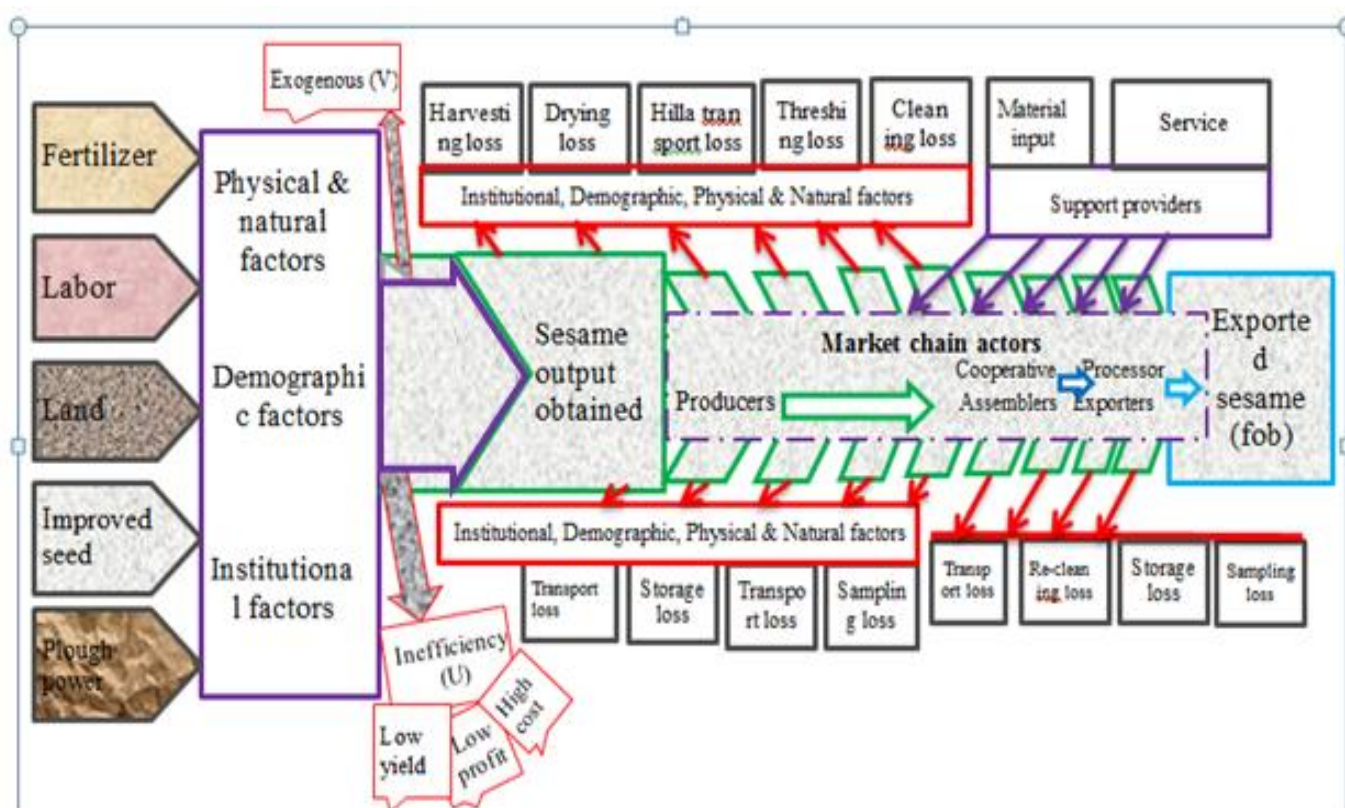


Figure 3. Conceptual framework of production efficiency, post-harvest loss and market channel of sesame
Source: Own sketch

As it is presented in Figure 3, the inputs in production system are fertilizer, labor, land, improved seed and plough power which are the bases for production system. So, production is the conversion of these basic production inputs in to output. According to Carlsson (1972), the conversion potential of inputs to outputs depends on the physical and natural, demographic and institutional factors (Figure 3). Performance of these determinants affects the achievement of producing output at the potential level.

Physical factors include variables such as farm distance, fertility status and road facility. Whereas, demographic characteristics include variables such as age, education level, experience, dependency ratio, off-farm income, livestock and standard home ownership, frequency of farm visit and cooperative membership. The institutional factors also include variables such as extension contact, training and credit sources. In addition to these physical factors explained, there are natural factors that affect the production system such as pests and diseases and weather conditions (rain and wind), uncontrollable by the operator.

The difference in performance of these production determinant factors and the natural conditions results in deviation of production level from its potential point. Further, this deviation from the potential point is categorized as because of production inefficiency (u) or by uncontrollable external factors (v) as presents in Figure 3. This deviation from the potential level reduces the total production so supplied amount.

Harvest and post-harvest grain loss is the loss of grain between the moments of harvesting and consumption which induce measurable reduction in foodstuffs (Tyler and Gilman, 1979; WB, 2011). According to Hodges *et al.* (2011) and Buzby and Hyman (2012), post-harvest loss can be differentiated as quality and/or quantity losses. Quantity loss is loss in physical substance (weight reduction) which could be occurred at all the stages through which production passes. As the focus of this study is post-harvest loss the pre harvest loss is not included here. As it is presented in Figure 3, the stages at which post-harvest loss could occur are harvesting, drying, piles transporting, threshing, cleaning, packaging, transporting, storing, re-cleaning and sampling at market (SBN, 2014) thought the market chain. Quantity loss during post-harvest stage from harvesting to marketing can be determined by the physical and natural, demographic and institutional factors explained in the above.

According to Mankiw (2003), an economy consists of people engaged in buying, selling, working, hiring and manufacturing that could be grouped to firms and households which is the combination of different commodities, from which sesame is one. Sesame, the concern of this study which is the major cash crop for the Ethiopia's economy passes through many hands in the market chain until it reaches consumers. But as it is presented in Figure 3, the market chain analyzed in this study is from producer to fob level. This market chain includes the major actors such as producers, assemblers, cooperatives, processors and exporters (Figure 3). There are also support service provides in the form of material inputs, services (transport, storage, weighing and re-cleaning), commissioning, institutional service (extension, training, improved seed, standardization/labeling and infrastructure facilities).

3. RESEARCH METHODOLOGY

In this chapter the study area, the data type, data sources and methods of data collection, the methods of data analysis are presented.

3.1. Description of the Study Area

The study was conducted in Kafta-Humera district; Western Zone, Tigray Regional State. Western zone of Tigray Region has four districts: Setit Humera (town), Kafta Humera, Welkayt and Tsegedie (WTZAO, 2014). The study covered the lowland areas of Kafta Humera district.

Kafta Humera district is bordered by Eritrea in the north, Sudan in the west, Tsegedie district in the South, Welkayt district in the East, and North western zone in the north east. The study area has 24 kebeles all of which have potential for sesame production. The district has a population of 53,945 male, 49,792 female and total of 103,692 with 26,352 households covering an area of 4,542.33 square kilometer with 396,852 ha cultivable land (KHARDO, 2013). The district is an investment area identified by government. There are more than 1,130 large-scale (categorized as; small owning of size from 20-150 ha, medium owning of size from 151-300 ha and large owning of size greater than 301 ha) producers who cultivate sesame (KHLAdO, 2015). In the district there are a total of 17 sesame market centers having a total of about 356 assemblers (KHCRO, 2015).

The study area has chromic vertisol soil type which is black in color. The soil is characterized by very deep clay texture susceptible to water logging during heavy rainfall. The annual temperature of the area ranges from 22.2-42⁰C with annual rainfall ranging from 400-650 mm in the months from June to September (Hagos and Fetien, 2011). However, considerable amount of rainfall is rained between the months of July and August. The district has sesame cultivation potential; lowland area, ranging from the Altitude (m) of 609 to 696 (Bereket and Yirgalem, 2012; KHARDO, 2013). The study area lies in the Latitude (⁰N) of 14⁰15' to 13⁰36' and Longitude (⁰E) 36⁰37' to 36⁰41'.

The study area is known for cultivation of various cereals predominantly sesame and sorghum. These crops were the district's important marketable crops as the reports of (KHARDO, 2013; HuARC, 2014).

In addition to crop production; the district population keep/rear special breed called *begait* cattle, goat and sheep to the greater share.

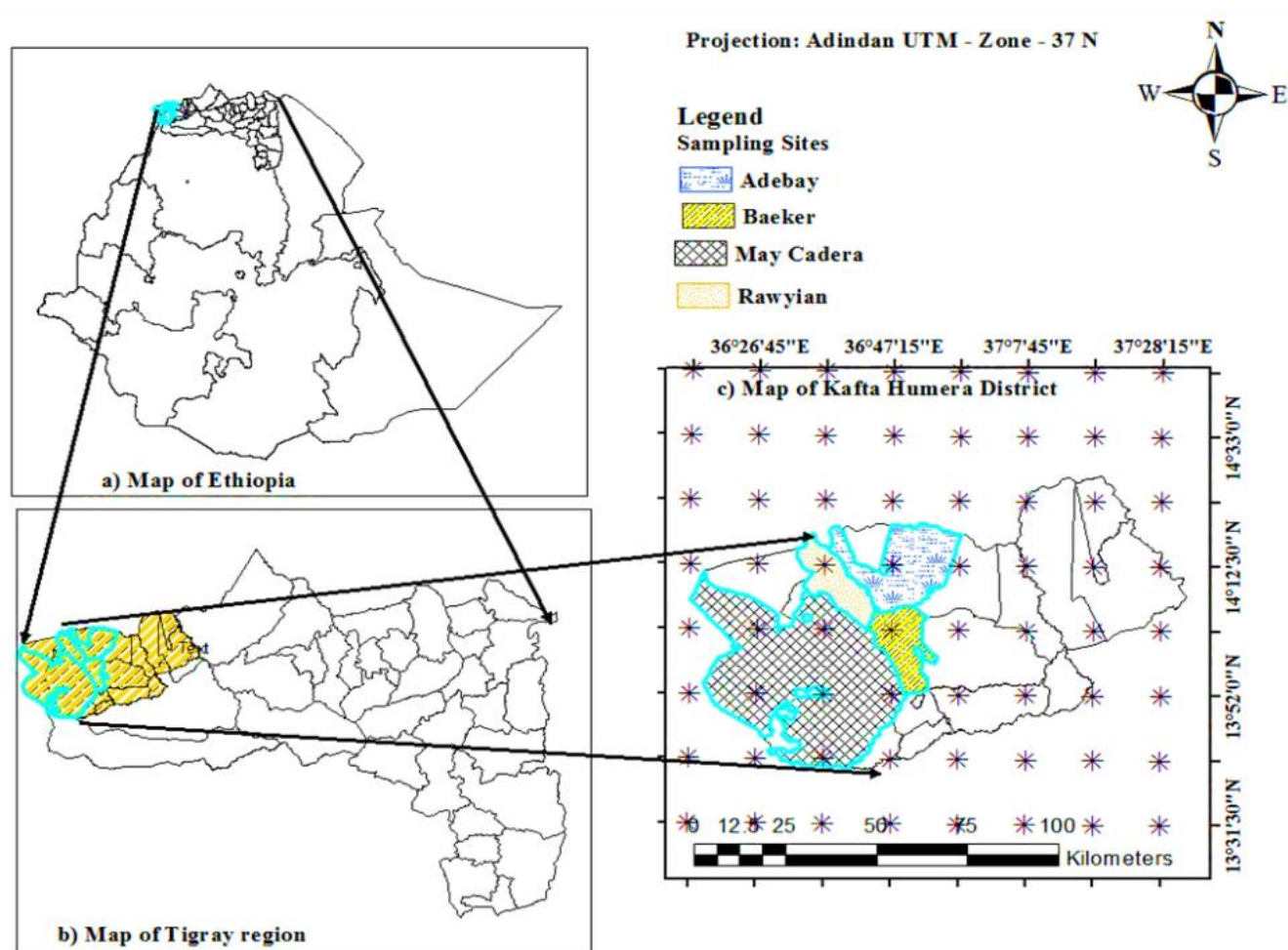


Figure 4. Map of the study area; Kafta Humera district, western zone Tigray

Source: Own study area map using Arc GIS (2016)

As it is presented in Figure 4, from the sesame producing kebeles in Kafta Humera district four kebeles (Adebay, Baeker, Mai Cadra and Rawyian) were selected randomly by picking a rolled paper. These kebeles could represent the district's sesame potential kebeles as owing society having similar culture, similar economic status, similar climatic condition and agro-ecology, similar farming system, similar topography and geographic arrangement, similar soil type and etc. These kebeles also share similar administrative bodies and similar expertize support from the district. The average distance from one kebele to the other next kebele is about 19 Km. The kebeles' average distance from Humera town ranges between 7 to 50 Km.

3.2. Data Types, Sources and Methods of Data Collection

Both primary and secondary data types were collected for the study. The data were collected using field survey, physical data recording on field and from different published and unpublished sources.

The primary data sources: It is collected using formal survey procedures from small-scale and large-scale sesame producers, assemblers, exporters and processors in four randomly selected sesame producing kebeles (Mai Cadra, Baeker, Adebay and Rawyian) (Figure 4). Besides, data for post-harvest loss were collected by field measurement at each stage of harvest and post-harvest handling in these kebeles. Before the formal survey, rapid market appraisal was conducted. Data were also collected from different governmental and non-governmental offices. Semi-structured questionnaires; rapid market appraisal (RMA) and focus group discussion were used to collect the data. The respondents selected for post-harvest loss data collection from field were those interviewed during survey. Post-harvest loss data were collected through the following methods.

During harvesting first a 10 m X 10 m quadrant was measured in the farm from which the capsules opened, dropped during harvest time and remain un-harvested were counted and the seeds in those capsules were also counted by seed counter. Then close to the quadrant measured one piles sesame was harvested and stacked/stand on sheet. This stand stayed for an average of 14 days for drying. Then; during threshing, threshers informed to thresh it on other sheet. Here the distance from piles standing to threshing place was covered by long plastic so informed to go on that way only. Finally, the threshed sesame straw bar was secondly threshed and loss during cleaning time was recorded.

Loss during transportation from farm to store was measured by collecting the dropped amount during transport. During storage time also the loss was obtained by measuring while entered and withdraws store. The loss while transporting from store was obtained by measuring when it is ready for transportation and as it reaches the market; so, by taking difference. For those who supply through ECX (investors) the marketing loss was obtained by taking the difference while entered and the amount sold. Sesame post-harvest loss from assemblers was obtained from sampled assemblers and recording the loss at storage, re-cleaning, transportation and standardization stages. The sesame grain loss for exporters and processors were obtained from survey taking difference of the amount sold from bought in both cases.

Secondary data sources: It is collected from the selected kebeles agricultural development office, primary cooperatives involved in sesame marketing, district's office of agriculture and rural development, district's office of land administration, district's office of custom and revenue, large-scale producers' cooperative, HuARC, western zone zonal office, ECX main office and Humera branch, different books, different published and unpublished reports, bulletins, and websites. The secondary data on the price of sesame grain for four years (2012-2016) was obtained from ECX main office.

3.3. Sampling Procedure and Sample Size

The study used multi-stage sampling technique for selecting sample sesame producers and assemblers. First, from Western zone Tigray, Kafta Humera district was selected purposively because of the availability of both small-scale and large-scale sesame producers in the same location and its potentiality to sesame production. Then, producers were clustered into small-scale and large-scale producers. Secondly, four kebeles (Mai Cadra, Baeker, Adebay and Rawyian) were selected randomly (Fig 4 and Table 1). In the third stage, depending on the probability proportional to size of sesame producing small-scale farmers from each sample kebeles, the specified numbers of respondents were obtained based on random sampling technique. The intended total sample size was determined based on the following formula developed by Yamane (1967). Considering confidence of 90% and accepting the error (e) of 9%,

$$n = \frac{N}{1 + N(e^2)} \quad (3.1)$$

Where n = sample size, N= total household of the district that is equal to 26,352 and 1,130 for small and large-scale producers respectively. Based on the calculation, 128 small-scale and 126 large-scale sesame producers were sampled (Table 1). According to KHLAdO (2015), large-scale sesame producers were clustered in to three based on their farm size (small-scale investors, medium-scale investors and large-scale investors). For drawing the sample respondents, the study followed the same calculation as that of applied in small-scales selection (eq. 3.1, for e= 9%). Finally, from the list of each cluster; using simple random sampling technique the respondents were selected as it is presented in Table 1.

Sesame market centers in the district were also selected purposively. Then from the above randomly selected kebeles, a total of 44 local assemblers (10% of the total assemblers) were selected using simple random sampling technique from the total local sesame assemblers in four market centers based on the

probability proportion to size (Table 2). But, for the market center at Rawyian the described numbers of assemblers were only opened, while the remaining were closed. Besides, a total of 4 primary cooperatives from the above selected kebeles and one additional large-scale producers' cooperative were sampled. A total of 13 exporters and one processor were also interviewed.

Table 1. Number of sampled small and large-scale producers from each kebele

Kebele	Large-scale			Small-scale		
	Total pop.	Sample	Percent	Total pop.	Sample	Percent
Adebay	98	16	12.7	2817	36	28.13
Baeker	149	25	19.84	1953	24	18.75
Mai Cadra	409	68	53.97	3526	45	35.16
Rawyian	107	17	13.49	1805	23	17.97
Total	763	126	100	10101	128	100
Small-scale investors	929	97	76.98			
Medium-scale investors	109	15	11.91			
Large-scale investors	93	14	11.11			
Total	1131	126	100			

Source: For small-scale KHARDO, 2013 and for large-scale KHLAdO, 2015

To generate sesame post-harvest loss data, a total of 56 small-scale producers and 40 large-scale producers were selected randomly from those formerly selected for the survey interview purpose. Additionally, from the local sesame assemblers randomly selected for survey purpose (Table 2), a total of 21 traders were randomly selected for post-harvest loss. Prior to formal survey, a rapid market appraisal was conducted in order to get the overall picture of sesame market chain.

Table. 2. Number of sampled assemblers from each kebele's local sesame assemblers

kebeles	Local assemblers/collector			Cooperatives	
	Total population	Sample	Percent	Total	Sample
Adebay	19	7	15.91	1	1
Baeker	26	9	20.45	1	1
Mai Cadra	59	20	45.45	1	1
Rawyian	51	8	18.18	1	1
Total	155	44	100	4	4

Source: KHCRO, 2016

Regarding the sampled sesame assemblers and cooperatives in the district; these selected kebeles cover about 42% of the total assemblers in the district. Finally, the total numbers of assemblers selected for this study were taken based on the probability of proportion to size of the assemblers in the sampled kebeles.

3.4. Methods of Data Analysis

In this study, both descriptive statistics and econometric models are employed for analyzing the data collected.

3.4.1. Production Efficiency and Sources of Inefficiency Differentials

To attain the first two objectives of the study, both descriptive statistics and econometric models are employed. The descriptive statistics include simple measures of central tendency, frequency and percentages. Whereas, in the econometric analyses model the SFA on the Cobb-Douglas production functional form was applied to estimate the level of technical, allocative and economic efficiencies and the relation between farm level socio-economic and institutional variables and inefficiencies, respectively applying one step procedure. This method was applied in STATA software for stochastic frontier model with half normal through the specification of production inputs to be entered in the independent part (model 1) and sources of inefficiency variables to be entered in model 2 simultaneously by further specifying the type of the model (either the production model the default one, otherwise highlighting the cost function for the cost function in the second model).

3.4.1.1. Estimating sesame production efficiency

The SFA was fitted to estimate the level of technical, allocative and economic efficiencies of small and large-scale sesame producers in Kafta Humera district. Because, most importantly SFA allows segregating of the external factors' effect from the inefficiency resulted by the decision making unit; which were familiar to the study area. From Aigner *et al.* (1968) and Meeusen and Broeck (1977) the SPF model is defined in the Cobb-Douglas functional form as:

$$\ln Y_i = \beta_0 + \ln \sum_{j=1}^k \beta_j X_{ij} + \varepsilon_i \quad (3.2)$$

Where

$$\varepsilon_i = V_i - U_i \quad (3.3)$$

$\ln$ = natural logarithm; $j= 1 \dots k$ input use; $i= i^{\text{th}}$ producer; Y_i = represent sesame yield obtained by the i^{th} producer, X_{ij} = denotes the j^{th} farm input used in sesame production by the i^{th} farmer, β_i = the vector of

unknown parameters to be estimated, $\varepsilon_i =$ is the disturbance term composed of two elements (v_i and u_i). V_i is the random error beyond the control of farmers (symmetric component), u_i indicates the technical inefficiency component.

Production function could be either Cobb-Douglas or the translog. Translog production function was first introduced by Christensen *et al.* (1971, 1973) and represents the generalized form of the Cobb-Douglas production function. According to them, this function has both linear and quadratic terms with the ability of using more than two factor inputs that can be approximated by second order Taylor series. So, SFA requires further specification of production function to estimate the production efficiency. Basically, for its best fitness and its dual nature applicability in the agricultural production efficiency analysis Cobb-Douglas production function was employed. But, its best fitness is estimated by the likelihood ratio test comparing to the translog form.

As it is developed by Battese and Coelli (1995) the Cobb-Douglas production function of the dual cost model was also used to specify the stochastic frontier cost function with its inefficiency component and to estimate all parameters together. It was also possible to estimate the dual cost function subject to given output level (Sharma *et al.*, 1999). Cost function represents the dual approach in the technology considered as a constant towards the profit optimizing behavior of the firms (Chambers, 1988). The stochastic nature of the cost production frontier would still imply that the theoretically minimum cost frontier would be stochastic in nature given as:

$$C = C(P, Y^*, \alpha) \quad (3.4)$$

Or,

$$\ln C_i = \alpha_0 + \left(\sum_{j=1}^k p_{ij}, \alpha_i \right) + \alpha_j Y_i^* \quad (3.5)$$

Where $i = i^{\text{th}}$ household; C_i = minimum cost of production; $j = 1 \dots k$, inputs used; P_{ij} = input prices of the j^{th} input; Y_i^* = farm revenue which is adjusted for noise v_i , and α 's are parameters to be estimated.

3.4.1.2. Variables of sesame production efficiency

These variables are the independent inputs in determining sesame production efficiency which could be divided in to the sesame production function inputs and cost function inputs. The sesame production and cost functions combined to determine the overall sesame production efficiency.

Production function: This uses the Cobb-Douglas production function that shows the relation of dependent variable with its independent inputs. In this study the dependent variable is the amount of sesame produced which is given by the following equation (eq. 3.6).

$$\ln Y_i = \beta_0 + \beta_1 \ln ld_i + \beta_2 \ln sd_i + \beta_3 \ln lb_i + \beta_4 \ln pw_i + \beta_5 \ln fq_i + (v_i - u_i) \quad (3.6)$$

Input variables: This refers to the physical and mental inputs used in sesame production. The major inputs for sesame production are: cultivated land size, amount of improved seed used, amount of labor used, the number of plough power used and amount of inorganic fertilizer applied. The major variables were specified based on what the formerly conducted studies, theories regarding the production inputs and on the in-depth observation of the researcher in this study in the study area.

Area allocated for sesame cultivation (ld): It is a continuous variable representing the size of land allocated for sesame by individual farmer measured in hectare. Theoretically, as land size increases in best match with the other inputs it results increase in production that is supported by Jema (2008), Myo *et al.* (2012) and Ermiyas *et al.* (2015). But, as it is difficult to make best much it may negatively affect to production as the managerial time, skill and practice is spread over the size beyond capacity which was supported by Zalkuwi *et al.* (2010), Chand *et al.* (2011), Abu (2012), Maqbool *et al.* (2012) and Wutyi *et al.* (2013). Based on the theoretical aspect, this study hypothesized that producers with smaller size become more efficient compared to large holders as the available resources could not much with it.

Improved sesame seed (sd): It is a continuous variable measured in kilograms that refers to the amount of improved sesame seed used. Theoretically, it increases production efficiency as it increases productivity far beyond the local ones. This idea was supported by the results of the studies done by SBN (2013_b), HuARC (2014), Abu (2012) and Ermiyas *et al.* (2015). Taking results of these studies, this study hypothesized that improved seed had positively contributed to production and productivity; so positively related to production efficiency.

Labor used (lb): This is to the quantity of labor force used in sesame production activities measured in terms of man days. Theories indicate that, proportionately with the other inputs labor could increase productivity as timely and effectively control every aspect of production. This idea was supported by the study results of Abu *et al.* (2012), Myo *et al.* (2012), Hidayah *et al.* (2013) and Ermiyas *et al.* (2015)

who found significant and positive relationship between production and labor amount used. Depending on these studies and theory, this study hypothesized that as labor increases proportional with the other resources it could improve productivity and then to production efficiency.

Oxen/tractor power (pw): It was the power that sesame producers used for cultivation of their land which is either by oxen and/or by tractor power. It is continuous variable measured in terms of power per hour. As the study results of Ermiyas *et al.* (2015), oxen power had insignificant positive relation with efficiency. But, theoretically as it could improve performance, this study hypothesized that as the number of plough power is available proportionately with the other resources it could enhance efficiency.

Amount of fertilizer applied (fq): It refers to the quantity of inorganic fertilizer used by producers so that they can improve the productivity of sesame production. It is the continuous variable measured in terms of the quintal applied. Theoretically; up to optimum level, fertilizer application increases productivity and so the production efficiency that was supported by the studies conducted by Abu *et al.* (2011, 2012), Hidayah *et al.* (2013), HuARC (2014) and SBN (2014) found significant positive relation. But, Myo *et al.* (2012) reported an inverse relationship between production efficiency and fertilizer application; whereas, Ermiyas *et al.* (2015) found insignificant relation. Taking the theoretical concepts, this study hypothesized that increment in fertilizer application could increase production efficiency.

3.4.1.3. Estimation of cost functions for sesame production

This refers to the cost of sesame production incurred by sesame producers in the study area calculated taking local market price of inputs at purchasing time. Therefore, total cost was obtained by multiplying the per unit input price for each input by its quantity utilized in production. In this study, the dependent variable is the total production cost incurred in sesame production. The inputs for cost function were cost of land, cost of seed, human labor wage, plough power cost, fertilizer cost, operational cost and material cost. The dual cost function of sesame production in Cobb-Douglas functional form is give as follows:

$$\ln c_j = \partial_{0j} + \partial_{1j} \ln cld_{j1} + \partial_{2j} \ln csd_{j2} + \partial_{3j} \ln clb_{j3} + \partial_{4j} \ln cft_{j4} + \partial_{5j} \ln cpw_{j5} + \partial_{6j} \ln cmt_{j6} + \partial_{7j} \ln cop_{j7} + (v_j - u_j) \quad (3. 7)$$

Where $\ln$ = natural logarithm; $j = j^{\text{th}}$ producer; c_j = actual cost of j^{th} producer; $i = 1 \dots 7$, i^{th} input variable cost; β_j = coefficients to be determined; $v - u$ = error; cld = cost of land; csd = cost of seed; clb = wage; cft = cost of fertilizer used; cpw = plough cost; cmt = material cost and cop = operation costs.

Then Minimum cost input demand equation can be expressed as:

$$\Delta C_i / \Delta p_i = \chi_{ie} (p_i, Y_i^*, \alpha) \quad (3.8)$$

Where Δ is the indication of the derivation

So, the optimization profit principle of the cost function is to minimize cost subject to the optimum amount of output to be produced. Due to the availability of two functions of the cost function and the production function the optimization technique is obtained through the Lagrange method. The minimum cost is derived analytically from the cost/ expenditure and/or profit function, using the methodology used in Arega and Rashid (2006), Ogundari *et al.* (2006), Zalkuwi *et al.* (2010) and Ermiyas *et al.* (2015)). Given input oriented function, the efficient cost function is written as:

$$\text{Min} \sum C = \sum_{j=i}^k (\chi_j, p_j) \quad (3.9)$$

Subject to

$$Y_i^* = \hat{A} \prod \chi_j^{\beta_j} \quad (3.10)$$

$$\hat{A} = \text{Exp } \beta_0 \quad (3.11)$$

The solution is the basis for deriving the dual cost frontier. By substituting the expenditure function and the adjusted yield for stochastic error in to the above minimization function to derive the following:

$$C(Y_i^*, Y_i) = H Y_i^{*u} \prod_i p_i^{\alpha_j} \quad (3.12)$$

All the parameters would be determined so that the minimum cost or expenditure of production which leads to the concept of cost efficiency can be determined. As it is possible to calculate the production expenditure, it is possible to find the parameters which lead to cost efficiency. According to (Sharma *et al.*, 1999), the explained cost measures can enable to estimate the AE and further EE.

Generally from the above explained concepts the farm specific TE can be defined in the ratio of observed outputs (Y_i) to the corresponding frontier output (Y_i^*) from existing technology as in eq. 3.13.

$$TE_i = Y_i / Y_i^* = \sum_i \chi_{it} p_i / \sum_i \chi_i p_{ip} \quad (3.13)$$

The actual sesame output obtained (unadjusted) by the i^{th} farm divided to the possible frontier output (adjusted) of the i^{th} farm. Also since the farm economic efficiency (EE) is the ratio of the minimum costs adjusted or expenditure (C^*) to the actual total production cost or expenditure (C) as in eq. 3.14.

$$EE = C_i^* / C = \sum x_{ie} P_i / \sum x_i P_i \quad (3.14)$$

Cost efficiency (CEE) takes the values of one or higher with one is for cost efficient farm. From these two equations the AE can also be derived as the ratio of EE to TE given as in eq.3.15.

$$AE = EE / TE = \sum x_{ie} P_i / \sum x_{it} P_i \quad (3.15)$$

All these enable this study to attain the target focus of estimating the level of the three efficiency measures in sesame production (first objective).

3.4.1.4. Sources of sesame production inefficiency

Measurement of efficiency (TE, AE, and EE) by itself could not be the end goal, it is also important to identify the major sources that prohibit efficiency. The inefficiency estimates derived from the model as a function of socioeconomic, institutional and geographic variables that explain variations in TE, AE and EE across farm households. Following the adoption of Battese and Coelli (1995) for analysis of inefficiency using the Cobb Douglas functional form, estimation of the inefficiency measure for sesame producers specified as:

$$U_i = \sigma_0 + \sigma_{1i} w_{1i} + \sigma_{2i} w_{2i} + \sigma_{3i} w_{3i} + \dots + \sigma_{15i} w_{15i} \quad (3.16)$$

Where U_i = inefficiency level of i^{th} producer; w_1 - w_{15} = source of inefficiency variables. The independent variables considered as source of production inefficiency differentials are explained as follows:

Amount of credit used (loan): It is a continuous variable measured in birr. As financial resource is the power of an individual to obtain the commodity that he/she is required, the amount of credit supports the power of sesame producer to perform the production activities as planned which could improve productivity so reduce inefficiency. The studies conducted by Myo *et al.* (2012), Abu *et al.* (2011, 2012)

and Ermiyas *et al.* (2015) found significant negative relation between credit access and inefficiency; that support theoretical aspect of the relation. Accordingly this study hypothesized that the amount of credit negatively affect to sesame production inefficiency.

Number of extension contact (extn): It is a continuous variable measured in number of times of contact of sesame producers with extension agents. Extension service is meant to introduce improved technologies and expand best practices that could enhance productivity. Theoretically, this variable was expected to have negative contribution to production inefficiency that was supported by the studies conducted by Abu *et al.* (2011, 2012), HuARC (2014) and Kahsu *et al.* (2014). But, studies conducted by Jema (2008) and Ermiyas *et al.* (2015) shown that extension service had significant and positive relationship to inefficiency. So, based on the theoretical perspective this study hypothesized negative relationship between the number of extension contact and sesame production inefficiency.

Soil fertility status (fertstatus): It is a dummy variable that takes values of ‘0’ for low fertile, ‘1’ for medium and higher fertile soils. The study result of Ermiyas *et al.* (2015) shows that soil fertility had negative relationship to production inefficiency. So, this study hypothesized as soil fertility status negatively affects to sesame production inefficiency.

Dependency ratio (famnw): It is a continuous variable indicating the number of dependents in the family that consume the capital to be allocated for production. Positive contribution of this variable was expected to inefficiency. This was supported by the studies conducted by Jema (2008), Abu *et al.* (2011, 2012) and Ermiyas *et al.* (2015) found as family size had positive relation to inefficiency. So, this study hypothesized the positive relationship between sesame production inefficiency and dependency ratio.

Years of sesame production experience (exp): This refers to number of years the household head practiced sesame production. There is a fact that, as farmers become experienced they could manage production activities through their experience from past. Studies conducted by Abu *et al.* (2011, 2012), Myo *et al.* (2012) and Hidayah *et al.* (2013) found positive relationship between productivity and experience so negative relation with production inefficiency. But, Ermiyas *et al.* (2015) reported negative relationship with respect to technical inefficiency while positive relationship with allocative and economic inefficiencies. Based on these studies and theory, this study hypothesized the negative relationship between sesame production experience and its’ production inefficiency.

Number of training obtained (numtrain): It refers to the number of training received on sesame production and marketing. As training is provided by identifying the skill gap the producers had, training has negative relationship with production inefficiency. Regarding this variable, Abu *et al.* (2012) and Ermiyas *et al.* (2015) found negative relationship with overall production efficiency. So, this study was hypothesized as training has negative relationship to sesame production inefficiency.

Distance of farm from residence (distfh): It is a continuous variable measured in kilometers indicating how far the sesame farm was from his/her residence. This may affect the frequency of visit and while transporting to farm it consumes time, so hinders sesame production efficiency. As the study of Ermiyas *et al.* (2015) distance had positive relationship to inefficiency. This study also hypothesized positive relationship of the distance of sesame farm from residence and sesame production inefficiency.

Ownership of house (Ohom): It is a dummy variable that is given '1' for those who own standardized home (that can act as collateral in obtaining credit), otherwise '0'. Theoretically, as the family is wealthier, then it is possible to allocate the capital for efficient production. The study conducted by Jema (2008) also found negative relationship between house ownership and inefficiency. This study was so hypothesized negative relationship between ownership of home and sesame production inefficiency.

Educational level of the household head (eduhhd): It is a continuous variable measured in number of level of schooling years. The study result of Myo *et al.* (2012) revealed significant negative relationship between education level and inefficiency, while Abu *et al.* (2012) found positive relationship. Based on the theories and earlier studies, this study expected negative relationship between years of schooling and sesame production inefficiency.

Livestock holding other than oxen for plowing (ownliv): It is a continuous variable measured in TLU. Livestock might contribute organic fertilizer and enable producers to act as source of capital from selling. So, this study hypothesized that there could have negative relationship with livestock holding (TLU) and sesame production inefficiency.

Membership in local organization (memb): It refers to either the sesame producer was member in any social associations mostly cooperatives or not. It is a dummy variable valued as '1' if the farmer is a member and '0' otherwise. In theoretical perspective, local organizations organized and serve to act as

source of inputs, sharing experiences and solving producers' problems at nearby. The services provided by the organization could then improve production capacity of producers. So, this study hypothesized negative relationship between sesame production inefficiency and membership in cooperatives.

Age of the household head (agehhhd): It is a continuous variable expected to have negative relationship with the production inefficiency when it contributes the productive labor while in the productive age level and improves his experience. In the study conducted by Zalkuwi *et al.* (2010) age significantly and negatively affected inefficiency. Based on the theories and the former results, this study hypothesized the negative relationship between age of the household head and sesame production inefficiency.

Off-sesame farm income (noninc): It is a continuous variable which refers to the amount of money obtained from different off-sesame farm sources. Theoretically, as income is obtained from off-farm sources without allocation of any production time in those off-farm sources, the variable has negative relation to inefficiency. But, if the farmer allocated his production time in the off-farm sources, this may lead to positive relation. Therefore, this study hypothesized negative relationship between off-sesame farm income amount and sesame production inefficiency as most producers in the area did not allocate labor for other activities.

Road infrastructure availability from farm to home (road): It is a dummy variable with its values '1' for animal and personal road, '2' for pista/standard road. There is a fact that, this variable negatively contributes to sesame production inefficiency. Because as road is accessible; farmers could reach his farm on time so effectively and timely handle the farm activities; during transportation of the product also there is reduction in the amount to be lost. This study then hypothesized negative relationship between road accessibility and inefficiency level.

Frequency of sesame farm visit (freqgo): It is a continuous variable indicating the number of times the household members visit their sesame farm. Theoretically, this could negatively contribute to inefficiency because if the farmer visits his farm frequently, he/she will manage his/her farm better. The producers who frequently visit his/her farm could also perform activities timely. Therefore, this study hypothesized a negative relationship between frequency of farm visit and sesame production inefficiency.

2.4.1.5. Estimation of the best possible production function

This is the method that enables to select which model to be used for the data on hand; so the relation between dependent and independent variables could be best explained. So, selecting the best production function relative to other functions (among response, translog, and Cobb-Douglas) is based on the tests of fitness to the data generated. The response function was not competitive with the translog and Cobb-Douglas, so the test was restricted for translog and Cobb-Douglas production functions.

In specifying the best production function this study conducted hypothesis tests for the parameters of SFA model using the generalized likelihood ratio statistic. This is defined by eq.3.17, that H_0 is the value for Cobb-Douglas and H_1 is for translog functional form. Here H_0 is referring as there's no difference among the production function forms (no contribution of the interaction of the variable). The test is being evaluated with the critical values of χ^2 test. If the calculated χ^2 for the degrees of freedom is lower than the tabulated value then the study fails to reject H_0 so follow Cobb-Douglas production function. Otherwise translog production function would be used.

3.4.1.6. Likelihood ratio test

Likelihood ratio test is used to compare the goodness of fit of two hypotheses; the null and the alternative. So, it is possible to make the hypothesis test that is not possible in non-parametric models of the deterministic approach. Log likelihood ratio test requires the assumption of identically and independently distributed (i. i. d) error terms in the model.

The likelihood ratio (LR) test is given as in eq. 3.17 as follows.

$$LR = \lambda = -2 \ln[L(H_0)/L(H_1)] = -2[\ln L(H_0) - \ln L(H_1)] \quad (3.17)$$

Where, λ is the LR, $L[H_0]$ = LL value of the null-hypothesis, $L[H_1]$ = LL value of the alternative hypothesis, and $\ln$ = natural logarithms.

Following eq.3.17 also enables the study to detect either there is error (external and inefficiency) or not through the comparison of the calculated χ^2 with the tabulated value for the specified degrees of freedom. Keeping the test of H_0 : there is no error (all the coefficients of the inefficiency sources

variables are zero), while H_1 : there is error (deviation) and the coefficients of the inefficiency source variables are different from zero. If H_1 is accepted and H_0 is rejected, then the study continues to identify the sources of inefficiency otherwise stopped. The parameters then obtained using the likelihood ratio as give in the following: λ , γ and δ^2 .

$$\lambda = \delta_u^2 / \delta_v^2 \text{ or } \dots \delta_u / \delta_v, \quad (3.18)$$

$$\gamma = \delta_u^2 / \delta^2 \quad (3.19)$$

$$\delta^2 = \delta_u^2 + \delta_v^2 \quad (3.20)$$

Applying likelihood ratio (LR) estimation method of testing goodness of fit for the model, the best model would be selected. Given the specification of the SFA, H_a that inefficiency is present, is defined by, $H_a: \gamma \neq 0$ where γ is the variance ratio; the ratio of inefficiency to the total deviation from the efficient frontier level defined by eq.3.19. If H_0 is failed to be rejected, it indicates δ_u^2 is zero. Hence the error term is due to external factors (not from the operator him/herself). So, it is simply applicable to use the response function for determining the coefficient of the error term.

In selecting the best fitting model of production function; so further the level of technical, allocative and economic efficiencies and for inefficiency detection mechanisms, the studies conducted by Chimai (2011), Abu *et al.* (2012), Hidayah *et al.* (2013), Abebe (2014), Asad *et al.* (2014), Berhan (2015), Chakwera (2015) and Ermiyas *et al.* (2015), used log likelihood ratio and Gamma (γ) test following the likelihood ratio. Generally, this study has used the SFA with Cobb-Douglas production function form based on the test result of the model selection specification.

3.4.2. Sesame Post-harvest Loss and Its Sources

Depending on the type of data at hand the study employed both descriptive statistics and multiple linear regression methods to analyze the data at hand. Because, the descriptive statistics enables to describe and compare the amount/quantity of sesame grain lost using mean and frequency/ratio. Multiple linear regression method on the other case was used to analyze the linear relationship between the quantities of sesame grain post-harvest loss and potential explanatory variables using the cross sectional data obtained from small and large-scale producers. The model is given as:

$$Y_i = \alpha_0 + \alpha_1 X_{1i} + \alpha_2 X_{2i} + \alpha_3 X_{3i} + \dots + \alpha_{15i} X_{15i} + \varepsilon_i \quad (3.21)$$

Where $i = i^{\text{th}}$ respondent; ε = Random-error Y_i = the post-harvest loss of sesame for the i^{th} producer; α = parameter coefficients to be determined; $X_i = 1, 2 \dots 15$, explanatory variable of the i^{th} respondent.

Multiple linear regression model validity tests: It is tested and evaluated for its validity of fulfilling the rules of OLS such as the normality, heteroskedasticity problem, autocorrelation, endogeneity and severe multi-linearity problems that prevent from making inferences about the general population in the study area. The data was tested for heteroskedasticity problem using the Breusch-Pagan method; for severe multi-collinearity among the variables using the VIF; for endogeneity problem using the Wu-hausman test of the instrumental variable and for omitted variables using the Ramsey RESET test.

Variables definition and hypothesis

The dependent variable: In this study the dependent variable is the amount of sesame grain lost from producers' perspective measured in Kg at the time starting from harvest to the time of sale to assemblers or exporters. There is loss beyond the producers' stage, but due to difficulty to get the data, this study was limited to the loss occurred in the producer level.

Independent variables: These are the variables expected to affect sesame grain post-harvest loss. The amount of loss at different stages was assigned as during harvesting, drying, piles transportation, threshing, winnowing/cleaning and packaging and bagging, transportation from field to store/home/market, storage and sampling. The independent variables are defined and hypothesized as follows:

Age of the household head (agehhd): It is a continuous variable measured in years. Regarding this variable there is a fact that, when an individual is in the working age range, he/she becomes more productive as he can manage resources and time; so that loss amount would be reduced. The study result of Basavaraja *et al.* (2007) revealed that age of household head was negatively related to the amount of post-harvest loss. This study also hypothesized that as the active worker age increases, it could negatively affect post-harvest loss amount.

Education level of the household head (eduhhd): It is a continuous variable which refers to the years of schooling that the household head attained. Theoretically as the household head is becoming educated

his/her grain post-harvest loss controlling mechanisms improved so reduces post-harvest loss. The study conducted by Basavaraja *et al.* (2007) also obtained that education level of the household head was negatively related with post-harvest loss amount. Depending on the theory and former study results, this study hypothesized inverse relationship between education level and amount of sesame post-harvest loss.

Total amount of sesame production (TSsY): It is a continuous variable measured in Qt. theoretically, as the amount of sesame seed produced is high, there is greater opportunity to take time in store, becomes bulky in transportation, while relatively less amount is simple for managing. So, as the quantity increases the post-harvest loss amount is also increasing. So that this study hypothesized that there would be positive relationship between quantities produced and post-harvest loss amount.

Area under sesame production (landsz): It is a continuous variable measured in hectare. Theoretically, as the land size under sesame production increases post-harvest loss of sesame grain also increases. This is because there may be management power and skill would be spread out over the whole size of land so lead to reduction in controlling and supervising the farms which aggravate post-harvest loss. The result of the study conducted by Basavaraja *et al.* (2007) also shown that as land size increases, post-harvest loss increases. Based on the former study and theory, this study hypothesized that as the area under sesame production increases then sesame grain post-harvest loss also increases.

Weather condition (weazer): It refers to the natural phenomena including rainfall and wind which is a dummy variable that takes '0' if the weather during harvesting is favorable otherwise '1'. Theoretically, it is supported as the weather hazards happened during harvesting time it results an increase in post-harvest loss. As the study of Basavaraja *et al.* (2007), weather mismatching has positive relation with post-harvest loss amount. So this study hypothesized that the hazards of weather at the time of harvesting to threshing could aggravate post-harvest loss of sesame grain so has positive relationship.

Harvesting and threshing management (thrmgt): It is a categorical variable (0= good and carefully done, 1= carelessness) which indicates the performance of harvesting threshing laborers for their proper handling in harvesting and threshing. This study hypothesized an inverse relationship between harvesting and threshing management and amount of loss as the workers performance increases then the amount of sesame grain loss reduced.

Distance of piles transported to threshing place (disthila): It is a continuous variable which refers to the distance piles was transported from stacked place to the place where it was threshed measured in meters. There is a fact that, as the distance increases then it is familiar for more amounts to loss. So this study hypothesized direct relationship of the amount loss and distance piles transported.

Distance of sesame farm from residence (distfh): It is a continuous variable measured in kilometers. It refers to how far the producer travels from his home to reach his sesame farm. Theoretically as the distance increases, more time will be lost in journey. Also while transporting the product as distance increases, grain loss increases. In this study so, distance of sesame farm from home was hypothesized to have positive relationship to post-harvest loss.

Road infrastructure availability (road): It is a dummy variable that refers to the type of road available for transporting through. This is categorical variable that takes '1' for human and animal road; '2' for pista/standard road. Theoretically, availability of road access reduces loss. So, this study hypothesized negative relationship between standard road availability and post-harvest loss.

Mode of sesame grain transportation (modtrSfh): It refers to the mode used for transporting sesame grain from field to home/store. It is a dummy variable values as 1 = by donkey/caro, 2= by tractor or tracker). Logically as the farmers have access to timely transportation facilities, post-harvest loss reduced. The study conducted by Basavaraja *et al.* (2007) found an inverse relationship. In this study also, this variable was hypothesized to have an inverse relationship.

Duration at store (daystor): This refers for the number of weeks grain is stored. As the number of weeks increase, it leads more to be consumed by insect-pest so increased post-harvest loss. So, this study hypothesized that there is positive relationship between weeks stored and amount of sesame grain loss.

Number of extension contact (extn): This is a continuous variable which refers to the number of extension contact with sesame producers by the extension agent. Conceptually the service was formerly introduced to disseminate technologies that improve the existing appearance so improve once management. Depending on this idea, this study expected an inverse relationship of the service and loss.

Total amount of credit obtained (loan): It is a continuous variable indicating the amount of loan obtained for the sesame production from different sources. As sesame production requires high capital, the credit obtained enables producers to control the post-harvest activities on time so reduces the amount of loss. Therefore, in this study an inverse relationship between amount of credit and loss was expected.

Total amount of off-sesame farm income obtained (offinc): It is a continuous variable that refers to the amount of income used for sesame production which was obtained from sources out of the sesame production. This increases the amount of finance for properly handling the sesame production activities. This study hypothesized negative relation if there is no time competition with sesame otherwise positive relationship so the sign is indeterminate.

3.4.3. Analysis of Sesame Market performance

For the fourth and fifth objectives of this study descriptive statistics was used. The descriptive statistics using mean, frequency/ratio, and range are applied for analyzing market margin, analyses of concentration ratio (CR) and amount of the commodity handled.

3.4.3.1. Sesame market actors and their role in the sesame market

This is the fourth objective of the study which includes participants and their role in sesame market in Kafta Humera district that is analyzed and presented using descriptive statistics. It was applied to describe the major actors and their roles in the market chain and the mean amount of their holdings.

3.4.3.2. Market structure, conduct and performance

For measuring the fifth objective, this study used the S-C-P approach of describing and presenting the concentration of the market actors, characteristics of the market players, organizational structure of market actors and margins obtained by actors in the chain.

Market structure: It is measured by analyzing the concentration ratio, barriers to entry and exit to/ from market and vertical coordination/integration of the actors in the market chain.

Concentration ratio (C): It is the measure of the number and size of distribution of the market participants with their relative share in the market. This study used concentration ratio that shows proportion of the sesame grain amount accounted by 'r' large traders in assemblers and exporters considering as s_i = percentage market share of the i^{th} firm and r = number of firms owning largest share.

$$C = \sum_{i=1}^r S_i, i= 1, 2, 3, \dots r \quad (3. 22)$$

Even though there were no clear cut limit points for the indication of market structures, the commonly used points were as: no concentration ($CR_4=0\%$) means perfect competition; low concentration (CR_4 ranges from 0 to 50%) means competitive with weak power; medium concentration (CR_4 ranges from 50 to 80%) means an oligopoly; high concentration (CR_4 ranges from 80 to 100%) from an oligopoly to monopoly; total concentration ($CR_4 = 100\%$) , a monopoly (Christoph, 2007 and Kohls and Uhl, 1985)

The barriers to entry and exit to/from market are analyzed through systematic physical observation in the markets focusing on product differentiation, availability of market infrastructure, capital requirement and competition and government policies. The vertical coordination/integration of market participants is also analyzed by systematically observing the linkages among different actors along sesame market chain.

Market conduct: Many research results showed that there is no fixed way of analyzing market conduct but uses systematic way of reasoning and evaluation. Similarly, this study was designed to analyze and evaluate based on the systematic way of observation on the pricing strategies, collusive behavior of market participants and mergers (combination of market participants).

Market performance: It could be analyzed using price stability, profitability and market margin obtained and costs incurred to the market participants. But, in this study the market margin obtained by each market actors was used to measure the performance of sesame market in the study area.

Market margin: It is to identify the disparity between the purchasing cost and the income made by selling it. As explained by Mendoza (1995) market margin is calculated by finding the price variations at different segments and then comparing them with the final price to the consumer price. As the price

differences at each exchange stage are going to take its share from the final selling price paid by the consumers, then the consumer price is the base or the common denominator for all marketing margins.

$$TGMM = \frac{CP - FP}{CP} \times 100 \quad (3.23)$$

$$GMMP = \frac{CP - MGM}{CP} \times 100 \quad (3.24)$$

$$NMM = \frac{GM - MC}{CP} \times 100 \quad (3.25)$$

Where: CP= Consumer price; FP= Farmer's price; GM= Gross Margin MC= Marketing Costs; GMMp = Gross Marketing Margin of Producers, NMM = Net Marketing Margin; TGMM = Total Gross Marketing Margin, Gross Margin is a profit divided by sales revenue or gross profit divided by net sales revenue, expressed as percentage. But here in this study the consumer price would be changed by the *fob* price as it was the exported commodity considering the raw and processed sesame exported.

4. RESULTS AND DISCUSSION

It is in this chapter that, the results of the study are presented and discussed. The results obtained are presented in two separate sections; the descriptive statistics results and the econometric model results.

4.1. Descriptive Statistical Results

This section presents descriptive statistics results of sampled households' demographic and socio-economic characteristics, institutional services and inputs used in the econometric models.

4.1.1. Demographic Features and Availability of Production Resources

The average family size of small-scale sesame producers in the study area were five persons per family with ratio of one to one between male and female members (Table 3). It is also observed that the total active and non-active family members were three and two persons, respectively. Regarding large-scale producers, on average there were six persons in each family with the average composition of three by three for male and female members (Table 3).

Table 3. Household characteristics for both small and large-scale sesame producers

Variables	Small-scale		Large-scale		Difference (t-test)
	Mean	Std. Err	Mean	Std. Err	
Age (years)	45.22	0.70	48.4	0.68	-3.08
Experience (years)	13.86	0.55	19.8	0.54	-6.32
Total family size (No)	5.46	0.17	6.50	0.18	-3.52
Male family members (No)	2.73	0.11	3.30	0.11	-3.9
Female family members (No)	2.73	0.11	3.20	0.15	-1.32
Total active family size (No)	3.11	0.12	3.90	0.15	-2.58
Total non-active family size (No)	2.35	0.13	2.50	0.16	1.63
Dependency ratio	0.43	0.18	0.38	0.14	-9.68
Education level (years of school)	3.29	0.23	4.88	0.33	-4.24
Number of extension contact (No)	2.54	0.19	1.34	0.19	5.71
Number of training obtained (No)	0.93	0.15	0.91	0.091	-1.36
TLU	4.16	0.57	12.73	1.98	-4.25
Off-sesame income amount (Birr)	16,249.06	1,869.65	61,361.27	9,448.27	-4.16
Amount borrowed money (Birr)	19,037.01	3,084.94	347,960.30	61,874.10	-5.52
Amount of own income (Birr)	14,522.52	1,845.20	192,245.10	26,541.19	-6.70

Source: Survey result, 2016

The average numbers of active and non-active family members for large-scale producers were four and two, respectively. The sampled small-scale sesame producers have an average age of 45 years (Table 3). Regarding the sampled large-scale sesame producers their average age was 48 years. The average educational level (in years of schooling) of the sampled small and large-scale producers was about three and five years of schooling, respectively (Table 3). This indicates that in the study area large-scale producers have relatively more years of schooling than small-scale producers.

As presented in Table 3, the average sesame production experiences of sampled small and large-scale sesame producers were 13.84 and 19.8 years, respectively. Regarding the proportion of household head, 92% and 83% of the sampled small and large-scale sesame producers were male headed, respectively (Table 4). As it is also presented in Table 4, 89% and 79 % of the sampled respondents from small and large-scale producers were members of cooperative. It is also found that, 33.6% and 35.7% of the sampled small and large-scale sesame producers participated in off-sesame farm activities (Table 4).

Table 4. Gender, membership and off-sesame farm engagement of small and large-scale producers

Variable		Small-scale		Large-scale		Pearson chi ² (1)
		Freq.	Percent	Freq.	Percent	
Sex of household head	Male	118	92.19	105	83.33	2.34
	Female	10	7.81	21	16.67	(0.13)
Membership in association	Member	114	89.06	100	79.37	1.56
	Not	14	10.94	26	20.63	(0.21)
Participation in off sesame farm activities	Yes	43	33.59	45	35.71	0.01
	No	85	66.41	81	64.29	(0.92)
Application of fertilizer	No	65	50.78	18	14.29	38.54
	Yes	63	49.22	108	85.71	(0.00)
Obtaining status of off-sesame income	Yes	79	61.60	81	64.29	82.88
	No	49	38.40	45	35.71	(0.00)
Livestock ownership	Yes	55	43.00	68	50.00	1.49
	No	73	57.00	68	50.00	(0.22)
Living home ownership	Yes	91	71.09	120	95.24	31.72
	No	37	28.91	6	4.76	(0.00)
Obtaining status of extension contact	Yes	115	89.84	41	32.54	88.84
	No	13	10.16	85	67.46	(0.00)

The value in parenthesis implies the p-value

Source: Survey result, 2016

Labor availability and hiring

All the sampled sesame producers whatever their cultivated land size used hired labor at different stages of their sesame production activities (Table 5).

Table 5. Frequency of sampled producers who used hired labor, 2015/16 production year

Stages at which labor hired	Small-scale		Large-scale	
	Freq.	Percent	Freq.	Percent
Harvesting only	3	2.34	0	0.00
Weeding and harvesting	9	7.04	3	2.38
Land Preparation, sowing and weeding	2	1.56	0	0.00
Land Preparation, weeding and harvesting	1	0.78	0	0.00
Weeding, harvesting and threshing	22	17.19	3	2.38
Land Preparation, weeding and threshing	1	0.78	0	0.00
Sowing, weeding, harvesting and threshing	10	7.81	2	1.59
Land Preparation, sowing, weeding, harvesting and threshing	80	62.50	118	93.65
Total	128	100.00	126	100.00

Source: Survey result, 2016

As shown in Table 5, from the total sampled small and large-scale sesame producers 62.5% and 93.65% respectively hired workers for all production activities starting from land preparation to threshing. The number of labor hired by the sampled small and large-scale producers in all activities of sesame production are 167 and 2,911 man days per household, respectively (Table 6).

Table 6. Amount of labor hired in different activities of sesame production in man days

Activities	Small-scale		Large-scale	
	Average	Std. Err	Average	Std. Err
Land preparation	22.25	1.35	614.30	111.05
Sowing	3.38	0.29	12.01	1.54
Weeding	104.32	10.93	1701.93	217.26
Harvesting	29.97	5.22	583.50	134.77
Threshing	7.01	0.54	66.60	8.66
Total/household	166.932		2,979.34	
Labor hired in man days per hectare				
Land preparation	4.08	0.35	4.77	0.28
Sowing	0.62	0.07	0.1	0.07
Weeding	19.14	0.95	13.24	0.67
Harvesting	5.5	0.33	4.54	0.44
Threshing	1.28	0.10	0.52	0.05
Total /household	30.62		23.17	

Source: Survey result, 2016

On per-ha base as presented in Table 6, the hired labor for sesame production by small and large-scale producers were 31 and 23 man days/year, respectively. It also shows most of the hired labor is used for weeding followed by harvesting (for both producers).

Large-scale sesame producers in the study area incurred higher cost for hired labor per-ha in all the major production activities that lead to the average per-ha labor cost of birr 4137.74, which is higher than what the small-scale producers have invested (2655.04 birr/ha) (Table 7). This might be, due to the reason that small land size as in small-scale producers case is easily manageable for effective performance of the hired workers, but relatively difficult for large land size as in large-scale producers.

Table 7. Labor cost of sesame production per hectare for individual small and large-scale producer

Activity labor cost incurred	Small-scale		Large-scale	
	Mean (man days)	Std. Err.	Mean (man days)	Std. Err
Land preparation	285.82	27.30	396.10	20.77
Sowing	50.20	6.03	64.00	05.42
Weeding	1237.70	16.99	2183.05	92.41
Harvesting	812.39	47.38	1250.90	34.91
Threshing	268.93	13.12	243.69	6.55
Total / household	2,655.04		4,137.74	

Source: Survey result, 2016

Land size and ownership

The average land holding size of the sampled small and large-scale sesame producers in Kafta Humera district were 7.42 ha and 159.86 ha, respectively (Table 8). From the total land cultivated by the sampled small-scale sesame producers, 60.58% was obtained from their own; while the remaining 39.42% plough the rented-in land (Table 8).

Table 8. Household land holding and allocation of sample producers in Kafta Humera district, 2015/16

Land source& allocation	Small-scale			Large-scale		
	Mean	%	Std. Err.	Mean	%	Std. Err.
Total land size	7.42	--	0.68	159.86	--	28.38
Own land	4.48	60.58	0.41	148.28	92.76	26.66
Land rented-in	2.94	39.42	0.41	11.58	7.20	4.13
Land rented out	0.19	2.60	0.08	0.13	0.075	0.089
Uncultivated land	0.074	0.95	0.048	7.90	4.90	4.60
Sesame land	5.45	73.45	0.58	128.60	80.50	22.42
Sorghum land	1.69	22.78	0.20	23.10	14.44	3.39
Pulses land	0.016	0.22	0.015	0.13	0.075	0.09

Source: Survey result, 2016

As it is presented in Table 8, 73.45% of the total cultivated land by small-scale sesame producers was allocated for sesame production while 22.78% was allocated for sorghum production. Similarly, 92.76% of the total land cultivated by large-scale sesame producers was their own, while 7.24% was rented-in land (Table 8). As presented in Table 7, 80.5% and 14.44% of the total land size of large-scale sesame producers is allocated to sesame and sorghum production, respectively.

Variety of sesame seed applied and purpose of sesame production

The major sesame seed varieties used for production by the sampled small and large-scale sesame producers in the study area are Hirhir, Setit-1, Gojam azebe, and bounji (Table 9).

Table 9. Mean amount and percentage of sesame seed varieties used for production per household

Variety of seed used	Small-scale		Large-scale	
	Mean (Kg)	Percent	Mean (Kg)	Percent
Setit-1	11.48	44.10	34.70	7.94
Hirhir	12.81	49.10	381.40	87.30
Gojam Azebe	0.60	2.30	7.23	1.65
Bounji	1.20	4.60	13.77	3.20
Mean total seed used/household	26.16 Kg		437 Kg	
Mean total seed cost /household	768.17 birr		12,681.64 birr	

Source: Survey result, 2016

As it is presented in Table 9, for both groups of sesame producers in the study area hirhir variety takes the highest percentage of utilization for seed followed by setit-1 variety. The total amount of sesame seed used by individual small and large scale producers are 26.16 Kg and 437 Kg with the mean total cost of birr 768 and 12,681 respectively (Table 9).

Table 10. Amount and share of sesame produced and allocated for different purposes

Purpose of sesame produced	Small-scale				large-scale			
	Total (Qt.)	Mean (Qt.)	%	Std. Err	Total (Qt.)	Mean (Qt.)	%	Std. Err
Sold	1806.7	14.12	99.1	0.002	37284.5	295.91	98.67	0.0013
Seed	0.75	0.124	0.86	0.002	48.00	3.6	1.2	0.0007
Consumption	15.84	0.006	0.04	0.0003	453.25	0.38	0.13	0.0003

Source: Survey result, 2016

The total sesame produced by the sampled small-scale producers, 99.1% was for selling, 0.04% for home consumption and 0.86% for seed purposes (Table 10). Similarly, the sampled large-scale producers allocated 98.67% of their sesame produced in 2015/16 production year for selling and the remaining 0.13% and 1.2% for home consumption and seed respectively (Table 10).

Soil fertility status and application of inorganic fertilizer (UREA and DAP)

The soil fertility status of plots of the sampled small-scale sesame farmers range from poor fertile to high with majority of it is falling in the category of low (31.25%) and moderate (28.13%) (Table 11). It is also presented in the same Table that, the soil fertility status of plots of majority of sampled large-scale producers fall in moderate (61.11%) category. Even though, the larger percentage of respondents perceive their soil fertility status as moderate to lower level, 50.79% and 14.29% of the small and large-scale sesame producers did not yet apply any fertility improvement inputs in their sesame farm, whereas the remaining 49.22% and 85.71% had applied inorganic fertilizer even though it was not as per the recommended rate (Table 4).

Table 11. Soil fertility status of small and large-scale producers' sesame farm

Fertility status of the farm	Small-scales		Large -scale	
	Frequency	Percent	Frequency	Percent
Low and below	57	44.55	21	16.67
Moderate	36	28.13	77	61.11
High	35	27.32	28	22.22

Source: survey results, 2016

In this study it was also found that farmers did not apply fertilizer as per the recommended rate, rather they apply the amount what they have bought on all the land size they had. These and related reasons might have contributed to the low productivity of sesame in the study area.

Table 12. The total amount of fertilizer applied and its cost per individual small and large-scale producer

Amount of total fertilizer applied	Small-scale		Large-scale	
	Mean	Std. Err.	Mean	Std. Err.
DAP (Qt.) / household	1.51	0.25	52.41	10.04
UREA (Qt.) / household	0.59	0.12	19.84	4.2
TC_DAP (birr) / household	1,900.10	332.12	69,038.81	13,276.05
TC_UREA (birr) / household	695.00	133.73	22,635.65	4,931.37

Source: Survey result, 2016

The average amount of DAP and UREA applied on the sesame land of the sampled small-scale producers are 1.5 and 0.59 Qt with the total costs of birr 1,900 and 695, respectively (Table 12). Regarding the sampled large-scale sesame producers, the application of inorganic fertilizer on average was 72.25 Qt with the average cost of birr 91,674.46 per individual producer (Table 12).

Mode of ploughing used, ownership status and rental cost of plough power

In the study area, 90.63% of the sampled small-scale sesame producers did not own any plough power rather plough their farm by renting of either tractor and/or pair of oxen (Table 14).

Table 13. Mode of ploughing power used by sesame producers for plowing their sesame farm

Mode of plough and source	Small-scale		Large-scale	
	Number	percent	Number	percent
Using own oxen/donkey/camel	3	2.34	--	--
Renting of oxen/donkey/camel	1	0.78	3	2.38
Using own tractor	0	0.00	61	49.21
Renting tractor	115	89.84	57	45.24
Renting tractor and Using own oxen/donkey	9	7.03	5	3.17

Source: Survey result, 2016

Further, it is obtained that about 90% of the sampled small-scale sesame producers who did not own plough power plough their land by renting tractors (Table 13). They rent-in tractors on an hourly basis with the average cost of birr 708.45 per hour (Table 15). It is also found that, 39.68% of the sampled large-scale sesame producers in the study area did not own any plough power (Table 14).

Table 14. Mode of ploughing power used and its ownership by sesame producers

Ownership of plough power	Small-scale		Large-scale	
	Number	Percent	Number	Percent
No, not yet own any	116	90.63	50	39.68
Oxen only	2	1.56	14	11.11
Donkey only	7	5.47	---	---
Camel only	1	0.78	---	---
Donkey and oxen	2	1.56	---	---
Tractor only	---	---	6	4.76
Tractor with disk	---	---	56	44.45

Source: Survey results, 2016

Further, it is indicated that 45.24% of those large-scale producers who did not own plough power plough their sesame farm by renting tractors (Table 13), at the average cost per-hour of birr 695.00 (Table 15).

Distance of sesame farm land from residence and mode of transportation used

As it is presented in Table 15, the average distance of sesame farm land from residence of small-scale sesame producers was about 20.21Km; so that, they visited their sesame farm on average 46 times per the production season. Results as in Table 15 also show that, the average farm distance of the sampled large-scale sesame producers' from their residence was 26.66 Km so that on average they visited their sesame farm 49 times in whole 2015/16 production season (Table 15).

Table 15. Distance of farm, frequency of farm visit and plough power renting price by sesame producers

Variables	Small-scale		Large-scales	
	Mean	Std. Err.	Mean	Std. Err.
Frequency of farm visit (No)	46.00	1.2	48.95	1.67
Plough power renting price per hour (birr)	708.45	9.28	694.8	10.8
Average distance from residence (Km)	20.21	0.81	26.66	1.25

Source: Survey result, 2016

Off-sesame farm income sources

Regarding the sources of off-sesame farm income sources, 38.4% of the sampled small-scale sesame producers did not obtain income from off-sesame farm income sources (Table 4). But, the remaining 61.6% of the sampled small-scale producers obtained off-sesame farm income from so many sources as described in Figure 5 (Table 4).

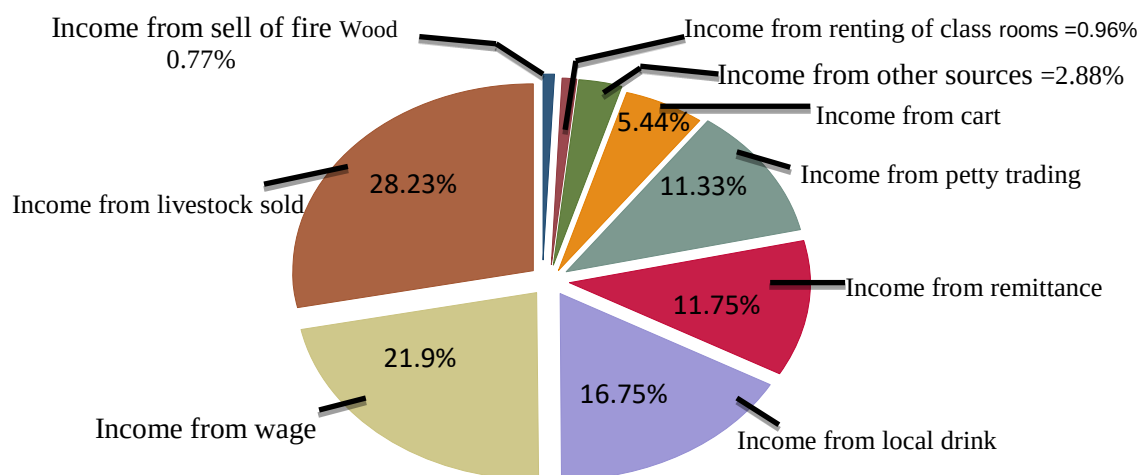


Figure 5. Share of income obtained from off sesame farm sources by small-scale farmers

As it is presented in Table 4, 35.71% of the sampled large-scale producers did not obtain income from off-sesame farm source, while the remaining 64.29% obtained from different sources as in Figure 6.

As it is shown in Figure 5, the highest off-sesame farm income obtained by small-scale sesame producers was from livestock selling (28.23%) followed by wage (21.9%). Regarding the large-scale sesame producers the highest off-sesame farm income also comes from livestock selling (49.51%) followed by renting of tractor (18.9) as it is presented in Figure 6. Generally, results shown that both small and large-scale sesame producers obtain higher off-sesame farm income from livestock selling.

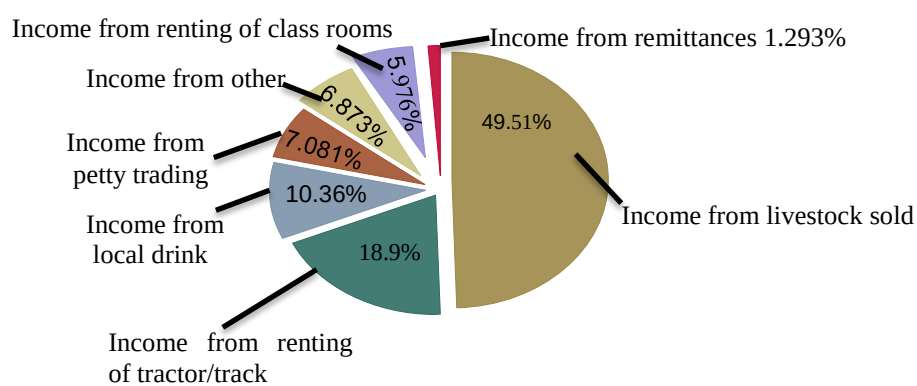


Figure 6. Share amount of income obtained from off sesame farm sources by large-scale producers

Ownership of livestock other than used for plough

As it is presented in Table 4, 57% and 50% of the sampled small and large-scale sesame producers, respectively did not own livestock. It also shows that, the average TLU were 4.16 and 12.73 for the sampled small and large-scale sesame producers, respectively (Table 3). Livestock contribute the highest source of income which is 28.23% and 49.51% off-sesame farm income obtained by small and large-scale sesame producers, respectively (Figure 5 and 6).

4.1.2. Institutional Support and Services in Sesame Production

This part refers to the support services provided by governmental and non-governmental institutions that enable sesame producers to achieve their target. The services provided for both categories of sesame producers were related to extension support, trainings and financial support. These support services provided to producers will be explained below:

Frequency of extension contact

The extension services provided aimed at helping, advising and guiding producers to improve productivity, achieving food security and producing marketable commodities such as sesame. In the study district, the service was provided in two ways one is that, DAs visit farmers' field, observe the farm and give an advice and corrective measures. The second way is that producers go to FTCs and contact DAs and get advice based on what they inform about their farm.

As presented in Table 4, 10.16% and 67.46% of the sampled small and large-scale sesame producers respectively did not obtain any extension advice in 2015/16 production season. These sampled small and large scale sesame producers who contacted with the extension service providers obtain on average about three and one times of contact with the extension service providers respectively (Table 3).

Credit service and its sources

In the study area, there are both formal and informal sources of credit which provide loan for sesame production. The informal sources of credit were traders, friends/parents and other farmers; whereas the formal sources were banks, DCSI and MPP cooperatives.

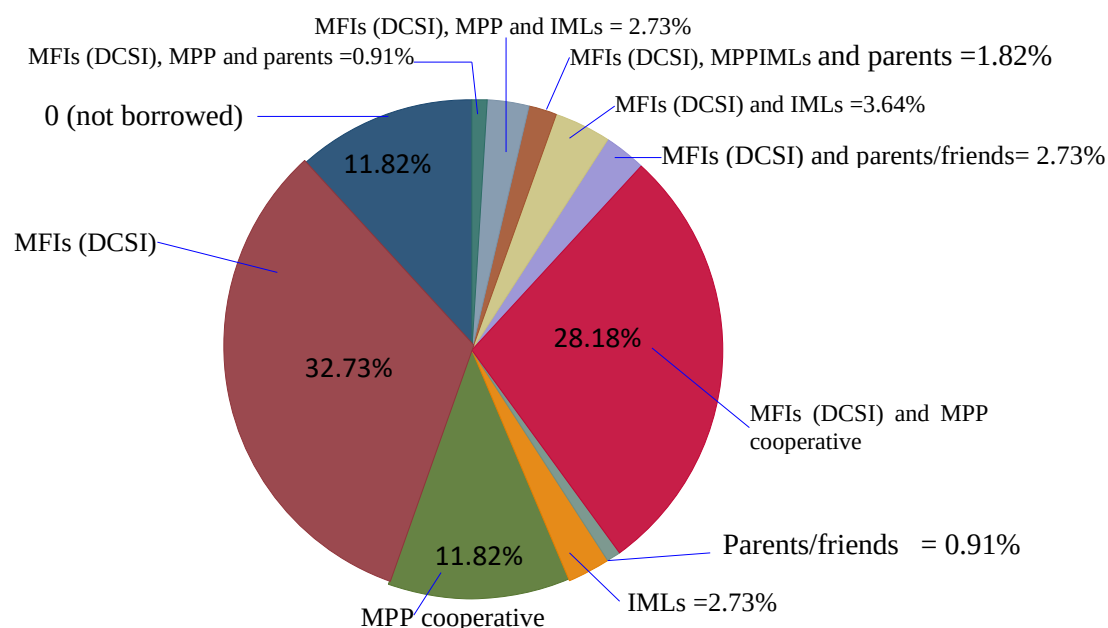


Figure 7. Share of different sources of credit for small-scale sesame producers in 2015/16

As it is presented in Fig 7 and 8, 32.73% and 19.51% of the sampled small and large-scale sesame producers' obtained their unfulfilled financial requirement (loan) from MFIs (DCSI).

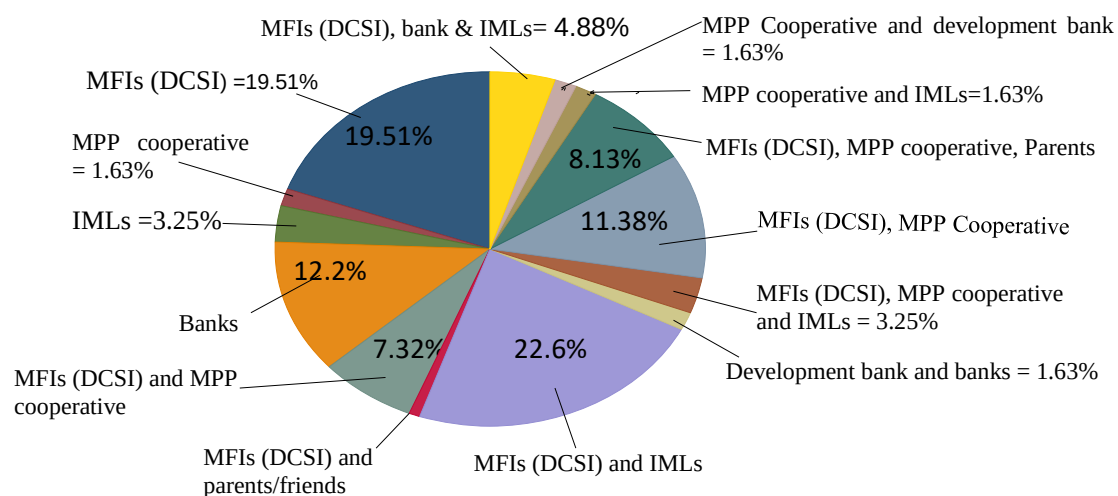


Figure 8. Share of different sources of credit for large-scale sesame producers in 2015/16

Generally as presented in Tables 3 and 4, it is possible to conclude that there is statistically significance difference between small and large-scale sesame producers in the study area regarding the variables of age, experience, family size, dependency ratio, education level, extension contact, amount of livestock owned in TLU, amount of off-sesame farm income, amount of credit obtained and amount of own money at 1% significance level.

As it is also revealed in Tables 3 and 4, the two categories were not significantly differentiated in terms of their gender participation, membership in association, participation in off-sesame farm activities, percentage of sampled respondents who own livestock and number of training obtained even at 10% significance level. Thus, taking this study by considering these two producer categories in their respective level is important as taking together has no reality and face heterogeneity.

4.1.3. Summary Statistics of the Sesame Production Inputs and Their Costs

The average sesame produced by the sampled small and large-scale sesame producers are 14.25 Qt and 299.43 Qt per household, respectively (Table 16). The production cost for the sampled producers were birr 25851.53 and 854469.84 for small and large-scale producers, respectively (Table 16).

Table 16. The summary of total production inputs and total costs for small and large-scale producers

Variable	Unit	Small-scale		Large-scale	
		Mean	Std. Err.	Mean	Std. Err.
Total sesame grain produced	Qt	14.25	1.24	299.43	52.59
Total sesame production cost	Birr	25851.53	3245.33	854469.84	91235.23
Total labor in sesame production	No	166.93	184.91	2979.44	403.34
Total cost of sesame labor	Birr	14469.85	1753.35	445387.67	70040.60
Total sesame sown land	Ha	5.45	0.58	128.59	22.42
Total cost of sesame land	Birr	3441.05	597.70	178981.01	39630.91
Total plough power hour	Hr	3.64	0.38	64.30	125.88
Total plough cost	Birr	2283.67	274.60	63530.04	6312.88
Total operating cost	Birr	2265.88	858.80	53458.69	7324.57
Total material cost	Birr	953.04	155.40	7657.32	1236.14
Total amount of sesame seed	Kg	26.11	2.70	436.98	62.32
Total cost of sesame seed	Birr	614.54	64.62	12681.64	1736.03
Total cost of fertilizer	Birr	1823.51	391.61	92773.63	18220.70
Total amount of fertilizer	Qt	2.09	0.37	72.24	14.12
Average sesame yield	Qt/ha	2.82	0.12	2.46	0.07
Average production cost / ha	Birr/ ha	4743.4	117.01	6644.43	1899.165

Source: Survey result, 2016

The average yield obtained by the sampled small and large-scale sesame producers in the study area were 2.82 Qt /ha and 2.46 Qt /ha, respectively (Table 16). Hence, the average production costs per-ha and per-Qt were birr 4743/ha and 1682/Qt for small-scale and birr 6644.43/ha and 2698.68/Qt for large-scale producers. This shows that large-scale producers were spending higher amount as compared to small-scale sesame producers (Table 16). The average labor hired also shown that small-scale sesame producers hired more number of laborers per-ha basis (31 man day) as compared to the large-scale producers (23 man days). But, the labor cost indicated that large-scale producers paid higher cost per-ha for hired labor as compared to small-scale producers.

4.1.4. Post-harvest Loss of Sesame Grain

As presented in Table 17, the amount of sesame grain loss in piles stacking (drying) accounts for the highest percentage of the total loss in both small and large-scale producers (50.44% for small-scale and 51.5% for large-scale). The loss during harvesting time (pod dropped, un-harvested remains and grain drops as the pod opens during harvesting) accounts for 16.41% of the total loss (Table 17). Regarding the

sampled large-scale producers, the loss due to un-threshed pods remained and pods thrown account for 17.4% (Table 17). However, the lowest loss (0.07%) of sesame produced by small and large-scale sesame producers were during selling and transporting from store to market, respectively (Table 17).

The average amount of sesame grain loss per individual producer in the study area was about 3.37 Qt (0.62 Qt/ha) and 73.65 Qt (0.57 Qt/ha) for small and large-scale producers, respectively (Table 16). This total loss amount lead to the ratio of loss to total production obtained (i.e., the percentage of loss) of 23.68% and 24.6% for small and large-scale producers, respectively. The study result is consistent with the results of Aramyan and Gogh (2011), FAO (2011) and Tefera *et al.* (2011_b); who found the range of loss between 20-40% of the total produced amount. It is also similar with the result obtained by Hodges *et al.* (2011) that the cumulative post-harvest loss of wheat, sorghum and maize, for Ethiopia was ranging from 15% to 25%. The result obtained also matches with the result of post-harvest loss found by Hodges (2012) for Tanzania to be 22% and for Benin 27% of the total produced amount.

Table 17. The amount of sesame grain loss at different stages from sesame producers

Stage at which loss occurred	Unit	Small scale				Large scales			
		mean	Per-ha	Per-Qt.	%	mean	Per-ha	Per-Qt.	%
Re-cleaning process loss	Kg	0.66	0.12	0.05	1.195	176.03	1.37	0.59	2.40
Loss during selling	Kg	0.25	0.05	0.02	0.073	6.42	0.05	0.02	0.087
Transport (from store to market)	Kg	0.38	0.07	0.03	0.113	5.50	0.04	0.02	0.075
Loss at storage	Kg	22.73	4.17	1.60	6.73	340.70	2.65	1.14	4.60
Loss due to poor quality sack	Kg	0.82	0.15	0.06	0.244	8.10	0.06	0.03	0.11
Transport (from farm to store)	Kg	1.16	0.21	0.08	0.343	340.00	0.26	0.11	0.46
Cleaning loss	Kg	10.75	1.97	0.76	3.184	131.40	1.02	0.44	1.80
Un-threshed thrown	Kg	38.98	7.15	2.74	11.56	1278.30	9.94	4.27	17.36
Threshing loss	Kg	2.81	0.52	0.20	0.834	74.80	0.58	0.25	1.01
Piles transport	Kg	33.50	6.15	2.36	9.924	522.10	4.06	1.74	7.10
Piles stacking/drying	Kg	170.10	31.21	11.96	50.40	3790.60	29.48	12.65	51.50
Harvesting loss	Kg	55.38	10.16	3.89	16.40	997.20	7.75	3.33	13.54
total grain loss	Kg	337.52	61.93	23.73	100.0	7365.15	57.27	24.58	100.00

Source: Own measured data, 2016

The study conducted by Vidyalaya (2013) also found the overall share of post-harvest loss across harvesting, storage, threshing and winnowing, transportation and handling as 56, 20, 19, 2 and 3%, respectively. Basappa *et al.* (2007) also found the loss at harvesting, threshing, cleaning, drying, storage, transportation, packaging taking the share of about 30, 12, 3, 22, 13, and 5%, respectively.

But, what differs from most of the studies was that sesame in Ethiopia, particularly in Kafta Humera district did not stay longer as it is export commodity. So storage loss was lower in this study. Rather due to its highly shattering nature and it is staying longer for drying, the highest loss was recorded during piles stacking/drying. The Food and Agriculture Organization (FAO, 2014) estimated about 32 percent of global food production was lost after harvest; while up to 37 percent in Sub-Saharan Africa.

Sesame grain loss during harvesting

This is the stage at which useful part of the standing sesame was cut, collected and piles stacked. Harvesting is performed as the crop matures when pods become brownish color and its leaves become yellow and start shading. Loss at this stage was due to over maturity of the crop (pods opened), when there is poor handling of the laborers some of the harvested part fails and part of the standing sesame remains not yet cut/un-harvested. Due to these faults sesame grain loss of 55.38 Kg (3.89 Kg/Qt) per individual small-scale producers and 997.2 Kg (3.33 Kg/Qt) for the individual large-scale producers happened (Table 17).

The loss during harvesting stage takes second rank in small-scale (16.4%) and third rank in large-scale (13.54%) sesame producers (Table 17). Regarding its maturity level, producers explained that it is better if sesame is harvested while the first lower three capsules/pods opened, so that one could say that sesame field is really matured. For this reason producer stay until balanced maturity is reached even though the lower part is lost. The solution for this might be adoption of improved non shattering seed varieties.

Sesame post-harvest loss during piles drying

This is the stage at which harvested sesame stays for drying so that pods will tear become easily to thresh. In this stage the weather hazards such as wind, rainfall and pests (termite, ants and webworm) results sesame grain loss in the study area. The poor stacking performance was also the other additional factor for sesame grain loss. The harvested sesame stayed for an average of 16 days by both small and large-scale producers for drying. During drying period on average a loss of 170 Kg (11.96 Kg/Qt) and 3790.6 Kg (12.65 Kg/Qt) of sesame grain was occurred from the individual small and large-scale farms, respectively; which accounts 50.4% and 51.5% for small and large-scale producer's total production (Table 17). This indicates that it is the stage at which greater amount of post-harvest loss occurred.

Sesame post-harvest loss during piles transportation

This refers to the transportation of stacked piles from the place where it was piled to the place where it would be threshed. The average distance the harvested sesame moved for threshing was 15.2 meters for small-scale and 13 meters for large-scales. The average amount of sesame grain loss per individual producer in this stage was 33.5Kg (2.36 Kg/Qt) and 522.1Kg (1.74 Kg/Qt) for small and large-scale producers; which account for 9.92% and 7.1% of the total loss, respectively (Table 17).

Sesame post-harvest loss during threshing

Threshing is the stage in which sesame grain extracted/separated from sesame pods/ capsules. Grain loss was occurred at this stage because of poor performance of threshing workers. According to the study results as in Table 17, the average amount of sesame grain loss at this stage per household was 2.81Kg (0.2 Kg/Qt) and 74.8Kg (0.25 Kg/Qt) from small and large-scale producer's field that hold the percentage share of 0.834% and 1.01% for small and large-scale respectively (Table 17).

Sesame post-harvest loss due to un-threshed remain pod

This is to refer the loss occurred due to the throwing of the sesame straw bar while it is not finishing its seed (seed remain in the pods). So that it is not a stage by itself rather it is sub-process beside to the threshing process. In this sub-process loss could happen by threshing while the pods not fully dry and tear; so grain could not withdraw during threshing. On the other case poor performance of threshing workers whom leads grain to remain inside sesame straw bar could also result grain loss. Holding these reasons, the average amounts of sesame grain loss because of un-threshed remain was 2.74 Kg/ha and 4.27 Kg/ha for individual small and large-scale producers; which account 11.56% and 17.36% from the total loss of small and large-scale producers respectively (Table 17).

Sesame post-harvest loss during cleaning

Cleaning stage includes winnowing and packaging processes. In this stage loss was resulted due to poor performance, high wind force, and limitation of materials used. Due to these causes the average amount of sesame grain loss from individual small and large scale sesame producers was 10.75 Kg (0.76 Kg/Qt) and 131.4 Kg (0.44 Kg/Qt); with the share of 3.184% and 1.8% from the total loss for small and large-scale producers respectively (Table 17).

Sesame post-harvest loss during storage

Sesame producers in the study area used either standardized store or their home. The standard store could be either rented or their own. The average sesame grain loss during storage for individual small and large-scale producer was 22.73 Kg (1.6 Kg/ha) and 340.7 Kg (1.14 Kg/ha) (Table 17).

Sesame grain loss from the marketing activities of assemblers

Table 18. Amount of sesame grain loss from individual assembler's in Kafta Humera

Variable	Mean (Kg)	Percentage	Min	Max
Re-cleaning loss	1190.33	50.71	0.00	4800.00
Loss during sampling	81.02	3.45	7.00	414.00
Sample taken at ECX	76.73	3.27	5.00	640.00
Market-Store transport loss	24.88	1.06	0.00	240.00
Storage loss	880.65	37.52	20.00	10450.00
Store-market transport	93.38	3.98	0.00	660.00
Overall total loss	2347.10	100.00	196.00	13040.00

Source: Survey result, 2016

The average amount of sesame grain lost at assemblers' stage was 23.47 Qt which accounted for 1.13% of the total bought (Table 18). The total amount loss was contributed by: 50.71% from loss during re-cleaning activities; followed by storage losses which account 37.52%, during sampling and sample taken collaboratively for 6.72% and the remaining loss during transportation from market that was bought to store (1.06%) and from store to ECX store (3.98%) as in Table 18.

4.2. Econometric Analyses of Production Efficiency and Sources of Inefficiency

In this section the sesame production inputs, efficiency level and sources of technical, allocative and economic inefficiency are analyzed by applying SFA of Cobb-Douglas functional form selected based on the maximum likelihood ratio result in the one step procedure using STATA software.

4.2.1. Hypothesis Testing and Model Selection

Before estimating the model parameters, levels of TE, AE, and EE and their determinants, it is better to identify and select the best fit functional form with the data at hand. Selection of the best fitting

functional form was done by likelihood ratio test assuming; the null hypothesis that the coefficients of all interaction of the inputs and the squares with themselves as a specification of the translog-production function are equal to zero (i.e., the production was determined only by the single individual inputs).

The log likelihood ratio test results of Cobb-Douglas and translog forms were -84.55 (5, d. f) and -78.16(15, d. f) for small-scale producers and -24.32(5, d. f), -21.21(15, d. f) for large-scale producers respectively. The likelihood ratios of the difference among the functions computed from these two results are 12.78 and 6.22 for small and large-scale producers respectively (Table 18). The likelihood result is so lower than that of the critical value at 95% confidence level that shows the coefficients in the translog functional form has no difference with the coefficients in Cobb-Douglas functional form. Finally, the null hypothesis was accepted and the Cobb-Douglas functional form was used as it best fits the data in the study.

The other related hypothesis to be tested is that there is no inefficiency (H_0 : all coefficients of inefficiency are zero) against the alternative hypothesis, which states that all parameter coefficients of the inefficiency model are different from zero (H_a : there is inefficiency). The likelihood ratio results obtained for this test are 104.78 and 92.67 for small and large-scale producers respectively which are higher than the critical values at specified degree of freedom (Table 19). As a result, the null hypothesis was rejected in favor of the alternative hypothesis that explanatory variables associated with inefficiency effects model are simultaneously different from zero.

Table 19. Maximum likelihood ratio test results of model selection, inefficiency and its sources

Null hypothesis	LR value calculated		Critical value (5%)		decision	
for Small & large-scale	Small-scale	large-scale	Small-scale	large-scale	Small-scale	large-scale
$H_0: \beta_{ij}=0$	12.78	6.22	25	25	Accepted H_0	Accepted H_0
$H_0: \gamma=0$	91.5	94.43	11.07	11.07	Reject H_0	Reject H_0
$H_0: \delta_1 = \dots \delta_{10}=0$	104.78	92.67	23.68	23.68	Reject H_0	Reject H_0

Source: Results of STATA 13 for frontier analyses of one step procedure

The parameter gamma (γ), estimated using the likelihood estimation result is the ratio of the variance of the inefficiency component to that of the total error term [$\sigma_u^2 / (\sigma_v^2 + \sigma_u^2)$]. This ratio measures how much the variability between the observed and the frontier output was contributed by the production inefficiency components. The more this ratio is close to 1, the more the output variability is affected by

the operator's performance error than the usual random noise. The value of this discrepancy ratio (γ) calculated from the maximum likelihood estimation was 0.915 and 0.944, for small and large-scale sesame producers respectively (Table 19).

The coefficient for the parameter γ can be interpreted in such a way that about 91.5 percent of the variability in sesame output of the small-scale producers in the study area was attributable to technical inefficiency effect, while the remaining 8.5 percent variation in the output was due to the effect of random noise. Similarly for the large-scale producers, 94.4 percent of the variation in sesame output was contributed by the technical inefficiency effect, while 5.6 percent was due to the external noise. This could indicate that there is room for improving output of sesame by first identifying those institutional, socioeconomic and farm specific factors causing this variation.

Generally it is proved that in the study area there was inefficiency in both categories of sesame producers. It is also specified that the efficiency of production and sources of inefficiency could be measured using the SFA of the Cobb-Douglas production functional form.

4.2.2. Estimation of parameters in Production Function

In this part the first two objectives dealing with the measurement of production efficiency and sources of inefficiency of small and large-scale sesame producers in Kafta Humera district were analyzed and discussed applying the SFA in the form of Cobb-Douglas production function.

4.2.2.1. Specification tests

In both small and large-scale sesame producers, production of sesame was determined by different inputs; such as amount of labor used, land allocated for sesame, amount of improved seed used, amount of plough power used, and amount of fertilizer applied. So, these inputs were taken as determinants of sesame production for both small and large scale sesame producers measured using the SFA in Cobb-Douglas production function form of the one-step procedure.

Different types of tests were applied for model validity checking. These tests are multi-collinearity test, the existence of constant variance (Heteroskedasticity test), and the variables capacity to explain the

model (the adjusted R-square). The test of multicollinearity measured using variance inflation factor (VIF). For all the variables the VIF measure is less than ten in both producer categories. The average VIF value for small and large-scale sesame producers is 3.84 and 5.21 respectively which is lower than ten, indicating that as there was no severe multi-collinearity problem among the variables (Table 20).

The heteroskedasticity (non-constant variance) test was made using the Breusch-Pagan test. The test result for small-scale sesame producers revealed that χ^2 (1) is 1.01 with P-value of 0.92. For the large-scale producers also the test result show that χ^2 (1) is 1.52 with P-value of 0.21. Hence, in both production systems the study fails to reject the null hypothesis (constant variance), indicating that there is no heteroskedasticity problem (Table 20).

The third model validity evaluation test this study used is the capacity of the variables to explain the dependent variable (the model) which is evaluated through adjusted R-squared. The value of adjusted R-squared for small-scale producers is 0.65 indicating that about 65% of sesame output was determined by the five inputs specified but the remaining 35% was determined by other inputs not yet included in the model. The value of the adjusted R-squared for large-scale producers is 0.92 indicating that the variables included in the model explain 92% of the variability in sesame output level (Table 20).

Table 20. SFA parameter coefficient for the sesame production by small and large-scale producers

Ln sesame production	unit	Small-scale			Large-scale		
		Coefficients	(S.E)	P> t	Coefficients	(S.E)	P> t
Ln land (L)	Ha	0.323**	0.145	0.027	-1.15***	0.422	0.007
Ln fertilizer (ferqt)	Qt	0.03***	0.001	0.003	0.024	0.022	0.276
Ln labor (Lb)	Man day	0.51***	0.136	0.000	0.021	0.022	0.352
Ln plow power (Pw)	Tractor hr	0.188	0.148	0.846	2.31***	0.432	0.00
Ln seed (Sd)	Kg	0.356***	0.129	0.006	-0.279**	0.125	0.025
Total (elasticity)		1.407			0.926		
Constant (C)		-0.98*	0.553	0.077	3.60***	0.45	0.00
Wald chi2 (5)		235.61		P= 0.00	2746.57		P= 0.00
Sigma_ U		0.726		p=0.001	0.482	0.044	P= 0.00
Sigma_ V		0.221	0.039	p=0.003	0.117	0.027	P= 0.00
gamma (γ)		0.915			0.944		
sigma ²		0.576			0.246		
MLR		-84.55			-24.32		
Adj. R-squared		0.6536			0.9156		
hettest. Prob. > chi2		0.9235			0.217		
VIF		3.84			5.21		

Ln= natural log; *, **, ***, indicates statistically significant coefficient at 10%, 5% and 1%, significance level respectively

According to the study result for the data obtained from small-scale sesame producers as presented in Table 20, the coefficients of amount of improved seed applied, amount of inorganic fertilizer applied and amount of labor used were statistically significant at 1% significance level; and size of sesame farm land was statistically significant at 5% significance level in production function of sesame in the study area. But plough power used was insignificant to determine the production of sesame in the study area.

The study on large-scale sesame production function in the study area also indicated that variables such as sesame land size and amount of plough power used are significant at 1% significance level; while amount of improved sesame seed is significant at 5% significance level for determining sesame production function. However, variables such as amount of inorganic fertilizer applied and total labor amount used become statistically insignificant in determining the sesame production (Table 20).

The studies conducted on TE by Baten *et al.* (2009), Ibrahim *et al.* (2014), Wassie (2014), Chakwera (2015) and Ermiyas *et al.* (2015) found farm size and labor was significant variables in determining production function. Moreover, studies done by Rahman and Umar (2009), Zalkuwi *et al.* (2010), Abu *et al.* (2012), Wakili (2012), Getachew and Beneberu (2014), Ibrahim *et al.* (2014), Wassie (2014), Berhan (2015) and Ermiyas *et al.* (2015) found that inorganic fertilizer and amount of seed applied as significant variables determining production function. So it is observable that the result found by this study in determining the inputs of sesame production by small-scale sesame producers in Kafta Humera district is similar with the results obtained by the listed former studies.

The inverse relationship between farm size and sesame yield for large-scale producers was also similar with the results obtained by Chand *et al.* (2011), Maqbool *et al.* (2012), Wutyi *et al.* (2013) and Berhan (2015). This relationship may be as land use and cropping intensities were higher for small farms as there was efficient allocation of labor. Specifically, Maqbool *et al.* (2012) reported that small farmers were 18.6% more productive than the large ones. So, the negative relationship of land and sesame production of large-scale producers in this study is justifiable.

Generally, large-scale producers produce in the third stage of production for land size and amount of improved seed applied. So, to become best match of the resources either reallocating the size of farm land among potential crops and so for seed or adoption of more modernized technologies are important.

Otherwise the business is not profitable with in the current production mechanism. Depending on the coefficient of the significant determinant variables in sesame production could be written as:

The coefficients could be interpreted as keeping all the other variables constant at their specified level, for the existing technology and at the specified period of time; the one percent increase in land size of small-scale sesame producer results in 0.32 percent increment of the amount of sesame production. In the same token the one percent increase of inorganic fertilizer applied in small-scale sesame farm results an increment of sesame production by 0.03 percent. For the other determinant variables also; the increment of each variable by one percent leads to the increase in sesame production by the coefficient in each variable. Here in sesame production by small-scale producers the input with higher coefficient is labor followed by seed and size of land; while the input with lower coefficient is fertilizer applied.

Similarly, for the sesame produced by large-scale producers, the one percent increment in their land size allocated for sesame production, leads to the decline in their sesame yield by 1.15 percent. The one percent increment in the amount of improved seed by large-scale producers also results to the reduction of the total sesame production by 0.28 percent. This indicates that the inverse relationship of land size, amount of improved seed with sesame production for large-scale producers.

Further it is indicating that farm size allocated for sesame production by large-scale producers was beyond the capacity of the other resources allocated in sesame production. Thus, it shows the imbalance of production inputs (the inputs did not match). However the one percent increase of the plough power hour of large-scale producers leads to increment of their sesame production by 2.31 percent. It is showing the positive relation of the amount of plough power hour used with sesame production.

Elasticity of sesame production and returns to scale

The study result shows that small-scale sesame producers had increasing returns to scale, while large-scale sesame producers had decreasing returns to scale. The summation of coefficient of parameters in small-scale sesame producer's production function was 1.51 (Table 20), which is greater than one. This indicates that the balanced one percent increase in all the production inputs simultaneously leads small-scale sesame production to increase by 1.51 percent. For large-scale producers also the summation of production inputs' coefficients was 0.93 (Table 20), which is below one, indicating that the one percent

increase in all the production inputs simultaneously leads to the increment of the sesame production by 0.93 percent only which is lower than the before combination of inputs application. Regarding the production function, the studies conducted on different crops at different time and location, by Ogundari and Ojo (2006), Ibrahim *et al.* (2014) and Ermiyas *et al.* (2015) found the returns to scale ranging from 0.84 to 1.2105. So, the result found in this study has consistency with the results of these studies.

Cost efficiency

This is the sub-section with in which the results of AE and EE are presented and discussed. Besides to the AE and EE the cost function will be observed. The study obtained that both error terms (u and v) for the two categories of sesame producers in the study area were statistically significant at 1% significance level Table 22. Further, the value of gamma ($\gamma = \delta_u^2 / (\delta_u^2 + \delta_v^2)$); which indicates the share of inefficiency in the total deviation is $\gamma = 0.984$ and $\gamma = 0.9257$ for small and large-scale sesame producers respectively. The value of gamma further implies that 98.4% and 92.57% of the variability from the efficient production cost frontier is contributed by the differences in decision maker's cost management inefficiencies not due to external conditions (Table 21).

Regarding the cost function determinant variables until now there were so many studies conducted by scholars in different parts of the world who studied at different sectors. Most of those studies obtain similar cost function determining variables even few of them may add or leave some of the variables. As it is presented in Table 22, estimation of the parameters in cost function of SFA for small-scale sesame producers revealed that all variables except cost of land and operating cost are statistically significant at significance level less than 10% with the expected positive relation. Regarding the large-scale sesame producers also, all variables have statistically significant and positive sign; except operation cost and material cost that are insignificant.

Table 21. Different tests of model validity for cost function in both producers

Null hypothesis	LR value calculated		Critical value (5%)		decision	
	Small-scale	large-scale	Small-scale	large-scale	Small-scale	large-scale
$H_0: \gamma=0$	98.4	92.57	11.07	11.07	Reject H_0	Reject H_0
$H_0: \delta_1 = \dots \delta_{10}=0$	58.22	77.27	8.67	9.39	Reject H_0	Reject H_0

Source: Survey result by STATA.13, 2016

Material cost includes the cost of agricultural materials, cost of packaging sack, harvesting and threshing materials and cost of tractor material and exchanging tools. Whereas the operating cost includes; cost of fuel and lubricants, cost of repairing of tractors, cost of medical service and feed expense for the plough animals, cost of transportation from and to the sesame farm (personal and sesame grain) and cost of loan taken for sesame production. This study shares similarities on the cost function parameters with the formerly conducted studies by Ogundari and Ojo (2007), Berhan (2015) and Ermiyas *et al.* (2015), in which cost efficiency determining inputs were wage rate, cost of seed, cost of agro-chemicals, and the amount produced. But individually also added the production variables such as cost of farm tools by Ogundari and Ojo (2007) and land rental cost by Berhan (2015) in addition to the above explained once.

Table 22. Sesame production cost parameters of both small-scale and large-scales

Total sesame Production cost	Small-scale			Large-scale		
	Coefficient	Std. Err	P> z	Coefficient	Std. Err	P> z
Ln Operation cost	-0.0267	0.019	0.165	0.006	0.007	0.44
Ln seed cost	0.06*	0.035	0.061	0.033**	0.0147	0.023
Ln fertilizer cost	0.0034*	0.002	0.068	0.007***	0.0022	0.001
Ln material cost	0.048***	0.01	0.000	-0.009	0.013	0.471
Ln plough cost	0.047**	0.023	0.041	0.039***	0.014	0.006
Ln labor coat	0.84***	0.028	0.000	0.242***	0.030	0.00
Ln land cost	0.008	0.07	0.411	0.083***	0.028	0.004
Ln production	0.118***	0.024	0.005	0.62***	0.024	0.00
Total /elasticity	1.061			1.0155		
Cons.	1.119***	0.208	0.009	5.22***	0.172	0.00
MLR	87.49			127.98		
Sigma_v	0.028***	0.0025	0.00	0.0395***	0.013	0.00
Sigma_u	0.221***	0.022	0.00	0.1393***	0.018	0.00
Sigma2	0.05***	0.009	0.00	0.021***	0.0043	0.00
gamma (γ)	0.984			0.9257		

*, **, *** indicates the significance level of the variable at 10%, 5%, and 1% respectively

4.2.2.2. Estimation of farm level technical, allocative and economic efficiencies of small and large-scale sesame producers

Technical efficiency

The mean level of TE found in this study for small-scale sesame producers was 62.04 percent, ranging from 18.25 to 91.03 percents (Table 23 and Appendix Table 1). This means if the average farmer in the

sample wants to achieve the TE level of his/her most efficient counterpart, then he/she (the average farmer) could realize a 31.85 percent input saving [i.e., $1-(62.04/91.03) \times 100$]. A similar calculation for the most technically inefficient farmer reveals input saving of about 80 percent [i.e., $1-(18.25/91.03) \times 100$]. This shows that there is a wide disparity among the small-scale sesame producers in their level of TE which in turn indicate that there exist a room for improving the existing level of sesame production through enhancing the level of small-scale farmers' technical efficiency. The mean level of TE further tells us that the level of sesame output of the sample respondents could be increased on an average by about 38% which is ranging from 8.97-81.75%, if appropriate measures are taken to improve efficiency.

The study also obtained that the mean TE of large-scale sesame producers was 71.46 percent ranging from 25.6 to 96.03 percents (Table 22 and Appendix Table 2). The result implies that if the average large-scale wants to achieve the TE level of his/her most efficient counterpart, he/she could realize a 25.59 percent input saving [i.e., $1-(71.46/96.03) \times 100$]. Similar calculation for the most technically inefficient farmer reveals cost saving of about 73.34 percent [i.e., $1-(25.6/96.03) \times 100$]. The mean level of the large-scales' TE show that there is an opportunity to increase efficiency on average by 28.64% (range in 04-74.4%) if the best match of the sesame production inputs allocated properly.

Table 23. Category of sample small and large-scale sesame producers based on their TE level

Category	number of respondents in each category				Mean difference (t-test)
	Small-scale	Percent	Large-scale	Percent	
TE $\leq$ 20	2	1.56	0	0.00	--
20 < TE $\leq$ 30	8	6.25	2	1.59	--
30 < TE $\leq$ 40	7	5.47	5	3.97	--
40 < TE $\leq$ 50	19	14.8	9	7.143	--
50 < TE $\leq$ 60	17	13.28	15	11.9	--
60 < TE $\leq$ 70	19	14.84	20	15.87	--
70 < TE $\leq$ 80	31	24.22	24	19.05	--
80 < TE $\leq$ 90	23	17.97	37	29.37	--
TE > 90	2	1.56	14	11.11	--
Total	128	100	126	100.00	--
Mean TE	62.04		71.46		9.42 (-3.89)

Source: Survey results, 2016; the value in parenthesis is the t-value of the TE comparison

Even though it is difficult to compare the efficiency results which was obtained at different times and at different locations; for estimating the consistency of the results obtained it is better to compare with the range that other researchers had obtained. The average and range of TE obtained in this study is similar

and consistent with the TE result obtained by Amaza *et al.* (2010), Chimai (2011), Wakili (2012), Dawit *et al.* (2013), Endrias *et al.* (2013), Abebe (2014), Chepng'etich *et al.* (2014), Getachew and Bamlak (2014), Hussain, *et al.* (2014), Chakwera (2015) and Ermiyas *et al.* (2015) with mean percentage that range from 34-77 percent. Here also the study conducted by Ibrahim (2007) found the mean TE of 65% and 72% for sorghum and sesame crops. The study by Wassie (2014) also reported the mean TE for the production of Teff and Wheat to be 63.56 and 67.26 percents, respectively.

To give a better picture about TE distributions for both small and large-scale sesame producers in the study area, a frequency distribution of the predicted TE is categorized as presented in Table 23. The level of TE is categorized by 10 percent interval. This study found that 43.75% of the sampled small-scale sesame producers were operating below mean TE, while 19.5% of the sampled small-scale sesame producers were operating in TE more than 80% (Table 23). As also explained in Table 23, 40.48% of the sampled large-scale producers were operating below mean TE; while 40.48% of the sampled large-scale producers operates above 80%. Thus, 56.25 and 59.55 percent of the sampled small and large-scale sesame producers were able to attain above mean level of TE. This imply that in the long run there is a room for improving the existing level of TE of sesame producers in the study area providing a special attention to introduce best alternative farming practices and improved technologies.

Allocative efficiency (AE)

The average predicted AE of small-scale sesame producers in the study area is 84.25 percent, ranging from 54.6 to 98.6 percent (Table 24 and Appendix Table 1). This implies that if the sampled average farmer wants to achieve AE level of its most efficient counterpart, then he/she could realize 14.55% cost saving [i.e., $1 - (84.25/98.6) \times 100$]. Following the same procedure the producer with lowest AE, could also realize the cost saving of 44.62% [i.e., $1 - (54.6/98.6) \times 100$]. Regarding the large-scale sesame producers also the average AE achieved is 89.88 percent (ranging from 56.94 to 98.16 percent) as it is presented in Table 24 and Appendix Table 2. With this deviation in AE if the average large-scale producer wants to operate the AE of his/her sesame farm to the level of his /her counterpart most efficient, he/she could obtain the cost saving of 8.44% [i.e., $1 - (89.88/98.16) \times 100$], however the most allocatively inefficient large-scale producer could save 42% [i.e., $1 - (56.94/98.16) \times 100$].

The average AE further tells us that sesame production cost in the study area could be reduced on an average by about 16% for small-scale and 10% for large-scale producers if appropriate measures were

taken to improve the level of cost minimization efficiency of sesame growing farmers. As it is presented in Table 24, about 51% and 38% of the sampled small and large-scale sesame producers respectively were operating below the mean AE. On the other hand about 36% and 59% of the sampled small and large-scale sesame producers respectively were operating in AE of more than 90%. From Table 24 also, about 49% and 63% of the small and large-scale producers (in their order) were able to attain above the overall mean AE.

Regarding the mean AE, the result obtained in this study is complementary with the result obtained by studies conducted by Ogundari and Ojo (2006,2007), Alboghdady (2014), Mburu (2014) and Chakwera (2015) who obtained the mean AE level that range from 57 to 96%. Generally, AE of small and large-scale sesame producers in Kafta Humera district show that most of the producers in both groups have relatively similar allocation of resources with the unit prices attached to each input, so leads higher AE.

Table 24. Distribution of AE of both sesame producer categories

Category	number of respondents in each category				Mean AE difference (t-test)
	Small-scale		Large-scale		
	Number	Percent	Number	Percent	
AE ≤ 20	0	0.00	0	0.00	--
20 < AE ≤ 30	0	0.00	0	0.00	--
30 < AE ≤ 40	0	0.00	0	0.00	--
40 < AE ≤ 50	0	0.00	0	0.00	--
50 < AE ≤ 60	2	1.56	1	0.79	--
60 < AE ≤ 70	12	9.38	0	0.00	--
70 < AE ≤ 80	24	18.75	8	6.35	--
80 < AE ≤ 90	44	34.38	43	34.13	--
AE > 90	46	35.94	74	58.73	--
Total	128	100.00	126	100.00	--
Mean	84.25		89.88		5.63 (-5.31)

Source: Survey result, 2016; the value in parenthesis is the t-value of the mean AE comparison

Economic efficiency (EE)

Following the relative ratio of actual cost incurred for the sesame production by each of the producers to the hypothetical minimum cost incurred by the group members while keeping the optimal output level, the EE result could be obtained. It is the multiplication of TE and AE. Applying this procedure the study found that, the mean EE of small-scale sesame producers was 52.65 percent ranging from 12 to 82.54 percents (Table 25 and Appendix Table 1). This range indicates that, if the average small-scale producer

in the study area wants to reach the EE level of his/her farm to the most efficient counterpart (optimum level), then he/she (the average farmer) could experience a cost saving of 36.21% [i.e., $1-(52.65/82.54) \times 100$]. Following the same computation method the most economically inefficient producer suggests gain in economic efficiency of 85.38% [i.e., $1-(12.06/82.54) \times 100$] if he/she operates in the way as the economically efficient person operates.

Regarding the large-scale sesame producers, the mean EE obtained was 64.58 percent ranging from 22.37 to 92.76 percent (Table 25 and Appendix Table 2). Taking this range of EE achievement, if the average large-scale producer wants to reach his/her farm's EE to the most efficient counterpart (optimum level), then he/she could experience the cost saving of 30.38% ([i.e., $1-(64.58/92.76) \times 100$]). Similarly, if the most inefficient large-scale producer wants to reach his/her EE to his counterpart of the most efficient decision maker, he/she could save cost by 75.88% [i.e., $1-(22.37/92.76) \times 100$].

The mean EE found in this study for both categories of sesame producers is similar with the results of Endrias *et al.* (2013), Abu *et al.* (2012), Myo *et al.* (2012) Hidayah *et al.* (2013), Wakili (2012), Dawit *et al.* (2013), Asad *et al.* (2014), Chepng'etich *et al.* (2014), Getachew and Bamlak (2014), Berhan (2015), Chakwera (2015) and Ermiyas *et al.* (2015), who found the mean EE ranging from 29 to 45 percents.

Table 25. Distribution of EE by both small and large-scale sesame producers

Category	Small-scale		Large-scale		Mean EE difference (t-test)
	Frequency	Percent	Frequency	Percent	
$EE \leq 20$	6	4.68	--	--	--
$20 < EE \leq 30$	10	7.81	6	7.14	--
$30 < EE \leq 40$	14	10.94	6	7.14	--
$40 < EE \leq 50$	18	14.06	13	15.88	--
$50 < EE \leq 60$	31	24.22	21	16.67	--
$60 < EE \leq 70$	28	21.88	27	28.57	--
$70 < EE \leq 80$	16	12.50	26	19.84	--
$80 < EE \leq 90$	5	3.90	25	3.17	--
$EE > 90$	--	--	2	1.59	--
Total	128	100	126	100	--
Mean	52.65		64.58		11.93 (-5.28)

Source: Survey data, 2016; the value in parenthesis is the t-value of the mean EE comparison

As could be understand from the range of the EE there is wider disparity among the small and large-scale sesame producers in their achievement. This wider distribution could be clearly identified if the sample

respondents' achievement is categorized with the range of 10 percent. Targeting this, frequency distribution of the predicted EE is presented in Table 25. As presented in Table 25, about 42% of the sampled small-scale and about 45% of the sampled large-scale sesame producers' EE was operate below mean level, while about 4% and 21% of the respondents respectively operate at EE of above 80% which is an indication that producers were unfairly efficient. Farmers were unfairly efficient; meaning there was greater disparity/variability in their EE achievement.

Generally as it is presented in Tables 23, 24 and 25; considering the three types of efficiency, large-scale producers score higher efficiency level than small-scale with the difference in TE, AE and EE of about 9%, 7% and 12%, respectively. This difference in efficiency achievement between the two categories is significant at 1% significance level. But it does not mean that large-scale were more efficient than small-scale, rather it is to mean that the deviation in resource allocation and productivity in large-scale producers was small as compared to small-scale producers.

4.2.2.3. Sources of technical, allocative and economic inefficiency of small and large-scale sesame producers

Having information about measurement of TE, AE and EE, identifying the major sources of inefficiency is the next important part of this study (part of the second objective). From the very beginning about fifteen socio-economic and institutional variables were hypothesized to affect the level of TE, AE and EE of sesame producers in the study area.

Before using all the proposed variables into the model a test for multi-collinearity using VIF method is important. Accordingly, regarding the technical inefficiency function the VIF result of each variable in the function of small and large-scale producers is below ten with the mean VIF of 2.9 and 2.73 for small and large-scale producers respectively (Appendix Table 3), indicating that there is no severe multicollinearity problem between the variables. Based on the Breusch-Pagan test result also, the null hypothesis could not be rejected as the $\chi^2(1) = 0.19$ with Prob. $> \chi^2 = 0.12$ for small-scale and $\chi^2(1) = 0.78$ with Prob. $> \chi^2 = 0.38$ for large-scale (Appendix Table 3). The test for cost inefficiency model validity also indicated the result of VIF for each variable in the model and the mean value of all variables of small and large-scale producers is below 10 (i.e., mean VIF= 3.43 for small-scale and mean VIF= 3.59 for large-scale producers) as shown in Appendix Table 3. Based on the Breusch-Pagan test

result also, the null hypothesis could not be rejected as the $\chi^2(1) = 0.26$ with Prob. $> \chi^2 = 0.31$ for small-scale and $\chi^2(1) = 0.19$ with Prob. $> \chi^2 = 0.12$ for large-scale (Appendix Table 3).

The adjusted R-squared also in both production and cost inefficiency, show that for the small and large-scale producers the variables in the model explained 51 and 69 percents of the variation in the sesame production inefficiency function, respectively (Appendix Table 3). Regarding the sesame production cost inefficiency function, the adjusted R-squared result for the small-scale producers show that the variables in the model explained 92.57% and 91.46% of the variation, respectively (Appendix Table 3). In general, the results obtained from the tests indicate absence of severe multi-collinearity, variances are constant and no omitted variable problem.

As a result all variables hypothesized for the estimation of frontier production and cost inefficiency function are entered in to their respective models. Therefore, all the hypothesized variables were retained in the model for estimation its significance as source of the technical, allocative and economic inefficiencies in sesame production in the study area. Coefficients of these variables included in the model were estimated simultaneously by the maximum likelihood procedure in the SFA following the one-step procedure. One important point to be considered is that the dependent variable is inefficiency component of the total error term estimated in combination with production or cost frontier. Hence, the coefficients should be interpreted as the effect of each variable on the level of inefficiency. However, one can also interpreted the estimated coefficients directly as effect of the variable on TE by taking the opposite sign of respective coefficients as it is displayed in this study.

As indicated in Table 25, education level of household head, experience of household head in sesame production, frequency of sesame farm visit, extension contact, and amount of loan obtained were significantly and positively contributing to TE of small-scale producers. But variables such as membership in local associations, distance of sesame farm from home, number of training obtained has statistically significance with negative contribution to TE. But variables such as age of the household head, owning of standardized home, ownership of livestock, dependency ratio, type of road from farm to home, and amount of off-farm income obtained have statistically insignificant coefficients in determining TE of small-scale producers.

Regarding the large-scale producers as in Table 27, variables such as education level, experience, frequency of sesame farm visit, distance of sesame farm from residence, ownership of standard home, and ownership of livestock were statistically significant variables with positive relation to TE. However, variables such as, association membership and amount of loan obtained for sesame production has significant negative effect on TE. The remaining variables such as age, training, extension contact, off-sesame income and dependency ratio were insignificant to determine the TE of sesame production of large-scale producers in the study area.

From Tables 26 and 27, the variables with significant and negative coefficient imply that these variables positively contributed to inefficiency. In contrast, the variables with significant and positive sign indicate that reduce TE of sesame producers. Taking these significant coefficients as in Tables 26 and 27, the inefficiency function for both small and large-scale sesame producers in Kafta Humera district could be formulated as:

$$U(\text{small scale}) = -0.64 - 0.01\text{eduhhd} - 0.0044 \text{exp} + 0.08\text{memb} + 0.006\text{distfh} - 0.002\text{freqgo} + 0.03\text{numtrain} - 0.04\text{extn} - 0.007\text{lnloan} \quad (4.1)$$

$$U(\text{large - scale}) = -0.6 - 0.014\text{eduhhd} - 0.006 \text{exp} + 0.1\text{memb} - 0.003\text{distfh} - 0.004\text{freqgo} - 0.033\text{road} - 0.23\text{ownhom} - 0.051\text{ownliv} + 0.011\text{lnloan} \quad (4.2)$$

The function in eq.4.3 represents the inefficiency function of the small-scale sesame producers in Kafta Humera district, while the function in eq.4.4 represents the inefficacy function of the large-scale sesame producers in the district. The statistically significant variable are discussed as follows considering the assumptions of keeping all the other variables constant at their certain level, for the existing type of technology and at its specified time period. The coefficients of those socio-economic and institutional variables included in the cost efficiency model were estimated simultaneously by maximum likelihood procedure in SFA using the estimated level of cost inefficiency as dependent variable. One important point to be considered is that the dependent variable is the inefficiency component of the total error term estimated in combination with the production frontier.

As presented in Appendix Table 4, variables such as age, education level and extension contact has statistically significant negative relation to cost inefficiency of small-scale sesame producers in the study area. But, variables such as frequency of farm visit, farm distance and amount of credit have statistically

significant positive relation with cost inefficiency of small-scale sesame producers in the study area. Regarding large-scale sesame producers, variables such as education level, sesame farm visit and livestock ownership have significant and negative relationship to cost inefficiency. However, variables such as cooperative membership, off-sesame farm income obtained and type of road have significantly and positively affected to sesame production cost inefficiency. The significant sources of technical, allocative and economic inefficiencies (Tables 26 and 27) are discussed in detail as follows.

Age of the household head (agehhd): It is found that this variable is significant at 5% significance level with positive relation to AE of small-scale producers, but insignificant in relation to AE of large-scale producers. The result further indicated that, the variable has insignificant relation with EE in both producers. Based on the relationship of the variable to AE of small-scale producers, this study could reveal that as small-scale sesame producers' age increases by one year the AE of their sesame production increases by 0.34 percent in the productive age range (Table 26).

The significant contribution might be because as age in sesame production that enables one to save cost. The result of AE obtained for the small-scale sesame producers is in line with the result of Zalkuwi *et al.* (2010). However the insignificance result in relation with AE of large scale and with EE of both small and large-scale is in line with the result of Jema (2008), Myo *et al.* (2012) and Ermiyas *et al.* (2015).

Education level of the household head (eduhhd): The result of this study shows that education level of the house hold head significantly and negatively affect to inefficiency at 5% and 1% significance levels for small and large-scale producers respectively. As it is presented in Table 26 and 27, if education level in years of schooling of small and large-scale sesame producers becomes one year higher relative to the others, his/her technical inefficiency of sesame production decreases by one and 1.4 percent, respectively.

It is also found that education level is statistically significant at 1% significance level for small and large-scale producers with negative relation to both allocative and economic inefficiencies. The relation may be because, education enables producers to have greater ability to understand, adopt and correlate the best matches of production inputs with lower cost and avoidance of misuse. Taking the positive relationship, as the small-scale sesame producer's years of schooling increases by one their allocative

inefficiency decreases by 1.25 percent; while economic inefficiency decreases by 1.7 percent. Regarding large-scale sesame producers, as education level increase by one their allocative inefficiency decrease by 0.6 percent; while their economic inefficiency decrease by 1.6 percent.

According to Huffman (1980) and Lockheed, *et al.* (1980), the relationship between education level and efficiency is theoretically justified as education level increases, once performing capacity increases and so best match of resources; because education is taken as the proxy for managerial ability. The result of this study is so similar with those studies that found inverse relationship between education level and technical inefficiency by Shumet (2011), Rahman *et al.* (2012), Wakili (2012), Beyan *et al.* (2013), Getachew and Bamlak (2014), Hussain *et al.* (2014), Shalma (2014) and Wassie (2014). But the study conducted by Abu *et al.* (2012) found significant positive relation of education level in determining technical inefficiency. The result of allocative and economic inefficiencies obtained in this study is in line with the results of Arega and Reshid (2006), Aye and Mungatana (2010), Otitoju and Arene (2010), Shehu *et al.* (2010), Shumet (2011), Myo *et al.* (2012), Chakwera (2015) and Debebe *et al.* (2015).

Experience in sesame production (exp): It is found that experience of sesame producers is significantly and negatively affected to technical inefficiency of sesame production at 5% significance level for both small and large-scale sesame producers. It is also found that experience is significant and negatively related at 10% and 5%, significance level to allocative and economic inefficiencies, respectively for large-scale sesame producers; while it is insignificant for small-scale producers. The relationship obtained could be resulted because, as experience is a proxy for managerial aspects and improves the skill and technical capacity of sesame producers. This might be due to the fact that, experience by itself is school for the sector. So, one with higher experience owns skill and potential to understand and immediately solve production related problems. Thus, experience enables producers to best match production inputs and use resources in cost saving aspect so attain higher productivity at minimum costs.

The relationship of sesame production experience in determining technical inefficiency implied that, there is an reduction in technical inefficiency by 0.44 and 0.6 percents for small and large-scale sesame producers, respectively as ones experience in sesame production increases by one year. The result of this study is consistent with the results of Abdukadir (2010), Myo *et al.* (2012), Hidayah *et al.* (2013), Berhan (2015) and Ermiyas *et al.* (2015); but conducted with the result found by Adeyemo *et al.* (2010).

According to the result of this study, as large-scale sesame producer's experiences in sesame production increases by one year, their economic inefficiency decreases by 0.5 percent. It is also found that the allocative inefficiency of large-scale producer's decreases by 0.37 percent per one year more experience in sesame production. Taking allocative and economic inefficiency of large-scale producers the result found is similar with the results of Zalkuwi *et al.* (2010), Abu *et al.* (2012, 2011), Myo *et al.* (2012), Hidayah *et al.* (2013) and Biam *et al.* (2016). However, it is in contrast to the result of Dawit *et al.* (2013) and Ermiyas *et al.* (2015).

Membership in cooperatives (memb): The technical and economic inefficiency of both small and large-scale producers are significantly and positively determined by being a membership in cooperative at 1 percent levels of significance. But, it is insignificant for allocative inefficiency achievement of both producers. Theoretically, membership in social organizations helps producers in achieving efficiency. But, the reason behind this unexpected result could be that members did not discuss related to sesame production skills and techniques while meeting and they may spend more time while discussing in other issues which compute time of sesame farm operation. Besides, while the producers want to take loan from their cooperative it takes weeks or even months; so that, producers did not get their planned credit to obtain from cooperative on its needed time, spending of time until getting the loan and at meetings which computed the sesame farm operating time.

Depending on the finding of this study, as sesame producer's become members of a cooperative their technical inefficiency raises by eight percent and ten percent, respectively for small and large-scale producers. Regarding the economic inefficiency also it raises by 8.6 percent for small-scale and by 10.3 percent for large-scale sesame producers. The result found in this study is similar with the results revealed by Beyan *et al.* (2013).

Distance of sesame farm from residence (distfh): It is found that farm distance is significant and positively affect to technical, allocative and economic inefficiencies of small-scale sesame producers at 1%, 10% and 1% significance level, respectively. Regarding to the large-scale sesame producers, farm distance is significant and negatively related to technical and economic inefficiencies at 1% and 5% significance level, respectively; while it is insignificant to allocative inefficiency. Accordingly, as distance of small-scale farm from residence increases by one Km, technical inefficiency of small-scale

producers increases by 0.6 percent. However, for large-scale producers as the farm distance increases by one Km, their technical inefficiency decreases by 0.3 percent. The result found in relation to allocative and economic inefficiencies also implied that as sesame farm distance increases by one Km then the allocative and economic inefficiencies of small-scale sesame producer raises by 0.4 percent and 0.7 percent respectively. Regarding large scale producers also, as sesame farm distance increases by one Km their EE increases by 0.2 percent.

The reason of the variable to have negatively related with efficiency achievement of small-scale sesame producers may be as distance increases farmers spend their operational time in journey until they reach the farm. Additionally if the farm is far distant, their frequency of farm visit would also reduce. But for large-scale sesame producers as distance increases there is high probability of the family members or manager to live in the site; so, whole day follow up is observed. This enables producers to better manage their farm which may lead to better achievement in economic inefficiency. However for the small scale producers they did not construct class at farm to live in while working farm activities rather prefers going back to their town home daily even paying transportation fee, so they spent more time in journey than managing their farm. Regarding to the relationship between distance of the farm land from residence and technical inefficiency achievement, Jema (2008) and Ermiyas *et al.* (2015) found negative relationship. This study also found similar related to TE of small-scale producers.

Frequency of sesame farm visit (freqgo): It is found that this variable significantly and negatively determines the technical inefficiency of sesame production for both small and large-scale producers at 5% and 1% significance levels respectively. It is also found as frequency of farm visit is significantly and positively related to both allocative and economic inefficiencies of small-scale sesame producers at 1% significance level. But, regarding to large-scale sesame producers it is significantly and positively related to both allocative and economic inefficiencies at 10% and 1% significance level, respectively.

So, according to the study result as small-scale producer visit his/her farm one time more his/her allocative and economic inefficiencies raises by 0.3 and 0.4 percent, respectively; while their technical inefficiency decreases by 0.2 percent. Similarly, as the large-scale sesame producer increase his/her sesame farm visit by one times more, his/her technical, allocative and economic inefficiencies decrease by 0.4, 0.6 and 0.4 percent respectively. Theoretically, the relation could be interlinked, as there is nearby farm follow up it enables understanding of the real happening so easily solutions could be

emanated and solved as quickly as possible. Thus, the production problems could be solved and yield could increase. But, the reason for direct relationship to economic inefficiency of small-scale producers could be, as these producers frequently visit their farm, they spent more money for traveling to farm.

The difference in the relationship of small and large-scale producers may be induced, as almost all small-scale farmers go by paying for transportation and reach farm as tiered and not timely; unlikely large-scale producers used their own transportation mode so reach at their planned time with fair transportation cost and reach farm timely. So that large-scale producers could properly manage their farm activities at its regular time. These cases were familiar facing to the small-scale sesame producers in the area which also consumes their time for waiting. Also even they reached their farm, they reach after they felt tired.

Ownership of standardized home (ownhom): It is found that this variable significantly and negatively determines the technical and economic inefficiencies of large-scale sesame producers at 1% significance level; while insignificant in relation to their allocative inefficiency. But, for the technical, allocative and economic inefficiencies of small-scale sesame producers the relationship of this variable is insignificant. According to the result found, as large-scale producer owns standard home that could hold as collateral their technical and economic inefficiencies decreases by 23 and 22 percent relative to the one who did not own living home.

The reason for the positive contribution of the standard home to TE and EE achievement of large-scale producers may be that, as producers had their own house, they do not pay house rent rather they may allocate the money for sesame production. Also house ownership can be used as collateral for obtaining loan. Due to these reasons large-scale producers could improve their owning of finance which enables them to do sesame production activities timely and properly. Thus, improves their efficiency. The result of this study matches with the result revealed by Jema (2008).

Ownership of livestock (ownliv): The result of this study found that TLU significantly and negatively affected to technical and economic inefficiencies of large-scale sesame producers at 10% significance level for both; while insignificant in relation to their allocative inefficiency. But, regarding to small-scale sesame producers, the variable has insignificant relation in technical, allocative and economic inefficiencies. The relationship of this variable implies that as large-scale producer's TLU increases by one, their technical and economic inefficiencies decreases by 5.1 and 0.56 percent, respectively.

The reason for the relation of large-scale producers could be that as livestock enables them to obtain off-sesame farm income. However, small-scale sesame producers in the study area had lower livestock population and the amount of off-sesame farm income obtained from livestock selling is being lower compared to the large-scale ones. Regarding, the relationship of TLU and TE, the result in this study is similar with the result of Wassie (2012), but in contradiction with the result revealed by Wondimu and Hassen (2014). In relation of TLU and EE of large-scale producers the result found is similar with the reports of Amos *et al.* (2007), Idiong *et al.* (2009), Otitoju and Arene (2010), Shehu *et al.* (2010), Chakwera (2015) and Debebe *et al.* (2015).

Extension contact (extn): It is found that this variable is statistically significant with negative relationship at 1% significance level in determining technical and economic inefficiencies of small-scale sesame producers, while insignificant to their allocative inefficiency. However, it is insignificant to technical, allocative and economic inefficiencies of large-scale sesame producers. According to the result found in this study for small-scale producers, as the number of extension contact increases by one beyond the other producers then the technical and economic inefficiencies of small-scale sesame producer decreases by four and 4.6 percent respectively.

Table 26. Sources of technical, allocative and economic inefficiencies of small-scale sesame producers

Variables	Technical inefficiency		Allocative inefficiency		Economic inefficiency	
	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient	Std. Err.
Age household head (years)	0.001	0.002	-0.0034**	0.0017	-0.00114	0.002
Education level (schooling years)	-0.01**	0.005	-0.0125***	0.0045	-0.017***	0.005
Experience (years)	-0.0044*	0.0026	0.003	0.002	-0.002	0.0027
Coop. membership (yes=1, no=0)	0.08***	0.03	0.025	0.026	0.086**	0.033
Dependency ratio (No)	0.012	0.013	0.012	0.011	0.02	0.013
Distance of farm (Km)	0.006***	0.002	0.004*	0.0022	0.007***	0.0026
Frequency farm visit (No)	-0.002**	0.001	0.003***	0.001	0.004***	0.0013
Road type (Dummy)	-0.0153	0.018	0.0076	0.0062	0.0026	0.0074
Ownership of home (Dummy)	-0.008	0.02	-0.001	0.022	-0.008	0.0257
Ownership of livestock (TLU)	0.007	0.022	-0.011	0.02	0.008	0.0232
Number of training obtained (No)	0.03***	0.011	0.03***	0.01	0.047***	0.016
Ln Off-sesame farm income (Birr)	0.0005	0.002	0.002	0.0019	0.0003	0.0024
No. of extension contact (No)	-0.04***	0.01	-0.0133	0.0081	-0.046***	0.01
Ln Total loan obtained (Birr)	-0.007***	0.002	0.004**	0.002	-0.0044*	0.0025
_cons	-0.64***	0.13	-0.963***	0.121	-0.594***	0.143

*, **, *** indicates the significance level of the variable at 10%, 5%, and 1% respectively

The positive relation is because the main target of extension service is to capacitate farmers in their production skill, technique, in technology adoption and application and in information sharing. So that, if producers are capacitated their production power increases. Being this, small-scale sesame producers who frequently contacted with DAs could gain skill on how to manage production inputs and could so adopt improved technologies. Thus, their efficiency is so improved. The reason for the insignificant relation may be that DAs could not follow the farms in detail. Rather, large-scale producers are advised to hire experts.

In relation to technical inefficiency of small-scale sesame producers, the result of this study is similar with the results of Makombe *et al.* (2011), Abba (2012), Wakili (2012), Dawit *et al.* (2013), Abebe (2014) and Getachew and Bamlak (2014). But, the result for large-scale producers EE is similar with study of Wassie (2014). Regarding the economic inefficiency of small-scale producers also, the result found in this study is similar to the result of Hussein (2007), Otitoju and Arene (2010), Shehu *et al.* (2010), Chakwera (2015) and Debebe *et al.* (2015). The insignificant effect found in this study is similar with result of Biam *et al.* (2016).

Amount of credit obtained for sesame production (loan): It is significantly and negatively affect to technical and economic inefficiencies of small-scale producers at 1% and 10% significance levels respectively, while positively to their allocative inefficiency at 5% significance level. Regarding the large-scale sesame producers also, credit is significantly and positively related to technical, allocative and economic inefficiencies at 10%, 10% and 5% significance levels respectively.

According to this result, as small-scale sesame producer obtains one percent of what the required income to obtain from credit, his/her technical and economic inefficiencies decreases by 0.007 and 0.0044 percent, respectively; while allocative inefficiency will raise by 0.004 percent. Regarding the large-scale sesame producer also, as they obtains one percent of the amount what he/she expected to obtain from credit and invested in similar to the current way at sesame production, their technical, allocative and economic inefficiencies increases by 0.011, 0.003 and 0.01 percent, respectively.

The reason for negative relation in large-scale producers' case may be they spent the loan obtained in payment of laborers and fertilizer purchase which did not have significance contribution in TE achievement. The negative relation may be as producers obtained loan, they mostly improperly allocate

it. It may also be due to the reason that as loan is obtained from informal money lenders, who were most familiar in Kafta Humera district that requires higher interest rate. The result obtained in this study from small-scale sesame producers is consistent with the result obtained by Khan and Saeed (2011).

Availability of road facility from farm to home (road): It is also found that this variable is significantly and negatively related to technical, allocative and economic inefficiencies of large-scale sesame producers at 1%, 5% and 1% significance level, respectively; but insignificant to technical, allocative and economic inefficiencies of small-scale producers. The relationship of the variable in determining efficiency of large-scale producers is implying that as large-scale producer obtains access to normal road, his/her technical, allocative and economic inefficiencies decreases by .033, 0.008 and 0.033 percent, respectively. It is because accessible road enables producers to timely reach so manage farm activities timely and also reduced amount of grain loss while transporting.

Table 27. Sources of technical, allocative and economic inefficiencies of large-scale sesame producers

Variables	Technical inefficiency		Allocative inefficiency		Economic inefficiency	
	Coefficient	Std. Err	Coefficient	Std. Err	Coefficient.	Std. Err
Age household head (years)	0.001	0.002	-0.001	0.001	0.001	0.002
Education level (schooling years)	-0.014***	0.004	-0.006***	0.002	-0.016***	0.004
Experience (years)	-0.006**	0.002	-0.0037*	0.002	-0.005**	0.002
Dependency ratio (No)	0.004	0.008	0.004	0.004	0.006	0.008
Distance of farm (Km)	-0.003***	0.001	0.0002	0.0006	-0.002**	0.001
No of extension contact (No)	-0.01	0.007	0.005	0.0037	-0.007	0.007
Frequency farm visit (No)	-0.004***	0.0007	-0.006*	0.0004	-0.004***	0.0007
Home ownership (Dummy)	-0.23***	0.068	-0.022	0.036	-0.22***	0.06
Livestock ownership (TLU)	-0.051*	0.03	-0.017	0.016	-0.056*	0.03
Number of training obtained (No)	-0.003	0.01	0.001	0.007	-0.001	0.013
cooperative membership (Dummy)	0.10***	0.04	0.0204	0.02	0.103***	0.037
Road type (Dummy)	-0.033***	0.009	-0.008**	0.004	-0.033***	0.01
Ln Off sesame income (Birr)	0.003	0.003	0.0027	0.003	0.004	0.003
Ln Total loan obtained (Birr)	0.011*	0.006	0.003*	0.0016	0.01**	0.006
Constant	-0.6***	0.139	-0.87***	0.075	-0.54***	0.14

*, **, *** indicates the significance level of the variable at 10%, 5%, and 1% respectively

Number of training obtained by household head (numtrain): It is significantly and positively related to technical inefficiency at 1% level of significance for small-scale sesame producers, while insignificant for the large-scale sesame producers. The reason for this unexpected result could be that the training

provided may not be specific production problem based on sesame and may not be attractive. The training also competes time of sesame farm operating as the producers spend their. These situations were familiar in the area so may lead to the unexpected relation. Taking the relationship of the variable, as the number of training obtained by small-scale sesame producer increases by one their technical inefficiency raises by three percent. The result of this study is in line with the result found by Ermiyas *et al.* (2015).

4.3. Analysis of Sesame Post-harvest Loss Determinants

This section identifies the determinants of sesame post-harvest loss of small and large-scale producers in Kafta Humera district. These factors were identified applying a multiple linear regression model. VIF test was used for detecting multicollinearity problem, Breusch-Pagan test used for testing heteroskedasticity problem, Ramsey RESET test used for testing the omitted variable problem and Wu-Hausman test used for testing the endogeneity problem.

The result of VIF test of each variable in the model in both sesame producer categories is also lower than 10 with the overall mean value of 2 for both small and large-scale producers (Table 28). The study also proved that, there is no omitted variable problem as tested applying the Ramsey RESET test. The Ramsey RESET test using powers of fitted values considering degrees of freedom is $F(3, 100) = 0.27$ with $P > F = 0.85$ and $F(3, 102) = 2.02$ with $P > F = 0.12$ respectively for small and large-scale producers. The endogeneity test also shows that there is one direction endogeneity problem between the explanatory variable of total sesame output and the dependent variable in both sesame producer categories. The solution for this problem is the utilization of instrumental variable (IV) tested by applying the Wu-Hausman and Durbin (score). Being this, the instrumental variable selected in both cases is the average sesame productivity. After applying this model consistency of the model is proved.

Based on the Breusch-Pagan test for heteroskedasticity, the null hypothesis could not be rejected as $\chi^2(1)$ is 0.80 with P-value of 0.37 for small-scale producers and $\chi^2(1)$ equals to 0.59 with P-value of 0.44 for large-scale sesame producers. So, there was no heteroskedasticity problem for both small and large-scale producers (Table 28); proving that there is constant variance in the model. Besides, the Adjusted R-squared value of 0.80 for small scale and 0.95 for large-scale producers that imply 80% and 95% of the sesame post-harvest loss amount from small and large-scale producers respectively are

explained by the explanatory variables in the model. Taking the model validity tests and proving as the model is valid the study determines the post-harvest loss determinant variables.

Table 28. Determinants of sesame post-harvest loss for small and large-scale producers

Variable	Small-scale			Large-scale		
	Coefficient	Std. Err	VIF	Coefficient	Std. Err	VIF
Age (Years)	0.003	0.01	2.56	-0.0024	0.012	1.90
Education level (Schooling years)	-0.073**	0.03	2.26	-0.013**	0.0057	1.85
Land size (Ha)	0.018*	0.01	2.52	-0.05*	0.03	3.89
Distance of sesame farm (Km)	0.0169*	0.009	3.58	0.05*	0.032	2.22
Ln Total sesame output (Qt)	0.24***	0.02	4.42	0.25***	0.03	3.60
Weather condition (Dummy)	0.04***	0.009	1.42	0.06***	0.01	2.04
Distance hila transported (M)	0.01***	0.005	1.20	0.02***	0.0065	1.82
Days stored (No Week)	-0.002	0.003	1.56	0.005*	0.003	1.48
Road type (Dummy)	-0.037	0.036	1.59	-0.10***	0.028	1.65
Number of extension contact (No)	-0.16**	0.07	1.25	-0.006	0.020	1.79
Ln loan obtained (Birr)	-0.01	0.014	1.66	-0.04*	0.0198	1.80
Ln off sesame income (Birr)	0.009	0.012	1.45	-0.02***	0.0086	2.00
Threshing management (Dummy)	0.048	0.05	1.22	0.078**	0.0378	1.56
Days staked (Days)	0.06***	0.0176	1.27	0.04**	0.018	1.53
Mode of transportation (Dummy)	0.065*	0.035	2.00	0.11***	0.037	1.57
Constant	2.13**	0.99		0.52	0.885	
Mean VIF			2.00			2.04
Adj. R-squared	0.8125			0.9495		
Hetest	chi2(1) = 0.80	Prob. = 0.3707		chi2(1) = 0.59,	Prob. = 0.4412	
Ovtest	F(3, 100) = 0.27	Prob. = 0.8155		F(3, 102) = 2.02,	Prob. > F = 0.12	

*, **, *** indicates the significance level of the variable at 10%, 5%, and 1% respectively

As it is presented in Table 28, post-harvest loss determinant variables were not the activities that harvested sesame passes. Rather, those determining factors were the demographic, socio economic, farm attributes and institutional factors that are described with its significance level in Table 28. In determining sesame post-harvest loss from small-scale producers this study found variables such as; age of the household head, number of days sesame stored, total amount of loan obtained, total amount of off-sesame farm income obtained, type of road from sesame farm to store and sesame threshing management were statistically insignificant variables (Table 28).

The significant sesame post-harvest loss determining variables presented in Table 28 will be discussed as follows; but, while interpreting the results it is important to take the assumptions of holding other variables constant at certain level (not zero), with the existing type of technology and at specified time period. So the discussion bellow needs to consider these assumptions.

Education level of the household head (eduhhd): It significantly and negative determines post-harvest loss of both small and large-scale sesame producers at 5% significance level. The result shows that, if the household head attained one more year of schooling he/she could reduce his/her sesame grain post-harvest loss by 7.3 and 1.3 percents for small and large-scale producers respectively. The reason for this relation may be as education enables to properly manage and control production activities. The result found in this study is in line with the study results obtained by Basavaraja *et al.* (2007).

Land size (landsz): The result found shows that this variable is statistically significant at 10% significance level in affecting sesame post-harvest loss from small and large-scale producers. The variable has positive relationship to post-harvest loss from small-scale producers, but negative to large-scale producers. The relationship of the variable for small-scale producers implies that as sesame farm size increases by one ha, the amount of sesame post-harvest loss increases by 1.8 percent. In contrast, as the land size of large-scale increases by one ha, sesame post-harvest loss decreases by 0.05 percent.

The reason for the relationship discrepancy of land size to post-harvest loss between small and large-scale producers may be, as large-scale producers hire at least one farm operator (manager) who follows the farm activities regularly. It is also familiar that if the large-scale producers' farm size becomes larger, more than one manager will be hired so as to collaboratively solve problems. The probability of obtaining laborers for handling the harvesting and threshing activities by small-scale producers is also limited as workers goes to large-scale produces. For the relationship of land size and sesame post-harvest loss from small-scale producers, the result found is consistent with the results of Basavaraja *et al.* (2007).

Distance of sesame farm from residence (distfh): It is significant and positive related variable in determining post-harvest loss at 10% significance level for both small and large-scale sesame producers. According to the result found if sesame farm is far distant from residence by one Km, the amount of sesame grain post-harvest loss from small and large-scale producer increases by two and five percent respectively. The reason for this relationship could be as farm is distant, laborers may not properly manage the harvesting and threshing activities, secondly the frequency of follow up and management becomes reduced and thirdly grain loss increase while it is transporting. The result of this study is similar with the result of Ayaneliji *et al.* (2011).

Total amount of sesame production in 2015/16 (lnTSsY): This is significantly and positively related to sesame post-harvest loss at 1% significance level for both small and large-scale producers. The result implies that if total production increases by one percent, sesame grain post-harvest loss increases by about 24% and 25% for small and large-scale producers respectively.

This result shows that, total production is the most determinant factor of sesame post-harvest loss in both small and large-scale producers. This relationship could be due to the fact that, as production increases the managerial aspects could be shared out for the entire product. It may also be for the reason that as the amount of output increases, the storage capacity to accommodate all becomes limited. The result found in this study is in line with the results of Ayandiji *et al.* (2011) and Basavaraja *et al.* (2007).

Weather condition (weazer): It is found that this variable is significantly and positively related to sesame grain post-harvest loss at 1% significance level for both small and large-scale sesame producers in the study area. So, as wind and rain is happening during harvesting to threshing time the amount of sesame grain post-harvest loss increases by 3.7 and 1.2 percent for small and large-scale producers. The result obtained in this study is so consistent with the result of Basavaraja *et al.* (2007).

Distance piles transported to threshing place (disthila): This is a significant variable that positively affect the determination of sesame post-harvest loss at 1% significance level for both small and large-scale sesame producers. The result found is indicating that as the distance piles transported from stacking place to threshing place increases by one meter, sesame grain post-harvest loss increases by one and two percents for small and large-scale producers respectively.

Number of sesame storage days (week): It is a significant variable which positively determine sesame grain post-harvest loss at 10% significance level for large-scale sesame producers, while insignificant for small-scale sesame producers. The result implies if the number of sesame grain storage weeks increases by one, sesame grain post-harvest loss for large-scale producers increases by 0.45 percent. The reason for this relationship could be because small-scale producers mostly store not for longer periods, but large-scale producers might stay relatively longer. During storage different factors such as pests, moisture loss and dropping of grain from its packed sack may happen that reduce sesame grain weight.

Road infrastructure availability (roadfh): It is statistically significant variable that negatively determines sesame post-harvest loss at 1% significance level for large-scale producers, while it is insignificant for small-scale sesame producers. The result shows that if large-scale producers had access to road infrastructure, their sesame grain post-harvest loss declines by 10.4 percent.

Extension contact (extn): This is statistically significant variable which negatively determine sesame grain post-harvest loss for small-scale producers at 5% significance level. But it is insignificant to affect sesame grain post-harvest loss for large-scale producers. So; as extension contact on sesame production of the small-scale producers increases by one, sesame post-harvest loss reduced by sixteen percent.

Natural logarithm of credit obtained (lnloan): The study is found that this variable is statistically significant at 10% significance level that negatively affects post-harvest loss for large-scale sesame producers; but insignificant for small scale sesame producers. The result is implied that as large-scale producers obtain one percent of the loan amount they required to obtain from loan sources, their sesame grain post-harvest loss reduce by 3.6 percent. The reason for this relationship the case of large-scale producers might be that, as the large-scale producers obtain loan their farm activity could be conducted as per its planned time to be performed. Thus, post-harvest loss could be reduced.

Natural logarithm of off-sesame farm income (lnoffinc): It is statistically significant which negatively determine sesame post-harvest loss for large-scale sesame producers at 1% significance level. But, it is insignificant to determine sesame grain post-harvest loss for small-scale producers. The result is implied that; if the amount off-sesame farm income obtained by large-scale producers increase by one percent, then the amount of sesame grain post-harvest loss decreases by 2.4 percent.

The reason for the relationship regarding large-scale sesame producers might be because, sesame production in the area requires relatively large amount of budget for handling the activities mostly handled by hiring laborers. Being, as the producers' income increases it enables them to handle the farm activities at their planned time with the required performance. Thus, loss can be controlled when activities are handled as per the scheduled time and per the required performance.

Harvesting and threshing management (thrmgt): This is statistically significant variable in determining the amount of post-harvest loss at 5% significance level with positive relation to sesame

grain post-harvest loss for large-scale producers; but insignificant for the small-scale producers. According to the result obtained; as harvesting and threshing workers perform their activity carelessly, the amount of sesame grain post-harvest loss for large-scale producers increase by 7.8 percent.

Number of stacking days (daystak): It is statistically significant that positively determine the amount of sesame grain post-harvest loss for both small and large-scale sesame producers at 1% and 5% significance level respectively. The result shows that if the number of drying/stacking days increases by one, the amount of sesame grain loss increase by 6.4 and 1.8 percent for small and large-scale producers respectively. The positive contribution of this variable to sesame grain post-harvest loss may be, as the number of drying days increases there are pests to consume the seed (e.g. Webworms and rodents) and wind and rain have also made grain to lose out of pods. The result found in this study is complementary with the result reported by Ayaneliji *et al.* (2011).

Mode of sesame grain transportation (modtrSfh): This is statistically significant that positively affect sesame grain post-harvest loss at 10% and 1% significance levels for small and large-scale producers respectively. The result shows that if producers used caro/donkey for transportation, their sesame grain loss is reduced by 6.51 and 11.2 percents as compared to transportation by tractor/trackers for small and large-scale sesame producers respectively. The reason for this relationship could be, mostly the load/unload activities in tractors/trackers is done by hired workers who might provide less attention and care while performing the loading/unloading activities. Thus, induces higher amount of sesame grain loss as relative to the caro/donkey. So what is needed is to properly control/manage the workers performance so as to manage as of the caro/donkey that could be managed by one individual.

4.4. Analysis of Sesame Marketing

This is the section in which the fourth and fifth objectives will be addressed, presented and discussed. The market actors in sesame market chain and their roles, the S-C-P of sesame market will be discussed.

4.4.1. Actors of Sesame Market

The major sesame grain market actors in Western zone Tigray, Kafta Humera district up to export level are; producers (both small-scale and large-scale), local market assemblers, cooperatives, processors and

exporters. In addition to these explained major actors there are also service providers. These supporting actors were those that provide service in supplying materials, storage, balance, cleaning machine, transportation service, information access and training, controlling the regular market performance and commissioning activities.

4.4.1.1. Characteristics of the major market actors and their role

Sesame producers

In Kafta Humera district there exist two types of sesame producers, small-scale and large-scale. These are the only sesame producers in the study area who supply the Humera type sesame grain to the international and national markets.

Table 29. Marketing characteristics of small and large-scale sesame producers

Market characteristics		Small-scale		Large-scale	
		Freq.	Percent	Freq.	Percent
Who decide on sesame price	Buyers	124	96.88	126	100.00
	Producers	4	3.13	--	--
Buyers of sesame	Traders at local market/local assemblers	51	39.84	42	33.33
	MPP Cooperatives	60	46.88	18	14.29
	Exporters	--	--	36	28.57
	MPP Cooperatives and assemblers	17	13.28	30	23.81
Fairness of the price decided	No, unfair	119	92.97	126	100.00
	Yes, fair	9	7.03	--	--
Buyers were obtained through/at	Market center	110	85.94	82	65.08
	On farm	5	3.91	3	2.38
	Friends	13	10.16	9	7.14
	Commission agents	--	--	32	25.40

Source: Survey result, 2016

According to the study results in Table 9, small-scale sesame producers from Kafta Humera district supplied 99.1% of their sesame grain produced in 2015/16 to sesame markets, while they kept 0.86% for seed and 0.04% for their home consumption. Regarding the large-scale sesame producers in the district also, they supplied 98.9% of their produce in 2015/16 to sesame market, while they kept 1% for seed for the next production season and 0.1% for home consumption (Table 9). The percentage of sesame grain supplied to market is more than what the results revealed by Kindie (2007).

Buyers of sesame from producers

According to the institutional regulation of the Ethiopian government, sesame marketing was designed and controlled by the ECX. As the rules and regulations of the authority, sesame cannot sell out of the specified sesame market centers. Holding this rule and regulation, sellers took the commodity to the local market centers. The study also found that, large-scale sesame producers supply their sesame grain to markets to assemblers at local market, to cooperatives and to exporters (Table 29, 30). But, small-scale producers supply their sesame grain to assemblers at local market and/or cooperatives (Table 29, 30).

Table 30. Amount of sesame grain sold to assemblers, cooperatives and exporters from producers

Buyers of sesame	Small-scale producers			Large-scale producers		
	Total (Qt.)	Std. Err.	Percent	Total (Qt.)	Std. Err.	Percent
Amount sold to assemblers	581.3	7.98	33.05	4378.0	64.43	11.73
Amount sold to MPP. Cooperatives	1177.7	13.47	66.95	3285.0	45.83	8.8
Amount sold to Exporters	--	--	--	29649.0	678.87	79.46

Source: Survey result, 2016

As it is shown in Table 29, about 40% of the sampled small-scale producers sold their sesame product to assemblers; while 47% sold to cooperatives and the remaining 13% sold to both cooperatives and local assemblers. Similarly, about 33% of the sampled large-scale producers sold their sesame produce to local assemblers, 14% to cooperatives, about 29% to exporters and the remaining about 24% to both cooperatives and assemblers (Table 29). The study results further shown that, 33% and 67% of sesame produced by small-scale sesame producers is supplied to local assemblers and cooperatives, respectively (Table 30). Regarding the large-scale sesame producers also about 12%, 9% and 79% of their total sesame produce have supplied to local assemblers, cooperatives and exporters respectively (Table 30).

Generally, buyers of sesame grain from small-scale producers in the study area were only local assemblers and cooperatives. Then these buyers further supply to cooperatives, exporters, and/or processors that finally export to the international market. But, large-scale producers can directly supply their sesame produce to exporters or they export themselves. The buyers of sesame from producers are:

i. Local market level sesame assemblers

These were the traders at local sesame market centers, who collect sesame from small and large-scale sesame producers. According to the study result, local assemblers only bought sesame for trade to supply

to exporters. As it is presented in Table 31, assemblers bought 97.5% of the total amount from small-scale, while 2.5% from large-scale producers. The study result shows that the sampled local assemblers sold about 20% to cooperatives, while about 80% was sold to exporters through ECX (Table 31).

Table 31. Amount of sesame bought by local assemblers and sold to different buyers

Actors (sources) from whom sesame was bought	Amount bought by local assemblers at local market		
	Observations	Total bought (Qt.)	Percent
From small-scale	44	60850.00	97.53
From large-scales	44	1538.00	2.47
Total	44	62388.00	--
The sesame bought by local assemblers in 2015/16 where sold to			
Actors to whom sesame sold	Observation	Total sold (Qt)	Percent
To exporters	44	59693.65	79.55
To MPP Cooperatives	44	1836.82	20.45
Total	44	61530.47	--

Source: Survey result, 2016

ii. Cooperatives

As the report obtained from KHCRO (2015), in Kafta Humera district there are multi-purpose primary cooperatives in each kebele, one union and one federation. These cooperatives participate in sesame buying and selling activities. As reported by the sampled cooperatives authorities, they bought sesame from their members (that could be from small-scale farmers, large-scale producers and assemblers). The financial source of these cooperatives is from banks, their own and from the buyers especially processor.

Table 32. Amount of sesame grain bought and sold by cooperatives

Actors (sources) from whom sesame was bought	Amount bought by cooperative at local market		
	Total (Qt.)	Mean amount bought per individual (Qt.)	Percent
From small-scale producers	17900.00	3580.00	38.68
From large-scales	21318.00	4263.60	46.07
From local assemblers	7054.00	1410.80	15.24
The sesame bought by cooperative in 2015/16 were sold to			
Actors to whom sesame sold	Total sold (Qt.)	Mean amount sold per individual (Qt.)	Percent
To exporters	1778.000	352.60	3.84
To Union Cooperatives	2722.00	545.50	5.88
To processors	28472.00	5694.40	61.53
Directly export	13300.00	2660.00	28.74

Source: Own survey result, 2016

The study result show that about, 46% of the sesame bought by cooperatives was from large-scale producers, about 39% from small-scale producers and 15% from local assemblers (who are members of these cooperatives) (Table 32). According to personal observation and survey results, local assemblers and large-scale producers supplied their product to cooperatives for the reason that cooperatives offer a premium of birr of 70 to 90 compared to individual assemblers per Qt. This additional price attracts even the individual traders at local market centers who are members of the cooperative to supply to the cooperative. But what restricts them was, the market bylaw does not allow them to supply to cooperative and/or to other traders at the same status.

As this price difference paid by cooperatives is in favor of assemblers as they simply buy and transfer it to the cooperative with lower marketing costs. But the ECX regulation did not allow this transaction for minimizing the length of marketing chain. Understanding the ECX regulations, assemblers and large-scale producers sold their product to cooperative by making reasonable as it was their own production.

iii. Exporters

Sesame exporters were the last marketing chain link in the domestic sesame marketing chain. They were relatively well equipped with the necessary capital, facilities and knowledge. They have the composition in the national wise as they could buy and export the commodity produced in any of the sesame producing parts of the country; even there are companies from abroad (from India). Most of these exporters did not have cleaning machine rather clean by paying per Qt.

iv. Processors

This is one of the actors of sesame market chain that bought pure (free of chemical) sesame grain from producers through cooperatives in the study area. As reported by the company managers, it did not simply bought; rather check for being free from chemical and other mixes that could result in loss of its organic nature; by monitoring from sowing time to the end of harvesting. By conducting these activities the company assures traceability of the commodity to be supplied internationally. They also make trademark while the cooperatives bought from member producers then if there would happen any failures after the laboratory checkup that product would be returned back to the producer.

In 2015/16 the company bought 61.53% of the total sesame sold by the sampled cooperatives in the district. As the company report shows, all of the bought sesame grain could not be supplied to the international market; rather about 20 percent of the bought amount could not be exported. From the 20% of the amount they bought which could not be exported; 75% was the husk cover which could be sold for livestock feed by birr 19 per Kg, 16.6% was lower quality sesame grain which was used for oil extraction that was sold by birr 10.00/Kg. The remaining 8.8% of the un-exported remain amount was the loss incurred during re-cleaning and transporting activities.

The hulled high quality sesame was supplied to the international market for the world's high quality sesame product demanding countries of South Asia, Central America, Middle East, Oceania, Eastern Asia, South Asia, and Western Europe. However, most of the sesame exported to international market in raw product form was supplied to China that focused on the cheaper price. Thus, it is important to focus on the partial processing (hulling).

4.4.1.2. Service providers of sesame marketing chain and their role

The service providers in sesame market in Kafta Humera district were those that support the marketing transaction but not participate in handling (taking the risk) of the commodity traded.

In the study area the services provided by governmental organizations were related to extension service, training, improved seed, marketing consultancy, issuing and implementing the rules and regulations of sesame marketing. The individual support service providers were such as the transportation service providers, suppliers of packaging sack, sheet used during threshing and re-cleaning, tailors, garages and spare part shops, fuel and lubricant shops, tractors and storage renting service providers and weighting balance service providers. There were also financial service providers by banks, micro finance institution (DCSI), cooperatives and informal money lenders. The detailed explanation will be as follow:

i. Input service providers

These services include mostly the production inputs such as inorganic fertilizer and improved sesame seed. Fertilizer was only supplied by the hand of MPP cooperatives found in each kebeles. The other input supplied by the input service providers was improved seed supplied by HuARC, KHARDO.

Besides to the governmental source of sesame improved seed, there were also seed obtained from the producers themselves which was selected for seed during the harvesting time observing its performance.

ii. Tractor renting, garage and fuel and lubricant supply service providers

The tractor service is provided mostly by the large-scale producers who own for plowing their farm. So that, they rented out on an hour bases either after they had plough their own farm or simply rent out on monthly bases, while they plough their land by renting from others on hour bases.

The garages also provided the service of repairing the tractors (to be used in plowing and transportation), trackers (to be used in transporting sesame grain). It was provided by different garages found at Mai Cadra and Humera towns. These garages hardly work especially during production season (April to July). The fuel and lubricant supplier shops also play important role in supplying the fuel for tractors and trackers. Without this input the farm could not plough and the sesame grain would not be transported, so that these shops were also accounted as service providers of the commodity obtained.

iii. Agricultural tools, food preparation utensils, packaging sack and threshing sheet suppliers

The agricultural tool that was used in the sesame farm in the study area includes axe, sickle, ploughshare and other related tools are mostly done by carpenters and sold in local markets. The food preparing and consumption utensil which are used in the sesame farm by the sesame production activity workers are also bought from the traders at local market centers located in each kebeles.

The packaging sack is a material used for packaging the sesame grain which was mostly supplied by cooperatives located at each kebeles. But it was also supplied by the individual traders who were not specific to supply only that material rather they supply the packing material on the seasonal bases. The material sheet for threshing cleaning and re-cleaning activities was also supplied to producers and traders by individual traders in Humera and other Kebeles residences. Here the tailors also provide the production support service by tailing the sheets used for the threshing purpose who are located in Humera and the kebeles residences.

iv. Laborers hired in sesame production, loading/unloading and re-cleaning activities

According to the information from SBN (2013_b) the workers hired in the western zone with the greater share in the Kafta Humera district. This is indicating that; production, loading, unloading and re-cleaning activities require higher number of workers.

v. Store renting, re-cleaning machines and weighting balance

Except few sesame producers and traders most of them do not own store. In this case even though some of the small-scale producers stored in their residence, the remaining small-scale producers and large-scale producers used rented store. Most of the assemblers in the study area also use on monthly basis rented store. The exporters use the sesame store in the store rented by ECX. So, it is possible to conclude that store renting takes place at all stages of the chain in the production year. Besides to the above, in the study area there were only 13 sesame grain re-cleaning machines that perform re-cleaning service for the exporters where most of the exporter used rented in sesame grain re-cleaning machines on per quintal bases. In the study area the number of track load weighting balance are only two which perform measuring the load weight. These two weighting balances provide service to large-scale producers, assemblers and exporters.

vi. Institutional support services

The services provider institutions are ECX (Humera branch), KHARDO, research center (HuARC), custom and revenue office and land administration office. The ECX Humera branch is mainly structured to control the marketing aspects of sesame targeting the benefits of the stockholders by issuing rules and regulations, implementing and follow up of these designed rules and regulations.

ECX Humera branch also provides the standardization by taking sample and gives standard for the sesame grain to be exported. But some drawbacks in standardization, timely performing the duties like, limiting the number of days allowed for storing sesame grain entered to the store of ECX (which is only 30 days), lack of timely information, too limited coverage while the supply was too vast, limitation in utilization of standardized laboratory technology and lack of owning standardized store.

The KHARDO is implementing different activities in improving the productivity of sesame as it is the major crop in the study area. Some of the activities undertaken by KHARDO were supporting the sesame

producers and traders through extension service and training provision. Besides the office implemented field days, demonstration of best practices and field based support system.

Regarding sesame marketing also the office had a position to follow up the daily transaction and availability of store (during licensing). But even though it was important to control the market transaction of the traders, that was limited to the purchasing price, controlling for the transaction not to takes place out of the sesame market and the follow up was for limited time not beyond spot walk.

However, for the marketing part it would be better if the office incorporate monitoring of markets the whole day, covers the focus of evaluation to as who opens and who did no and further for what reason of not opening the purchasing office, the regular participation of the trader in the sesame market center in purchasing activities, what problems had facing the producers at the market and also the problems facing traders. Also, it would be better if the office clearly evaluates the ownership and utilization of store for the sesame assemblers. This is because even the assemblers rented store, they did not used for storing the commodity, rather they store in the office at the market center with lower standard for storing.

The research center in the zone (HuARC) is providing support service starting from production to export. These services are improved seed generating and demonstration, training, filed level support service and consultancy services. But, this have limitation in reaching to large number of producers, the training is mostly on production aspect not on marketing aspect and demonstration of improved seed is at slow rate.

Custom and revenue office of the Kafta Humera district in collaboration with agriculture and rural development office and trade and industry office provides license, monitoring the performance of sesame marketing centers, collects tax revenues. The land administration office of Kafta Humera district also provides service of follow up on utilization of cultivable and non-cultivable land as per the rules and regulations. But, it has limitations in effective follow up and monitoring the rules and regulations.

vii. Financial and accounting service

Sesame sector is higher finance requiring sector for performing its activities. In most of the stockholders case this financial requirement could not fulfilled from their own equity. So, the credit is sourced from micro finance institutions (DCSI), cooperatives, banks and informal money lenders (IML).

viii. Transport service providers

These are the mode of transmission sesame grain among the producers, assemblers and exporters. In the district's local market centers there are good road facilities to take the collected sesame to ECX for standardization and storage until it is sold. The number of days sesame grain can stay at ECX for leveling determined the transportation cost of assemblers. According to the study result most small-scale producers (70.31%) used cart to transport from their farm to store. But, most of the large-scale producers (90.48%) used tractor for transporting the sesame grain from farm to store (Table 33).

Table 33. Mode of transportation used by the sampled producers

Mode of transport		For small-scale producers		For large-scale producers	
		Freq.	Percent	Freq.	Percent
From farm to Storage	Cart	90	70.31	10	7.94
	Tractor	38	29.69	114	90.48
	Truck	0	0	2	1.59
	Mean payment per Qt.	24.85 birr		34.63birr	
From Storage to market	Cart	128	100	84	76.66
	Tractor	0	0	24	19.05
	Truck	0	0	18	14.29
	Mean payment /Qt.	9.36 birr		14.51birr	

Source: Own survey result, 2016

All small-scale producers used caro to transport their stored sesame grain to market. Regarding the large-scale producers also most of them (76.66%) had used cart, to transport their product to market as in Table 33. As it is presented in Table 34, 60.42% of the assemblers did not transport the sesame they bought to store rather they store in the market center and directly take to the ECX. But, the remaining sampled individuals took to store using caro (39.58%).

Table 34. Mode of transportation used by sampled assemblers and payment of commission agent

Mode and cost of transportation		For local assemblers		
		No. traders	%	Mean
From local market center to Storage	0 (do not transport)	29	60.42	--
	Cart	19	39.58	--
	Total	48	100	--
	Transport cost /Qt.	--	--	1.33birr
From Storage to ECX store	Truck	48	100	--
	Transport cost /Qt.	--	--	19.72birr
Payments for commission agent	% Per total return	--	--	0.4
	Per Qt (Birr)	--	--	8.2 birr

Source: Survey result, 2016

For transporting sesame grain from farm to store, producers paid the average price of 24.9 and 34.6 birr/Qt for small and large-scale producers, respectively (Table 33). Regarding transportation from store to market the average price was 9 and 14.5 birr/Qt for small and large-scale producers respectively (Table 33). The sampled assemblers also paid the average transportation cost of 1.33 birr/Qt to transport from market to their store and 20 birr/Qt to transport from their store to the ECX (Table 33).

ix. Commission Agents

These categories of market actors are common in sesame marketing that are monitored by ECX and works their commissioning activities at ECX. They did their commissioning by discussing with their clients. These agents got on average 0.4% of the total return obtained or 8.2 birr/Qt (Table 33).

Figurative representation of sesame marketing chain

Sesame marketing chain is stretched from producers to consumers at abroad. But, this study is focused on the chain from producers to the export level (fob). It is restricted for the reason that to go beyond, it requires more resource and time. Figuratively the market chain can be presented as in Figure 11 and 12.

According the result of this study, the initial links for sesame marketing channels were producers (both small-scale and large-scale) and the final destinations in country were exporters. In between intermediaries; such as local sesame assemblers, cooperatives and unions and processors exist which play significant roles for the movement of the product to its final destination. The figurative representation of sesame market chain is so depicted from bottom-up structure that producers are at the bottom (base) then to intermediaries and then to processors and exporters so exported as the head of the arrow shows (flow from→to). The magnitude of the sesame hold amount by these channel participants is measured based on the 2016 business transaction from the production in 2015/16 production season.

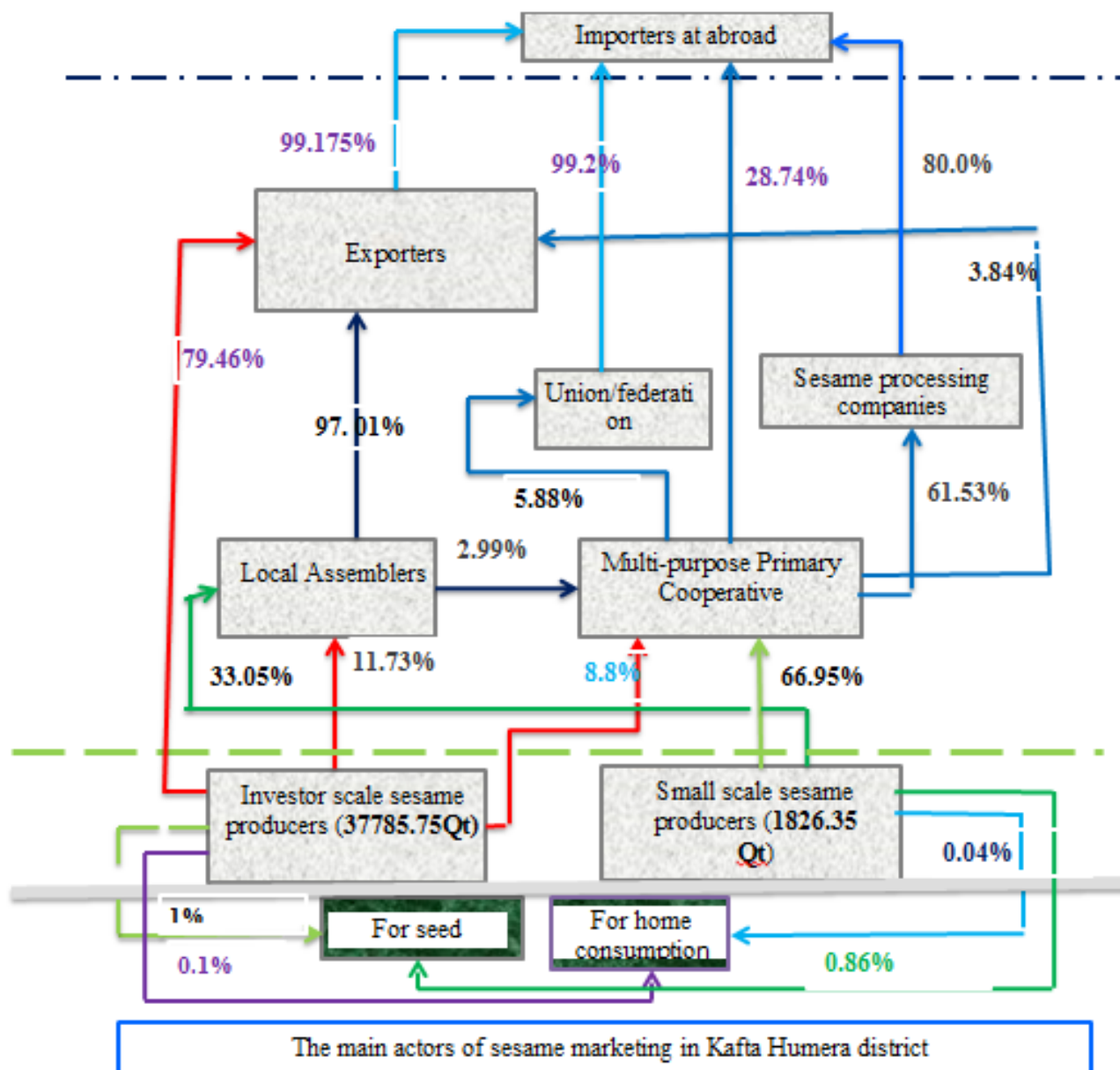


Figure 9. Major sesame market chain actors in Kafta Humera district

The support service provided by different sesame market chain participants is also depicted in figure 12. In this figure, the arrow head indicated the direction of the service from the service providers to the service receivers. The service providers are depicted in both sides (left and right), whereas the service receivers are in the middle to receive the service from both sides.

It is important to understand that the colors and line type in the two market chain figures have no implication with the chain rather it is used for the easier identification of the flow.

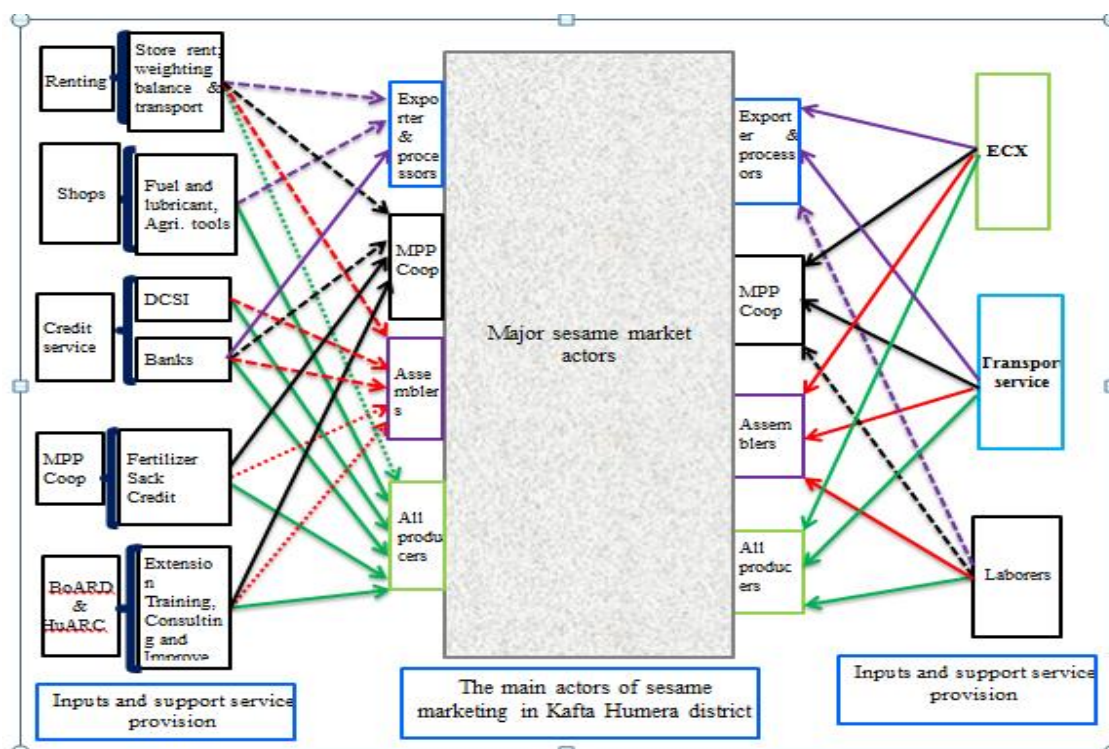


Figure 10. Sesame market chain support service providers in Kafta Humera district in 2016

Regarding the possible market channel, this study identified that there are ten possible marketing channels for the sesame grain from the level where it is produced to reach the level where it is exported. The shortest channels are channel number 3 and 7; while the longest channels here are Channel number 5, 8 and 10. According to the report from respondents the most common/familiar channels are channel 2 and 7. Channel 8 is the especial characteristics of large-scale producers who have the opportunity to supply to the exporters directly through ECX.

The identified market channels depicted in Fig 10 are:

1. Producer → Primary Cooperatives → Union → Importer
2. Producer → Primary Cooperative → Exporter → Importer
3. Producer → Primary Cooperative → Importer
4. Producer → Primary Cooperative → Processor → Importers
5. Producer → Assembler → Primary Cooperative → Processor → Importers
6. Producer → Assembler → Exporters → Importers
7. Producer → Exporters → Importers
8. Producer → Assembler → Primary Cooperative → union → Importers
9. Producer → Assembler → Primary Cooperative → Importer
10. Producer → Assembler → Primary Cooperative → Exporters → Importers

4.4.3. Structure, Conduct and Performance of the Sesame Market

4.4.3.1. Sesame market structure

As sesame was the second agricultural commodity to earn export exchange, the government policy selects and groups with the export earner cash crop commercial commodity. Sesame producers in the target area also know this strategy and allocate for selling except few who deduct for seed and consumption. According to the research findings, sesame export price did not significantly affected by the domestic factors. The existing reality was that international prices could significantly affect the export price and in turn it affects the producers' and traders generally national and regional price. This enables us to say sesame market is characterized as the Buyer's market. The study revealed that, the most common actors of sesame market in Kafta Humera district are producers (both small-scale farmers and large-scale producers), Cooperatives (primary and Union), local assemblers, Processors and exporters.

Measurements of sesame market structure

The market structure is measured by analyzing the level of concentration ratio, barriers to entry and exit to market and coordination/integration of the sesame market chain participants. These measures are presented and discussed as follows:

1. Measures of sesame market concentration ratio

There are local assemblers, cooperatives and exporters in the study area who are limited in their respective level. Concentration ratio (CR) is calculated from assemblers and exporters to estimate the power of market chain actors. Regarding the measure of market structure, this study analyzed the CR for local market assemblers and exporters.

The CR₄ measure of local market assemblers shows that, the top four assemblers only controlled 38.7% of the total sesame purchased amount in 2015/16 (Table 35). In similar calculation the CR₈ measures of local market assemblers indicated that, the top eight assemblers had only control 51.03% of the total purchased amount in 2015/16 (Table 35). The CR₄ and CR₈ result of local market assemblers indicated that, assemblers had weak/low power to control sesame market. Thus, sesame market structure of the local market centers is weak oligopoly. The results of HHI for the first four and eight assemblers (HHI=1640), also shown that the sesame market concentration was moderately concentrated.

Table 35. The concentration ratio of sesame grain assemblers in Kafta Humera district

Traders	Cumulative % traders	Purchased amount (Qt)	cumulative purchased (Qt)	CR		HHI	
				Percentage from total (%)	cumulative percentage	Merge %Share	Exclude (% Share) ²
1	2.04	13300	13300.00	12.29	12.29	24.08	580.00
2	4.08	11000	24300.00	10.17	22.46	19.92	396.75
3	6.12	9580	33880.00	8.85	31.31	17.35	300.93
4	8.16	8000	41880.00	7.39	38.70	14.48	209.85
5	10.20	4392	46272.00	4.06	42.76	7.95	63.25
6	12.24	3500	49772.00	3.23	45.99	6.34	40.16
7	14.29	2953	52725.00	2.73	48.72	5.35	28.59
8	16.33	2500	55225.00	2.31	51.03	5.52	20.49

Source: Own survey result, 2016

The CR₄ measures of sesame exporters shown that, the top four of the exporters only controlled 46.54% of the total sesame exported amount in 2015/16 (Table 36). In similar calculation the CR₈ measures of the power of exporters indicated that, the top eight exporters only controlled 63.24% of the total exported amount in 2015/16 (Table 36). According to the result of CR₄ and CR₈ of exporters found in this study, exporters had weak/low power to control sesame export market. The results of HHI for the first four and eight exporters (HHI=1570), also shown that the sesame market concentration was moderately concentrated. Thus, the export market structure is weak oligopoly. In both cases (assemblers and exporters), the result of CR₄ and CR₈ was in line with the result found by Bosena (2008); but, in contrast with what Kindie (2007) has found .

Table 36. The concentration ratio of sesame grain exporters from Kafta Humera district

Cumulative of traders	Cumulative % traders	Purchased amount (Qt)	cumulative purchased (Qt)	CR		HHI	
				Percentage from total (%)	cumulative percentage	Merge %Share	Exclude (% Share) ²
1	2	102600.00	102600.00	13.34	13.34	21.08	444.68
2	4	97652.00	200252.00	12.69	26.03	20.07	402.83
3	6	90070.00	290322.00	11.71	37.73	18.51	342.71
4	8	67780.00	358102.00	8.81	46.54	13.93	194.07
5	10	42180.00	400282.00	5.48	52.03	8.67	75.16
6	12	38000.00	438282.00	4.94	56.96	7.81	60.99
7	14	26980.00	465262.00	3.51	60.47	5.54	30.75
8	16	21279.50	486541.50	2.77	63.24	4.37	19.12

Source: Survey result, 2016

As it is presented in Table 35 and 36, the top four assemblers and exporters of sesame hold individually only 7.4% and 8.8% of the total marketed sesame, respectively. Similarly, the top eight assemblers and

exporters individually covering/own only 2.31% and 2.77% of the total marketed amount respectively. To sum up, applying the measure of concentration ratio (CR) for the top four and eight sesame market actors in both assemblers and exporters, sesame market structure in the study district is weak oligopoly.

2. Barriers of entry to sesame market

Sesame market in the study area is faced different barriers of entry that prevent market participants not to enter or not to continue in the market chain. According to the personal observation (RMA), reported by the governmental organizations in the district and report of the respondents at different levels; the major sesame market entry barriers were capital, governmental policies and infrastructural access. These sesame market entry barriers will be discussed as follows:

Capital barrier: The sesame marketing sector requires huge capital, which prevents individuals with lower capital from entering to the chain. As the systematic personal observation and report obtained from governmental organizations in the district and from sampled respondents, the newly entering individuals to the sesame market chain requested to have store, office at market center, office tools, weighing balance and initial cash at least half a million birr. Being these, individuals who did not have this minimum capital could not enter to the sesame market chain. However, as is presented in the concentration ratio section in the study district there are large numbers of individuals who fulfill the minimum required capital. The study is so indicating that even though there is capital barrier, since there are large numbers of individuals who fulfill the minimum requirement, sesame market is weak oligopoly market structure.

Governmental policy barriers: These barriers are the policies and strategies designed by government that prevent individuals who cannot fulfill the requirements from entering to the market participation/transaction. The policies also withdraw individuals who cannot fulfill the requirements which enable them to continue in the chain. As the report obtained from governmental organizations such as custom and revenue office and office of agriculture and rural development of the district, the major governmental barrier of sesame market is licensing.

a) Licensing barrier: All the sampled traders have specified trading license, unlike the condition during the study conducted by Kindie (2007) where there were traders having general not specified and

specialized license. The informal observation and discussion of the researcher also proved absence of trader working in the market center without license. According to the report from KHCRO (2016), there were restrictive entry criteria to sesame markets as bylaw/regulation of sesame marketing. The sesame market entrance is restricted for the reason that individuals who want to enter trade should fulfill the criteria for being licensed. As the report of KHCRO (2016), some of the criteria's for being licensed are the availability of standardized store, weighing balance, office at market center and capital not less than half million birr. For those who already licensed also the requirements are raised during license renewal performed yearly. These restrictions are followed up by the governmental organizations of the district; KHARDO and KHCRO in collaboration.

However, as solution for the absence of store and cash on hand; traders fulfill it by renting store and borrowing money from different loan providers. Here what was observed as problem is that, some of the traders who rented store did not use it (they rent for obtaining the license); rather they store in the office at market center. This is for the reason that to reduce the transporting cost from market center to store.

b) Place restrictions: it is a government policy that sesame is only sold and bought in sesame market centers by only the licensed assemblers and/or multi-purpose cooperative. Thus, anyone who sell and buy sesame out of the market centers will be punished. As the report of KHARDO (2015), in each kebeles there was one market center; where selling and buying of sesame out of it is unlawful.

c) Level restrictions: It is one of the government policies that restrict local assemblers to buy from producers only and to sale to exporters through the ECX channel. This restriction also limits exporters to only buy the sesame labeled (standardized) by ECX; from the ECX store only by bidding at ECX.

Infrastructure access barriers: This is related to the availability of road infrastructure availability and information access barriers which prevents market participants from entering to or continuing in the market chain.

a) Types of markets (typology of markets): The sesame market centers are formal market places that regularly authorized gatherings of individuals who have license to buy or sell sesame and regularly followed by government organizations. According to the report of KHCRO (2016), the formal sesame markets in Kafta Humera district existed in 17 kebeles in which these market centers were opened every

day and interested buyers and sellers meet to transact exchange. These local market centers in the district are located at closer distance to the residence of sesame producers, on average not more than 7 Km distance. This enable sesame producer well accessed to market center.

b) Market information: It is the weapon for producers and traders in their production and marketing decisions. According to the systematic personal observation and report of the sampled respondents, there was no regular and updated source of market information in the study area. Producers did not have any regular source of market information; rather they mostly obtained from neighbors and buyers that may not be regular and timely (Table 36). It is found that 52% of the sampled small-scale producers obtained market information by own (themselves) search the market centers (Table 36). It is also found that about 96% and 17.5% of the sampled assemblers and large-scale producers, respectively obtained market information through commission agents (Table 36).

Generally, there is sesame market information asymmetry (not common and timely updated information) in the study district. This information asymmetry negatively affects profitability of sesame market participants. Thus, it also acts as entry barrier to sesame market.

Table 37. Source of market information for sesame producers and local assemblers

Source of market information	Large-scale		Small-scale		Traders	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Neighbors	8	6.35	21	16.41	2	4.17
By own search the market center	13	10.32	67	52.34	--	--
From radio and television	6	4.76	3	2.34	--	--
From buyers	12	9.52	10	7.81	--	--
From neighbors and own market search	4	3.17	12	9.37	--	--
From buyers, neighbors and own market search	29	23.02	11	8.59	--	--
From radio and television and neighbors	3	2.38	4	3.13	--	--
By own market search and from buyers	23	18.25	--	--	--	--
From ECX commission agent	6	4.76	--	--	47	95.92
From ECX commission agent and by own market search	22	17.46	--	--	--	--
Total	126	100	128	100	49	100

Source: Own survey result, 2016

3. Coordination/integration

As the systematic personal observation and the report of the sampled respondents, there were some local sesame assemblers that coordinated/integrated with producers. It is found that assemblers in all market centers coordinate to obtain the supplied sesame without competition. This coordination was performed by former relationships of friendship, formerly loan provision with free/ lower interest rate and formerly negotiate with the producer while at their home; as the trader is going to add some price beyond others (covering the transportation cost) so to sale for him (not to sale to others). As the result of their integration; during the time that the producers wants to sale, he/she call to make ready for his/her coordinated buyer and the assembler buy with no competition (by expressing as he is already bought, saying that ‘this is mine’). Thus, coordinated assembler bought free of any competition.

Generally as observed from the above statements it is possible to conclude that the sesame market structure deviates from the norms of perfectly competitive market due to presence of barriers to entry as well as coordination of assemblers with producers. But the market concentration ratio calculated at assemblers and exporters’ level confirms the weak oligopoly power.

4.4.3.2. Sesame market conduct

This includes the way in which the market participants behave in the market. Market conduct is measured by the indicators such as pricing strategies, combination/mergers and collusion behaviors. These indicators were measured systematically by personal observation at the market level and discussion with the sampled market participants. It is also important to discuss the market behavior of the producers and traders.

a) Producers’ market behavior

The study result shows that all the sampled sesame producers (small-scale and large-scale) supplied their sesame production to the sesame market. This indicates sesame being the most important cash crop in the district. Yearly sesame product starts supplied to market during October and reaches its peak in December to February and declines after February. So, the Critical periods for sesame purchase were December to February.

The frequency of supplying sesame to market depends on production level. Small-scale sesame producers supplied their sesame to market on average twice in a year (Table 38). It is also shown that, 46% of the small-scale sesame producers supply only once a year; while 37.5%, 14.84% and 1.56% supplied two, three and four times a year, respectively (Table 38). Regarding large-scale sesame producers, they supplied their sesame to market on average about three times a year (Table 38). As it is presented in Table 38, 38.89% of the large-scale producers supplied their sesame produce three times a year; while 15.08%, 27.78% and 18.25% had supplied in one, two and four times, respectively. As it was reported by the sampled respondents, their sesame supplied amount is by terms for the reason of lower price and expecting that it may be raise latter. However, due to the supplier's fear of lowering the price and shortage of finance, they were forced to sale partly even at lower price. Thus, minimize the risk of price change.

Table 38. The frequency of sesame grain selling by the sampled small and large-scale producers

Number of selling batches	Small-scale		Large-scale	
	No. of respondents	Percent	No. of respondents	Percent
1	59	46.09	19	15.08
2	48	37.5	35	27.78
3	19	14.84	49	38.89
4	2	1.56	23	18.25
Total	128	100	126	100
Mean frequency	1.719 (0.068)*		2.60 (0.085)*	

*The value in parenthesis is for the standard error
Source: own survey (2016)

b) Price setting strategies

As it is presented in Table 30, producers selling price was decided by the buyers. That is about all of the sampled small and large-scale producers reported that those were the buyers that decide on the selling price of sesame from producers. This price setting power of the traders is emanated from the lower competitiveness of the market.

c) Combination of sesame market participants

As the study result shown, sesame market participants at different stages were combined for their individual benefits. It was personally observed that, some traders combined themselves to kick out few others; so reduces competition. The sampled respondents also reported that, exporters were combined

with commission agents to obtain market information. Further, sesame exporters combine each other and decide not to compete for the case that bidding becomes among few for specified time period. Thus, lower competition which further reduces sesame selling price.

d) Collusion in price setting

According to the personal observation and discussion with the sesame market participants, assemblers in the sampled local market centers (except in Mai-Cadra) open their marketing office in the market center not more than three days per week. It is also found that assemblers discuss in deciding the price by how much to buy so not to buy beyond that fixed level. This was because, assemblers colluded and discussed to arrange time table of purchasing among themselves. Hence, lower competition and no more price negotiations with the producer as already brings his sesame to the market paying transportation cost. The personal discussion with assemblers and producers also indicated that, exporters collude among themselves not to compete while bidding at ECX. Thus, lowers the selling price which directly hurts producers and assemblers. Therefore, as there is un-negotiated price setting, combination and collusion of sesame market participants, it is possible to conclude that the conduct of sesame market in the study area deviates from competitive market norms.

4.4.3.3. Sesame market performance

The sesame market performance of the study district is evaluated based on the level of profit and marketing margins obtained by different market actors.

a. Cost structure and profitability of sesame producers

The profit obtained by sesame producers from sesame production is calculated taking the difference between total return obtained from the commodity and the total cost incurred for it. For the sesame traders also the profitability was calculated taking the difference between the total return obtained in trading the commodity and total marketing transaction costs.

As it is presented in Table 39, small-scale sesame producers in 2015/16 production season earn a net return of on average 319 birr/ha or 113 birr/Qt. regarding large-scale producers also, in 2015/16 production season they could not cover both sesame production cost per-Qt (2701 Birr), that were lagged

by 1999 (-) birr and the cultivation cost per-ha (6644.4 birr), which were lagged by 813(-) birr (Table 39). The reason that makes small-scale to be profitable may be relatively higher productivity and the lower cost of production/ha and per Qt, compared to that of the large-scale producers.

Table 39. The summary of average per hectare sesame production costs of sesame producers

Variables	Small-scale		Large-scales	
	Mean	Std. Err.	Mean	Std. Err.
Land preparation cost of labor	462.43	27.30	396.10	20.77
Sowing cost of labor	77.77	6.03	64.00	5.42
Weeding cost of labor	1022.86	16.99	2183.00	92.42
Total fertilizer cost	416.28	50.32	581.20	34.70
Sesame seed cost	143.55	5.27	146.95	12.63
Harvesting cost of labor	1080.11	47.38	1250.80	34.90
Threshing cost of labor	294.41	13.12	243.69	6.55
Plowing cost	303.82	6.89	148.38	14.90
land rental cost	71.23	5.58	661.12	37.69
Personal transportation expenses	1.30	0.43	35.60	4.89
Sesame grain transport expenses	26.30	1.98	84.93	4.01
Store expenses	1.11	0.70	3.15	0.88
Expenses of getting buyers	1.64	0.60	16.16	3.15
Market information expenses	0.65	0.412	1.65	0.25
Re-cleaning expenses	4.12	2.245	18.10	2.90
Payments for maintenances and repair	0.00	0.00	146.99	13.09
Fuel & lubricant expenses	0.00	0.00	152.66	13.62
Payments for medical services	1.172	0.70	0.81	0.47
Agricultural tool cost	314.83	40.30	95.79	10.03
Cost of packing sack	31.36	1.34	10.75	0.07
Cost of rope for packing	1.26	0.07	0.95	0.05
Cost of loan (interest on capital)	460.30	44.86	353.02	16.96
Chemical cost	0.00	0.00	12.87	3.18
Tax payments	26.9	2.48	35.76	2.80
Total cost/ha	4743.402		6644.43	
NR/ha obtained	318.92		-1999.00	
Revenue/ha	5062.32	233.20	4645.39	127.4
Revenue/Qt. (price)	1795.15	25.66	1888.37	18.03
Average Yield	2.82	0.12	2.46	0.07
Cost /Qt.	1682.06		2701.00	
NR /Qt	113.11		-812.63	
% NMMss profit	4.85%			

Source: Survey result; applying STATA, 13.0

The reasons for the failure to make profit for large-scale producers may be their lower productivity and decrease in price (Table 39 and Fig 11). Even small-scale sesame producers; who were in a better

position than large scale producers in profitability level, also generated lower profit as compared to the preceding years that may be due to decline in selling price of the commodity.

As it could be understood from Fig 11, sesame price was raising continuously before two years (before, 2014), but after the mid of 2014 it sharply declines to the level below 2000 birr/Qt in 2015/16. Given an increase in wage rate and decrease in market price of sesame since mid of 2014, large-scale sesame producers become unprofitable from sesame production.

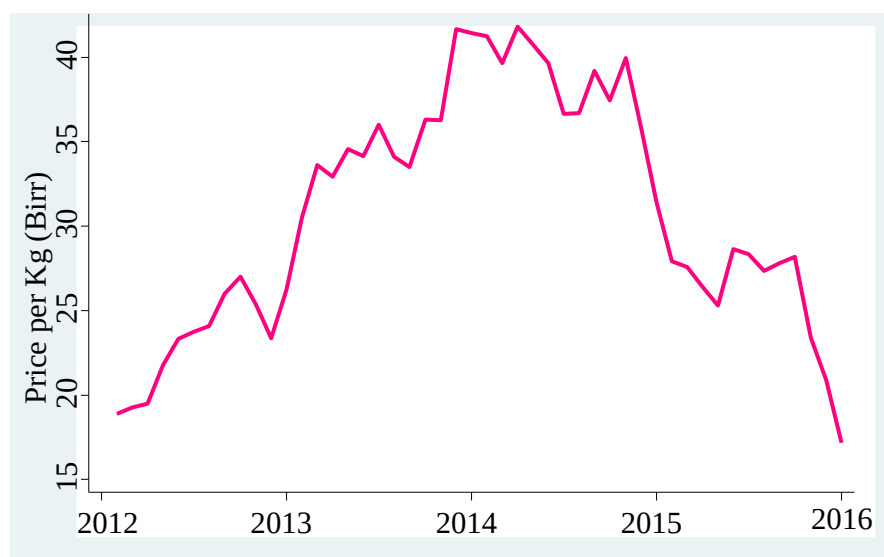


Figure 11. The price series of Kafta Humera store, 2012-2016

Source: ECX, 2016

According to the personal observation and information obtained from informal discussion with the sampled respondents, due to the failure in achieving profit from sesame production; there were large numbers of producers (mostly large-scale producers) that fail to payback their loan taken for sesame production.

Table 40. Response of the sampled producers and traders in the fairness of the sesame price

Fairness of the sesame buying price		Freq.	Percent
Traders	No, not fair	48	100.00
	Yes, Fair	0	0.00
Small-scale producers	no, unfair	119	92.97
	yes, fair	9	7.03
Large-scales	no, not fair	126	100.00
	Yes, fair	0	0.00

Source: Survey result, 2016

The survey result as shown in Table 40, also implied that 100%, 93% and 100% of the traders, small and large-scale sesame producers respond that selling price of sesame from producers was not fair as it could not cover its production costs.

b. Marketing margins obtained by sesame market chain actors

Marketing margin is measure of the share obtained by individual market actors from consumer price paid for the commodity. In this study it is the share of producers, assemblers, exporters and processors from what the importers in the other country had paid (fob price). Thus, consumer price here is the *fob* price. The net marketing margin was also obtained by calculating the net return obtained from the transaction and divided by the export price at fob. It will be discussed in detail as follows:

Total costs, return, gross and net market margin of sesame assemblers

The survey result as presented in Table 41 implied that, considering the raw-sesame grain TGMM in the complete distribution channel is 25.39% that is calculated by taking the fob price of 2332 birr/Qt and the purchase price of 1732.3 birr/Qt (Table 41). Regarding assemblers, their total return obtained from sesame trading is 171.75 birr/Qt, while they incurred the total marketing cost of 122.87 birr/Qt and faced a loss in return of 22.23 birr/Qt. Thus, they obtain the net return (profit) of 26.43 birr/Qt.

As presented in Table 41, the highest share of assemblers' sesame trading cost was accompanied by the yearly payments for different services (such as for municipality, TOT and accounting report) that accounts for 15%, then cost of standardization (14%), followed by transportation cost (13%). The least share of the costs was cost of renting store (3.1%) followed by cost provided to commission agents at ECX (06%) and continued by cost of sack (07.5%). Considering the fob price and the purchase price, the net marketing margin (NMM) obtained by assembler is 1.13% (Table 41). Following the same consideration, the GMM obtained by assemblers is 7.36% (Table 41).

Total return, total cost, gross and net market margin of exporters

As it is presented in Table 41, exporters of sesame grain in Kafta Humera district obtained a total return of 420 birr/Qt by committing the total cost of birr 301.75/Qt. These actors also faced a total return loss of 15.75birr/Qt. Taking all these returns and costs the net return obtained by exporters is 102.85 birr /Qt

(Table 41). From Table 41, the NMM is so calculated considering the fob price of un-hulled seed of 2332 birr/Qt is 4.41%. Following the same calculation the GMM obtained by the exporters was 18.03 percent. As it is presented in Table 41, the net return per Qt obtained by processors is higher than what exporters had obtained and exporters obtained higher net return as compared to assemblers.

Table 41. Marketing costs of sesame assemblers, exporters and processors

Cost incurred in	Processor	Exporters	Assemblers
	Mean /Qt. (Birr)	Mean /Qt. (Birr)	Mean /Qt. (Birr)
Purchase Price	1,898.80	1909.00	1732.30
Raw Material	172.18	0.30	0.48
Wages and salary	105.49	16.00	21.31
Traveling expenses	12.31	0.50	0.38
Utilities	9.11	0.10	3.75
Fuel, oil and lubricants	12.34	0.00	0.00
insurance	1.99	0.00	0.00
Repair & maintenances	9.95	0.00	0.73
Stationery	1.82	0.27	0.31
Audit fee	6.64	0.83	0.40
Transportation expenses	112.12	180.00	15.62
Land expenses	22.18	0.00	0.00
Depreciation	8.09	0.00	0.29
interest rate	28.48	0.00	15.1
Yearly Payments (Tax)	79.20	53.18	15.15
Load/ Unload	12.00	12.00	13.76
Market information and facilitation	18.58	18.58	23.19
Sack price	15.00	15.00	9.18
Municipality cost	7.00	5.00	3.30
Selling price (Fob price)	3,445.00	2332	1903.83
Total return-bought cost (GMM)	1,546.20	420.35	171.53
Sum processing and marketing cost (TC)	634.49	301.75	122.87
Trade total return (TR)	911.71	118.6	48.66
Total net return loss by sesame grain Loss	318.06	15.75	22.23
Net return (profit) per Qt	593.65	102.85	26.43

Source: own calculation applying STATA, 13.0

Total cost, return, gross and net market margin of sesame processors

Sesame processing was being infant not yet widely introduced to Ethiopia even though it has an important implication to production of the commodity as it creates good ground for the purchasing price and increase its shelf life. The chain was that cooperatives collect organic sesame grain (free of chemical,

fertilizer was not applied in production) from member producers and supply to the company. During purchasing time there were also workers hired by hulling company to control purchasing of chemical free sesame and tag a code for traceability control.

According to the data in Table 41, the average purchasing and selling price of the hulling companies was birr 1898.80 and 3445 per Qt, that lead to the total return and net return per Qt of birr 1546 and 594, respectively. As in Table 41, the total value addition cost and the sesame grain loss during hulling and re-cleaning activities were also higher to swallow more gross return of the company.

Calculating marketing margins (considering the raw sesame fob price)

The GMM of producers was 74.61% of fob price while the remaining 25.39% was shared by other market participants other than producers. The GMM of assemblers was 7.36%; indicating that the share of fob price that assemblers obtained before any deduction. The exporters also shared the GMM of 18.03% from the fob price before making any deduction of cost.

TGMM (complete distribution channel) = 25.39%

GMM (Assemblers) % = 7.36%

GMM (Exporters) % = 18.03%

GMMp (producers participation) % = $100\% - 25.39\% = 74.61\%$

Calculating net marketing margin (considering the raw sesame fob price)

Considering the raw sesame fob price, the NMM obtained by exporters was 4.41 percent. This indicates that the net share obtained by exporters from the total export price (fob price) of the commodity was 4.41 percent that is the net received to the exporter's pocket. The NMM obtained by sesame assemblers from export price received by the exporters was 1.13 percent. It is implying that assemblers only received 1.13 percent of the sesame export price for their participation in sesame marketing transaction.

The NMM obtained by producers was categorized in to two. These were the NMM obtained by small-scale and large-scale sesame producers. Small-scale sesame producers obtain NMM of 4.85%; while

large-scale producers face net loss. The result of net return obtained by small-scale producers implied that, covering all costs they additionally obtain 4.85 percent of the fob price.

NMM (exporters) = 4.41%

NMM (assemblers) from Fob price = 1.13%

NMMp small-scale (small-scale producers) = 4.85%

However large-scales did not gain the net gain rather they were exercised the net loss as discussed above.

Generally, the NMMs obtained by local assemblers is fair because it was the return which enables them to continue in the marketing transaction system otherwise they would not continue. An indication of unfairness was the higher share of exporters and the net loss of large-scale producers. Thus, the sesame market performance is unfair and deviate from the norms of the competitive market.

Calculating gross and net market margin considering fob price of processed sesame grain

In this section let's see the difference on share of the different actors engaged on sesame considering fob price of hulled sesame grain. All the steps followed in calculating the share while considering the raw sesame fob price would be followed. But what is differentiated is the fob price and addition of one actor; the processor (hulling company). The result obtained on share of actors in the chain from fob price of hulled sesame calculated following similar way is described as:

Gross marketing margin (considering the hulled sesame price):

From the total hulled sesame fob price 62% which is more than the producers' share was obtained as the TGMM of. As it is observed from the calculation, processors had greater GMM among middle men actors (45%), followed by exporters (12%) and lastly assemblers (5%). Surprisingly producers obtain only 38% of their products share as it is sold processed that is an indication of poorly performing market.

TGMM (complete distribution channel) %=62.00%

GMM (Assemblers) %= 5.00%

GMM raw (Exporters) %= 12.00%

GMM (processors) % = 44.88%

GMMp (producers participation) % = 100% - 62.00% = 38%

Net marketing margin (considering the hulled sesame price):

NMM (processors) % = 17.23%

NMM (raw exporters) % = 3.00%

NMM (assemblers) from Fob price % = 1.00%

NRp small-scale (small-scale producers) % = 3.28%

As the performance of market is also evaluated taking the NMM of actors from fob price; processors take the highest share (17.23%), followed by exporters who hold the share of 3% and then by assemblers (1%). As comparison small-scale sesame producers had took the share of 3.3 percent, while large-scale producers did not share any net profit rather net loss. The processing companies obtained NMM more than five times of the NMM obtained by small-scale producers and beyond the other actors.

The reason for this fact may be that the top quality hulled sesame has higher market demand with too much higher price than the raw sesame. The difference of the raw sesame export price from hulled sesame was 1113.00 birr/Qt. So for the future it will be better if higher encouragement either through financial supporting and/or consultancy for more number of processing (hulling) companies to be planted so that hulled sesame would be supplied to the market where there is relatively higher demand.

Generally, this study concludes that the sesame market performance deviates from the norms of the competitive and from efficiently performing market. It is in the direction in contrast to the share obtained in the competitive market. Thus, the sesame market is poorly performing market which did not afford the satisfaction of the producers the base of the commodity.

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary and Conclusions

Sesame is the major cash crop for both small and large-scale producers in Kafta Humera district. Its area coverage and total production has increasing; while its productivity declining over the years. Sesame production was faced short comings of lower productivity; high post-harvest loss and poor market performance. This study is so tried to measure production efficiency and identifying sources of inefficiency, post-harvest loss and its determinants and market performance the case of Kafta Humera district.

The district has 24 kebeles with population of about 27,483 households who cultivate on about 396,852 ha of land. Multi-stage sampling procedure was followed to draw sample respondents. Primary and secondary data were used for this study. The primary data were collected through interview using semi-structured questionnaire from a total of 128 small-scale and 126 large-scale producers, 44 local assemblers, 5 cooperatives, 18 exporters and one processor. In this study, four sample kebeles Mai Cadra, Adebay, Rawyian and Baeker were drawn randomly. Whereas, secondary data were collected from governmental and non-governmental organizations at different levels (kebeles, district and zonal), cooperatives, websites, published and unpublished reports and books.

The method of analyses that this study used include descriptive statistics and econometric models. For production efficiency and its sources of inefficiency one step stochastic frontier method of Cobb-Douglas functional form is used. To analyze factors affecting sesame post-harvest loss multiple linear regression is used. The performance of sesame market is also evaluated by using S-C-P approach.

The percentage of sesame grain post-harvest loss shared was during harvesting (16.41%, 13.5%), piles drying (50.44%, 51.5%), un-threshed left over (11.55%, 17.4%), piles transportation (9.9%, 7%), storage (6.73%, 4.62%), cleaning (3.2%, 1.8%) which contribute to the total loss of 23.7% and 24.6% of the total production for small and large-scale producers respectively. The loss encountered by assemblers, exporters and processor accounted to 1.14%, 0.83% and 20% of the bought amount respectively.

Likelihood ratio result of testing the existence of coefficients different from zero for inefficiency sources indicated that there was inefficiency as log likelihood is 104.78 and 92.67 for small and large-scale producers respectively. The gamma (γ) results equal to 91.5% and 94.4% for small and large-scale producers respectively indicated that the deviation was raised due to the inefficiency of production. The study obtained

that labor, sesame land size, amount of improved seed and amount of fertilizer are inputs which significantly and positively determine small-scale sesame production. Regarding the sesame production by large-scale producers only the amount of plough power was significantly and positively affect, but sesame land size and improved seed are negatively and significantly affected production. So, the production elasticity for small and large-scale producers was 1.5% and 0.93%, respectively.

According to this study, the average TE, AE and EE of small-scale sesame producer was 62% (18.25 to 91.03%), 84% (55 to 98%) and 53% (12 to 83%) respectively. Regarding the large-scale producers also the average TE, AE and EE was; 71% with the range of 26 to 96%, 90% with the range of 56.94 to 98.16% and 65% with the range of 22 to 93% respectively. Education level and amount of credit, farm distance, training and frequency of farm visit had significant relation to TE, AE and EE levels of small-scale sesame producers. Extension contact, cooperative membership had significant relation to TE and EE. Besides to the above, age had significantly related to AE, while experience had significant relation to TE. Regarding the sources of TE, AE and EE of large-scale producers this study found variables such as education level, frequency of farm visit, experience, credit, and road facilities had significant relation. But, variables such as sesame farm distance, home ownership, TLU and cooperative membership had significant relation in TE and EE.

In relation to sesame grain post-harvest loss, this study found farm size, total sesame grain produced, weather condition, distance piles transported, stacking days, distance of sesame farm and mode of grain transportation were variables which significantly and positively related with sesame post-harvest loss for small and large-scale producers ($P < 0.1$). But, educational level significantly and negatively affects sesame post-harvest loss from small and large-scale producers ($P < 0.05$). Besides, extension contact had significant and negative relation to sesame grain post-harvest loss from small-scale producers ($P < 0.05$). Also; credit, off-sesame farm income and road facilities are significantly and negatively affected sesame post-harvest loss from large scale producers ($P < 0.1$). But, threshing management, number of storage day are significantly and positively affected sesame post-harvest loss from large scale producers ($P < 0.1$).

The total production cost/ha of small and large-scale produces are birr 4743 and 6644 respectively; while the revenues/ha are birr 5062 and 4645 which leads to birr 319 net return/ha and birr 1999(-) net loss/ha and net return/Qt of birr 113 and net loss/Qt of birr 812.6(-) respectively. The reasons for the net loss of large-scale producers were the lower productivity and lower price. Sesame market assemblers obtained return of 172 birr/Qt and net return of 26 birr/Qt. Exporters also obtained the return of 420.35 birr/Qt and net return of 102.85 birr/Qt. Similarly, processor obtained the return of 1546 birr/Qt and net return of 594 birr/Qt.

Considering the raw fob price, the TGMM equals to 25.4% with the share of 7.36%, 18% and 74.6% for assemblers, exporters and producers respectively; while the NMM shared as 4.41%, 1.13% and 4.85% for exporters, assemblers and small-scale producers.

The major actors of sesame market in Kafta Humera district were producers, cooperatives, assemblers, processors and exporters. These were supported by input suppliers, commission agents and government organizations. Small and large-scale producers supplied 99.1% and 98% of their produce respectively. Local assemblers sold 80% and 20% for exporters and cooperatives respectively; while cooperatives sold 3.84% to exporters, 5.88% to Union, 61.53% to processor and 28.74% direct export. CR₄ of assemblers and exporters indicated that the top four assemblers and exporters is lower than 50% (38.7% and 46.54% respectively) which indicate as sesame market in the study district is weak oligopoly.

Based on the study results found, this study conclude that small-sale sesame production in Kafta Humera district are producing with increasing returns to scale combining the inputs of labor, land size, seed and fertilizer which significantly contribute to production. Whereas, large-scale producers are producing with decreasing returns to scale as land size and seed amount are significantly and negatively respond to production. It also conclude that, there is wider gap in achievements of TE and EE in both producer categories, while the gape in AE achievements is relatively narrow, indicating producers provide more attention to cost allocation at the expense of the best allocation of production inputs. This achievement of production efficiency generally is determined by the physical, institutional and demographic factors. Thus, regarding these production determinants the difference among sesame production operators leads to sesame production inefficiency.

Regarding sesame post-harvest loss, this study conclude that in both small and large-scale producers and middlemen more than one fourth of the total production was lost at the stages starting from harvesting until exported. Sesame grain quantity loss is determined by physical and natural, institutional and demographic factors.

Regarding sesame marketing, the results of S-C-P measure of sesame market chain this study concludes that sesame market deviates from the norms of competitive structure and poorly performs. This even though there are many assemblers and exporters that their individuals share of the traded sesame amount is lower; there are market barriers such as information asymmetry, government policies in licensing and capital that lead sesame market to deviate from competitive norms. There is also collusion and combination in price setting.

Further, traders are price makers not on the bases of negotiation. The profit margins obtained by actors also indicate that the market is poorly performing market that damage producers. It could be also concluded that the hulled sesame is best demanding at higher price as compared to raw sesame.

5.2. Recommendations

Regarding small-scale sesame producers; labor, seed, land size and fertilizer were the significant inputs of sesame production. So, small-scale producers' productivity could be improved as improved seed, soil improvement enhancing technologies and mechanized labor substituting technologies for sowing, harvesting and threshing are introduced. Education level, number of extension contact and credit amount were variables which positively determine overall efficiency. So, there will be more improvements in farm-level efficiency if improvement is based on institutional capacity building by strengthening education provision, strengthening extension service with practical guide at field and strengthening credit access.

This study also found that cooperative membership, training, farm distance and frequency of farm visit positively determining the overall inefficiency of small-scale sesame producers. The contribution of cooperative could be turn back to negative if membership also considers productivity enhancing issues. It will also be better, if producers live near farms to follow up and effectively manage their farm activities to reduce inefficiency.

Regarding large-scale producers, land size and seed are negatively contributed inputs of sesame production. So, large-scale producers may be better and optimal if labor substituting and cost minimizing technologies and fertility enhancing technologies are introduced to optimally use the available land resource. It may also be important to enforce to hire certified experts and check the implementation as per the regulation set, since most of the large-scale producers hired traditional operating managers. It was also found that, education level, experience, farm distance, frequency of farm visit, TLU, house ownership and road access were negatively related to the overall inefficiency of large-scale producers; while cooperative and credit were positively related to their overall inefficiency. Hence, for further improvement of the sesame production efficiency of large-scale producers, it may be better if concerned organizations focus in further strengthening of capacity of producers through education, facilitate for producers' access to experience sharing and consulting experienced ones to enter into the business. It is also important, if producers are initiated to live at farm and frequently visit and effectively manage their farm. These producers will also become more economically efficient, if government facilitates the availability of road infrastructure and creating initiatives regarding the economic wise livestock utilization. It may also be better if government facilitates formal credit access in

time, at affordable interest rate, so as to help producers not to borrow from informal money lenders which let them to lose their asset when they face production and marketing risks and contribute negatively to sesame production in their future.

Regarding sesame post-harvest loss in small and large-scale producers; days stacked, weather condition and distance of piles transported were variables with positive relation. So, to reduce the impact of these variables technologies for piles drying, piles transporting, reducing weather hazards impact and pest attack effects from harvesting until threshing that could reduce post-harvest loss by more than half is important to be introduced. Total output, farm distance and mode of transportation were positively contributing variables to sesame post-harvest loss for small and large-scale producers that may be due to poor management. So, this loss will be minimized as government and other stakeholders support and initiate producers to effectively manage and follow up their farm activities.

Education level significantly and negatively affected to post-harvest loss for small and large-scale producers. So, strengthening the capacity of producers through education may reduce sesame loss. It is also better to reduce the sesame post-harvest loss, if the extension service provided for small-scale producers is strengthen with practice at field level. In studying sesame post-harvest loss of large-scale producers, this study found that access to road, land size, credit and off-sesame farm income were variables significantly and negatively contributing to lose. These were indicating as nearby follow up and effective management could reduce sesame grain loss, so if government and other stakeholders initiate producers to frequently visit and effectively manage their farms, strengthen credit sources available and accessible to large-scale producers at in time and at affordable interest rate, sesame grain loss will be reduced. Number of days sesame grain stored and management in harvesting and threshing stages also indicated that effective management could reduce sesame grain loss.

Since market information is one of the factors affecting market efficiency, it is important to access market information through ECX board and related sources; otherwise the price fluctuation could not be observed and adjusted. It may also good if governmental and other stakeholders provide attention to plant hulling industries and fulfilling traceability conditions for the hulled seed to be supplied to the international market. Hiring of marketing experts to follow, evaluate and manage the market situation at each market center will also be important to overcome the collusion of traders in price setting, and to improve daily service provision of all market center assemblers; so as to improve market performance.

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7. APPENDICES

7.1. Appendices Tables

Appendix Table. 1. Small-scale sesame producers' efficiency levels in Kafta Humera district 2016

ID	TE	CE	AE	EE	ID	TE	CE	AE	EE	ID	TE	CE	AE	EE
1.00	0.65	1.08	0.93	0.60	44.00	0.71	1.02	0.98	0.70	86.00	0.76	1.20	0.83	0.64
2.00	0.45	1.24	0.80	0.36	45.00	0.43	1.17	0.85	0.36	87.00	0.70	1.39	0.72	0.50
3.00	0.17	1.41	0.71	0.12	46.00	0.67	1.04	0.96	0.64	88.00	0.46	1.20	0.83	0.38
4.00	0.74	1.25	0.80	0.59	47.00	0.74	1.09	0.92	0.68	89.00	0.69	1.01	0.99	0.68
5.00	0.43	1.24	0.81	0.35	48.00	0.53	1.05	0.95	0.50	90.00	0.53	1.02	0.98	0.52
6.00	0.73	1.24	0.81	0.59	49.00	0.55	1.03	0.97	0.53	91.00	0.77	1.04	0.96	0.75
7.00	0.77	1.25	0.80	0.61	50.00	0.64	1.09	0.91	0.58	92.00	0.75	1.42	0.70	0.53
8.00	0.82	1.03	0.97	0.80	51.00	0.24	1.09	0.92	0.22	93.00	0.84	1.10	0.91	0.76
9.00	0.40	1.33	0.75	0.30	52.00	0.53	1.05	0.95	0.50	94.00	0.80	1.03	0.97	0.78
10.00	0.62	1.03	0.97	0.60	53.00	0.39	1.31	0.76	0.30	95.00	0.83	1.03	0.97	0.81
11.00	0.70	1.03	0.97	0.68	54.00	0.29	1.17	0.86	0.25	96.00	0.61	1.28	0.78	0.48
12.00	0.35	1.17	0.85	0.30	55.00	0.59	1.08	0.93	0.54	97.00	0.85	1.20	0.83	0.71
13.00	0.44	1.10	0.91	0.40	56.00	0.45	1.05	0.95	0.42	98.00	0.60	1.10	0.91	0.55
14.00	0.75	1.06	0.95	0.71	57.00	0.56	1.05	0.96	0.54	99.00	0.64	1.21	0.82	0.53
15.00	0.57	1.25	0.80	0.46	58.00	0.68	1.06	0.95	0.65	100.00	0.74	1.14	0.88	0.65
16.00	0.62	1.17	0.86	0.53	59.00	0.26	1.09	0.92	0.24	101.00	0.53	1.10	0.91	0.48
17.00	0.45	1.83	0.55	0.25	60.00	0.55	1.02	0.98	0.54	102.00	0.73	1.32	0.76	0.55
18.00	0.30	1.66	0.60	0.18	61.00	0.77	1.23	0.81	0.63	103.00	0.91	1.13	0.88	0.80
19.00	0.85	1.02	0.98	0.83	62.00	0.49	1.19	0.84	0.41	104.00	0.72	1.36	0.73	0.53
20.00	0.27	1.45	0.69	0.19	63.00	0.63	1.19	0.84	0.53	105.00	0.83	1.19	0.84	0.69
21.00	0.29	1.24	0.81	0.24	64.00	0.53	1.23	0.81	0.43	106.00	0.83	1.17	0.86	0.71
22.00	0.48	1.11	0.90	0.43	65.00	0.77	1.12	0.90	0.69	107.00	0.80	1.18	0.85	0.68
23.00	0.29	1.49	0.67	0.20	66.00	0.35	1.13	0.88	0.31	108.00	0.78	1.64	0.61	0.48
24.00	0.60	1.11	0.90	0.54	67.00	0.20	1.49	0.67	0.13	109.00	0.67	1.11	0.90	0.60
25.00	0.84	1.07	0.93	0.78	68.00	0.50	1.26	0.79	0.39	110.00	0.62	1.14	0.88	0.54
26.00	0.55	1.20	0.83	0.46	69.00	0.65	1.26	0.79	0.52	111.00	0.74	1.30	0.77	0.57
27.00	0.52	1.05	0.96	0.50	70.00	0.71	1.38	0.73	0.51	112.00	0.91	1.11	0.90	0.82
28.00	0.29	1.12	0.89	0.26	71.00	0.77	1.20	0.83	0.65	113.00	0.72	1.34	0.74	0.53

ID	TE	CE	AE	EE	ID	TE	CE	AE	EE	ID	TE	CE	AE	EE
29.00	0.54	1.12	0.90	0.48	72.00	0.30	1.58	0.63	0.19	114.00	0.53	1.23	0.81	0.43
30.00	0.44	1.03	0.97	0.43	73.00	0.82	1.21	0.83	0.68	115.00	0.39	1.56	0.64	0.25
31.00	0.70	1.11	0.90	0.63	74.00	0.85	1.14	0.88	0.75	116.00	0.84	1.13	0.88	0.74
32.00	0.43	1.06	0.94	0.40	75.00	0.80	1.02	0.98	0.79	117.00	0.81	1.20	0.84	0.67
33.00	0.45	1.36	0.74	0.33	76.00	0.76	1.45	0.69	0.53	118.00	0.82	1.10	0.91	0.75
34.00	0.35	1.23	0.81	0.28	77.00	0.74	1.26	0.79	0.59	119.00	0.66	1.26	0.79	0.53
35.00	0.48	1.03	0.97	0.47	78.00	0.86	1.26	0.79	0.68	120.00	0.77	1.21	0.83	0.64
36.00	0.53	1.02	0.98	0.52	79.00	0.74	1.26	0.80	0.59	121.00	0.83	1.15	0.87	0.72
37.00	0.37	1.32	0.76	0.28	80.00	0.81	1.05	0.95	0.77	122.00	0.72	1.07	0.94	0.67
38.00	0.67	1.10	0.91	0.61	81.00	0.72	1.11	0.90	0.65	123.00	0.74	1.23	0.81	0.60
39.00	0.71	1.72	0.58	0.41	82.00	0.88	1.28	0.78	0.68	124.00	0.50	1.57	0.64	0.32
40.00	0.82	1.50	0.67	0.55	83.00	0.81	1.09	0.92	0.75	125.00	0.43	1.31	0.76	0.33
41.00	0.52	1.48	0.68	0.35	84.00	0.66	1.25	0.80	0.53	126.00	0.78	1.50	0.67	0.52
42.00	0.45	1.20	0.84	0.38	85.00	0.43	1.26	0.79	0.34	127.00	0.84	1.11	0.90	0.76
43.00	0.75	1.19	0.84	0.63						128.00	0.90	1.24	0.80	0.72

Source: Own calculation applying STATA, 13.0

Appendix Table 2. Large-scale sesame producers efficiency level in Kafta Humera district 2016

ID	TE	CE	AE	EE	ID	TE	CE	AE	EE	ID	TE	CE	AE	EE
1.00	0.96	1.03	0.97	0.93	43.00	0.44	1.05	0.95	0.42	85.00	0.84	1.03	0.97	0.81
2.00	0.96	1.04	0.96	0.92	44.00	0.67	1.12	0.89	0.59	86.00	0.83	1.03	0.97	0.81
3.00	0.26	1.06	0.94	0.24	45.00	0.86	1.10	0.91	0.78	87.00	0.35	1.19	0.84	0.29
4.00	0.87	1.13	0.89	0.77	46.00	0.88	1.02	0.98	0.86	88.00	0.77	1.06	0.94	0.73
5.00	0.32	1.02	0.98	0.31	47.00	0.68	1.15	0.87	0.59	89.00	0.82	1.03	0.97	0.80
6.00	0.41	1.19	0.84	0.34	48.00	0.72	1.11	0.90	0.65	90.00	0.53	1.14	0.88	0.47
7.00	0.51	1.03	0.97	0.49	49.00	0.56	1.22	0.82	0.46	91.00	0.66	1.29	0.78	0.51
8.00	0.90	1.06	0.95	0.85	50.00	0.78	1.14	0.88	0.68	92.00	0.42	1.37	0.73	0.31
9.00	0.66	1.02	0.98	0.65	51.00	0.76	1.08	0.93	0.70	93.00	0.63	1.03	0.97	0.61
10.00	0.50	1.21	0.83	0.41	52.00	0.76	1.13	0.89	0.67	94.00	0.53	1.06	0.94	0.50
11.00	0.85	1.20	0.84	0.71	53.00	0.75	1.13	0.89	0.66	95.00	0.92	1.09	0.92	0.84
12.00	0.88	1.08	0.93	0.81	54.00	0.87	1.16	0.87	0.75	96.00	0.59	1.03	0.97	0.57
13.00	0.89	1.05	0.96	0.85	55.00	0.86	1.06	0.94	0.81	97.00	0.48	1.09	0.91	0.44

ID	TE	CE	AE	EE	ID	TE	CE	AE	EE	ID	TE	CE	AE	EE
14.00	0.73	1.14	0.88	0.65	56.00	0.90	1.16	0.86	0.78	98.00	0.63	1.76	0.57	0.36
15.00	0.45	1.02	0.98	0.44	57.00	0.87	1.06	0.94	0.82	99.00	0.88	1.09	0.92	0.81
16.00	0.58	1.09	0.91	0.53	58.00	0.85	1.08	0.93	0.79	100.00	0.85	1.03	0.97	0.82
17.00	0.28	1.23	0.81	0.22	59.00	0.82	1.03	0.97	0.80	101.00	0.68	1.07	0.94	0.64
18.00	0.63	1.08	0.93	0.58	60.00	0.91	1.06	0.94	0.86	102.00	0.75	1.09	0.92	0.68
19.00	0.66	1.14	0.88	0.57	61.00	0.67	1.09	0.92	0.61	103.00	0.58	1.17	0.86	0.50
20.00	0.81	1.19	0.84	0.68	62.00	0.89	1.03	0.97	0.87	104.00	0.81	1.13	0.88	0.72
21.00	0.58	1.04	0.96	0.55	63.00	0.91	1.07	0.94	0.86	105.00	0.72	1.06	0.95	0.68
22.00	0.76	1.22	0.82	0.62	64.00	0.89	1.16	0.86	0.77	106.00	0.83	1.04	0.96	0.80
23.00	0.92	1.03	0.98	0.90	65.00	0.84	1.10	0.91	0.76	107.00	0.71	1.07	0.94	0.67
24.00	0.74	1.10	0.91	0.67	66.00	0.84	1.22	0.82	0.68	108.00	0.87	1.10	0.91	0.79
25.00	0.91	1.09	0.92	0.83	67.00	0.91	1.06	0.95	0.86	109.00	0.61	1.15	0.87	0.52
26.00	0.68	1.24	0.80	0.55	68.00	0.85	1.23	0.81	0.69	110.00	0.34	1.29	0.77	0.27
27.00	0.84	1.12	0.89	0.75	69.00	0.50	1.36	0.74	0.37	111.00	0.59	1.02	0.98	0.58
28.00	0.80	1.14	0.88	0.70	70.00	0.74	1.35	0.74	0.55	112.00	0.53	1.09	0.92	0.48
29.00	0.85	1.09	0.92	0.78	71.00	0.31	1.37	0.73	0.23	113.00	0.91	1.09	0.92	0.84
30.00	0.88	1.13	0.89	0.78	72.00	0.63	1.14	0.88	0.56	114.00	0.59	1.04	0.96	0.57
31.00	0.84	1.04	0.96	0.81	73.00	0.70	1.12	0.89	0.62	115.00	0.48	1.11	0.90	0.44
32.00	0.77	1.08	0.92	0.71	74.00	0.79	1.20	0.83	0.65	116.00	0.53	1.08	0.93	0.49
33.00	0.32	1.31	0.76	0.25	75.00	0.54	1.06	0.94	0.51	117.00	0.91	1.08	0.93	0.85
34.00	0.77	1.12	0.90	0.69	76.00	0.78	1.21	0.83	0.64	118.00	0.87	1.03	0.97	0.85
35.00	0.79	1.02	0.98	0.77	77.00	0.92	1.06	0.94	0.87	119.00	0.68	1.09	0.92	0.62
36.00	0.46	1.20	0.83	0.38	78.00	0.75	1.11	0.90	0.68	120.00	0.73	1.13	0.89	0.64
37.00	0.61	1.20	0.83	0.51	79.00	0.91	1.08	0.93	0.84	121.00	0.55	1.18	0.85	0.47
38.00	0.67	1.29	0.78	0.52	80.00	0.63	1.10	0.91	0.57	122.00	0.73	1.06	0.94	0.69
39.00	0.62	1.06	0.94	0.59	81.00	0.83	1.11	0.90	0.75	123.00	0.77	1.04	0.96	0.74
40.00	0.63	1.13	0.89	0.56	82.00	0.77	1.13	0.88	0.68	124.00	0.82	1.05	0.95	0.78
41.00	0.87	1.18	0.84	0.73	83.00	0.80	1.08	0.92	0.74	125.00	0.71	1.09	0.91	0.65
42.00	0.55	1.06	0.94	0.52	84.00	0.93	1.09	0.92	0.85	126.00	0.81	1.13	0.89	0.72

Source: own calculation applying STATA, 13.0

Appendix Table 3. VIF test results of sesame production and cost inefficiency function

cost inefficiency function				sesame production function			
Small-scale		Large-scale		Small-scale		Large-scale	
Variable	VIF	Variable	VIF	Variable	VIF	Variable	VIF
Ln Total product	7.03	Ln labor cost	7.47	Ln Land cost	7.32	Ln land size	8.06
Frequency visit	7.02	Ln Total product	7.58	No. Extension	5.59	Ln seed amount	7.53
No. Extension	6.88	Ln Land cost	7.04	Distance of farm	4.97	Ln fertilizer amount	5.43
Ln Plough cost	6.38	Ln Plough cost	6.71	Experience	4.91	Ln Plough cost	3.71
Ln Operation cost	6.19	Ln Seed cost	6.45	Ln labor cost	4.29	Ln off-sesame income	2.48
Distance of farm	6.01	Ln material cost	6.19	Ln seed amount	3.52	No. Extension	2.09
Experience	4.88	Ln Operation cost	4.03	Frequency visit	3.41	Age head	1.99
Ln labor cost	4.38	Ln fertilizer cost	2.92	Education level	2.74	Frequency visit	1.93
Ln seed cost	3.98	No. Extension	2.84	Ln Plough cost	2.57	Coop. membership	1.92
Education level	2.61	Ln off-sesame income	2.48	Age head	2.29	Own livestock	1.90
Age head	2.37	Own living home	2.44	Own livestock	1.69	Dependency ratio	1.90
Ln total loan	1.90	Age head	2.4	Own living home	1.68	Distance of farm	1.88
Number of training	1.82	Own livestock	2.29	Number of training	1.66	Number of training	1.76
Own living home	1.81	Ln total loan	2.25	Ln total loan	1.63	Education level	1.69
Own livestock	1.79	Frequency visit	2.21	lnTAmFertqt1	1.50	Own living home	1.68
Dependency ratio	1.68	Experience	2.08	Ln off-sesame income	1.47	Experience	1.67
Ln material cost	1.57	Coop. membership	2.07	Dependency ratio	1.47	Ln total loan	1.53
Ln off-sesame income	1.53	Dependency ratio	2.06	Type road farm	1.33	Type road farm	1.48
Ln fertilizer cost	1.51	Distance of farm	2.03	Coop. membership	1.23	Ln labor number	1.34
Type road farm	1.48	Type road farm	1.95				
Ln Land cost	1.30	Education level	1.92				
Coop. membership	1.27	Number of training	1.75				
Mean	3.43		3.59		2.9		2.73
B-Pagan $P(X^2 = 0.19) = 0.12$		$P(X^2 = 0.78) = 0.38$		$P(X^2 = 0.26) = 0.31$		$P(X^2 = 0.19) = 0.12$	
Adj R-squared	0.51	0.69		0.92		0.91	

Source: own calculation applying STATA, 13.0

Appendix Table 4. Sources of cost inefficiency of sesame producers

Variables	Small-scale			Large-scale		
	Coefficients	Std. Err	P> z	Coefficients	Std. Err	P> z
Age	-0.08*	0.045	0.091	0.018	0.033	0.596
Education level	-0.44**	0.2	0.024	-0.268***	0.07	0
Experience	-0.05	0.057	0.378	-0.0142	0.033	0.666
Coop. membership	0.505	0.8	0.534	1.15*	0.63	0.069
Dependency ratio	-0.057	0.32	0.857	0.11	0.13	0.399
Distance of sesame farm	0.111*	0.067	0.099	-0.018	0.02	0.31
Farm visit	0.123**	0.051	0.017	-0.025**	0.011	0.029
Ownership of livestock	-0.491	0.51	0.334	-1.31**	0.504	0.01
Training	0.46	0.233	0.048	0.061	0.189	0.748
Extension contact	-0.645**	0.271	0.017	0.144	0.10	0.152
Ln Total loan obtained	0.003*	0.0016	0.079	0.081	0.116	0.177
Ln Off sesame income	-0.003	0.0023	0.222	0.152***	0.044	0.001
Road type	0.295	0.192	0.125	0.482***	0.161	0.003
Ownership of house	0.0034	0.513	0.995	-1.53	1.14	0.18
Constant	-8.11**	3.31	0.014	-8.338***	2.32	0
LLR	142.24			150.47		

Source: Own survey data, 2016

Appendix Table 5. Conversion factor for tropical livestock unit (TLU)

Livestock category	Conversion factor
Ox	1.10
Cow	1.00
Heifer	0.50
Bull	0.60
Calves	0.20
Sheep	0.01
Goat	0.09
Donkey	0.50
Horse	0.80
Mule	0.70
poultry	0.01

Source: Storck *et al.* (1991)

7.2. Appendices of Figures



Appendix Figure 1. Harvesting activities and loss at harvesting stage



Appendix Figure 2. Drying and threshing activities and loss at drying and threshing stage



Appendix Figure 3. Focus group discussion



Appendix Figure 4. Transportation process and loss at transportation stage

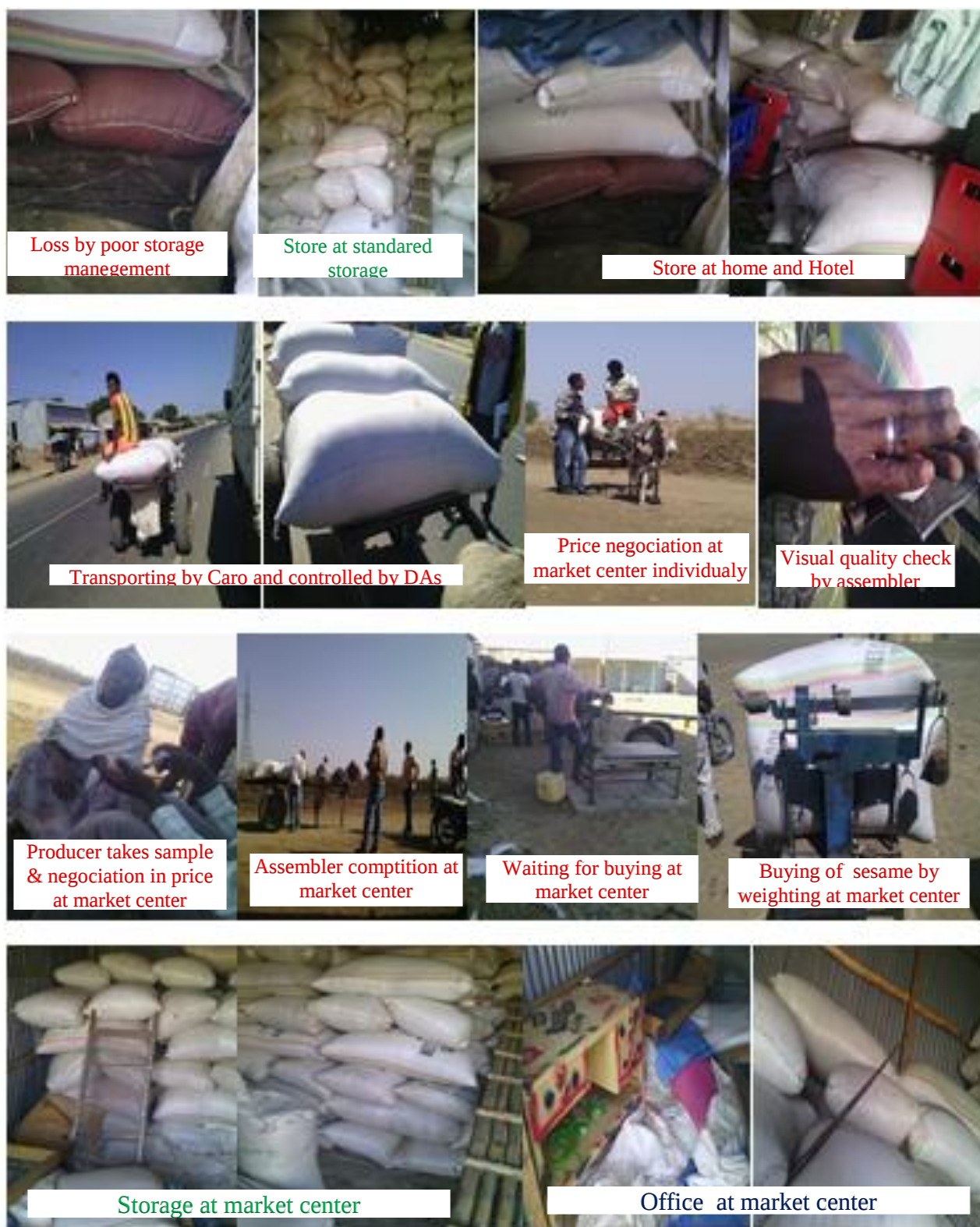




Appendix Figure 5. Re-Cleaning activities and loss at cleaning stage



Appendix Figure 6. Loading and packing activities



Appendix Figure 7. Buying and storage activities

7.3. Appendix Questionnaires

7.3.1. Appendix Questionnaires for sesame producers

Name of the enumerator: _____ **Questionnaire number:** ____ **Date of interview:** ____

A) Household Demographic Characteristics

1. Name of respondent _____ Phone number (if available) _____ Kebele ____ Got ____
2. Sex of household head: ____ 1=male 2=female
3. Religion _____ 1= for Orthodox 2 = Muslim 3= Others
4. Age of household head (in years) _____
5. Educational level of household head (in years of schooling)
 - 1). can't read and write 2). Can read and write 3) formal education grade _____
6. Marital status of household head 1. Married 2. Single 3. Divorced 4. Widowed
7. Experience of household head on sesame production (in years) _____.

B) Membership status in association/s

8. Had you/ (the household head) participate in any civil association/s? ____ 1) yes 0) no
9. What were the associations that the household head participated if your answer for # 8 is 1?
 - 1) Farmers association 2) Youth association 3) Edir 4) Women association 5) Cooperatives 6) other, specify _____
10. When was you become a member of the association/s and what was your position?

Association	Year of membership	No of family members participate in the association	Position of hhd	Remarks

11. What were the advantages you obtain from being member of the association in #10? ____
12. Had you obtain any additional knowledge because of being member of the explained association? ____
 - 1) yes 0) no

C) Family labor and their participation on sesame production

13. Number of total family members female = _____, male= _____, Total = _____
14. Did there any family members who are engaged in off sesame farm activities? 1) yes 0) no
15. If yes, how many of your family members are engaged in off sesame farming activities?

Male _____ female _____ total _____ members

16. Number of active and non-active household members

Contribution of family on sesame production	Sex	Age category (in Years)			Total engaged in On farm			Total engaged in Off farm		
		0-14	15-64	65 and above	Full time	part time		Full time	part time	
						Hrs /day	Day/ week		Hrs /day	Day/ week
Active family members	male									
	female									
Non-active family members	male									
	female									

Hint: Active refers to the members able to work on sesame farm activity

17. Did you face labour shortage in sesame production from family in 2015? ____ 1) yes 0) no

18. In which kind of sesame production activity was the family labor shortage you face? ____

1) Land preparation 2) Ploughing and sowing 3) Weeding and chemical spraying

4) Harvesting 5) Threshing and cleaning

D) Land holding

19. What was the total land holding size in 2015 by the household (including rented, shared; in & out)?

_____hr (when plough by tractor) or _____ ha

20. What was the total land size allocated for sesame production in 2015? _____hr _____ ha

Source of ownership	Size of land (ha)	Renting price (birr)		Area covered by the crop (ha)				Uncultivable	Fallow
		Per ha, tractor	Total	Sesame	Sorghum	pulses	Others		
Provided									
Rented in									
Rented out									
Shared in									
Shared out									
Total									

21. If you rented out land, why was that? _____

22. In how many sites was your sesame farm? _____

23. What was the average number of plots in each site? _____

24. What is the average distance among the sites? The nearest _____Km; and distant _____Km

E) Purposes of sesame production

25. What were the purposes of your sesame production? ____ 1) for selling 2) for consumption 3) for seed 4) others, specify _____

S. No	Purpose	Amount in Qt	% from total	Level* (standard)
1	For Selling			
2	For Consumption			
3	For Seed			
4	For processing			
Total				

* Level: 1 = 1st 2 = 2nd 3 = 3rd 4 = 4th 5 = UG

26. What were the bases for deciding the explained share from total on the sesame grain? _____

F) Improved seed application and Soil fertility status with its improvement

27. What was the fertility status of your sesame farm? ___ 1) low 2) good
28. Had you tried to improve the fertility of your sesame farm? _____ 1) yes 0) no
29. If your answer for #28 is 1, what was the mechanism that applied to improve soil fertility? ____
1) Application of inorganic fertilizer 2) application of organic fertilizer
30. If you did not applied fertilizer what were the reasons? _____ 1) Higher price/ too expensive 2) Soil is fertile 3) Not good to apply fertilizer in the area in the sesame farm 4) Unavailability of budget/loan to purchase fertilizer 5) Not timely available 6) Others specify _____
31. Do you use organic fertilizer on sesame field? ____ 0) no 1) yes
32. If the answer for # 31 is 1, what kind of organic fertilizer did you use? _____
1) Animal waste 2) Compost 3) Green manure
33. How many Qt/ha of the explained organic fertilizer had you applied? _____ Qt/ha
34. How much expenses had you spent to apply organic fertilizer (including transportation fee)? __ Birr
35. If you are not using organic fertilizer, why? ____ 1) Its bulky to transport 2) I don't have animals to prepare it 3) Lack of awareness 4) Others, specify _____
36. In how many years had you apply crop rotation with sesame? _____ years
37. With what crop had you rotate your sesame? _____
38. If you did not apply crop rotation on your sesame farm what was the reasons? _____
39. Do you practice fallowing? ____ 0) no 1) yes
40. After how many years of production had you leaved fallow the sesame land? _____ years
41. For how long had you fallowed your sesame land? _____ years
42. Status of application of sesame production inputs

Technologies applied		Recommended rate kg/ha	Amount applied (Kg/ha)	Paid Price per Qt (li)	Total applied (Kg) or (li)	Source	Transportation cost	Time of application	Total cost
Fertilizer	DAP								
	Urea								
Chemicals	1								
	2								

Hint: method of application = 1) Broadcasting 2) row 3) spraying 4) others

Source from = 1) Cooperatives 2) ARDO 3) Local Market 4) Research 5) NGOs 6) others, specify _____

Application Time = 1) in sowing only 2) in weeding 3) as germinated 4) half in sowing and half in weeding 5) others ____

43. If you used improved seed what was the varieties? 0) no 1) Setit 1 2) Humera 1 3) Others
44. What looks like the productivity of the explained improved seed varieties?

Variety		Method of application	Amount seed applied (Kg/ha)	Price per Kg	Total applied (Kg)	Source	Other expense	Total cost	Productivity (Qt/ha)
1. Setit 1									
Local	1								
	2								
	3								

Hint: Method of application = 1) Broadcasting 2) row; Source from = 1) Cooperatives 2) ARDO 3) Local Market 4) Research 5) NGOs 6) others, specify _____

45. If you did not use improved sesame seed what was the reasons? ____ 1) It was not better than the local available 2) It was not available at the time of sowing 3) Too expensive 4) It was drought 5) Others ____

G) Sesame Production activities costs and labor requirements

46. What was the average distance of sesame farm from home _____ hrs _____ Km
47. By what did you gone to your sesame farm from home? ____ 1) On foot 2) On our donkey/camel/ Caro 3) By public bus 4) By our tractor/ car 5) by contracting motor Bick 6) By paying for others` tractor 7) others _____
48. How many times had you gone to your sesame farm (frequency)? _____ times
49. How much expenditure had you spend for personal transportation to sesame farm from starting farm preparation to the end of harvesting and transporting _____ Birr
50. When did you start land preparation for sesame farm in 2015? In the _____ week of _____ month and it ends in the _____ week of _____ month
51. Do you think that the explained time of land preparation is appropriate period for sesame production? _____ 0) no 1) yes
52. If the answer for # 51 is 0, why you choose to do at the time explained in #51? ____ 1) Rain was late started 2) Laborers were unavailable before that time 3) Because of budget/money unavailability 4) Other, specify _____
53. How many times did you plough the sesame sown farm in 2015 before sowing? _____ times
54. Was your family labor enough for sesame land preparation activities? ____ 1) yes 0) no
55. What was the total hired man/day in sesame production land preparation in 2015 _____
56. How many expenses had you spent for land preparation? for laborers payment _____ birr and for oxen/tractor 1st plough _____ birr; 2nd plough _____ birr = total _____ birr
57. From where was fulfilled the labor for land preparation? from: _____

Source of laborer	laborer (No) man day	Per individual paid Rate (birr)	Food expenses		Other expenses	Total
			Grain	Cook		
Family labor*						
Hiring of daily laborers						
monthly laborers						
Contract provision						
Hiring permanent workers						
Total						

*Family labor payment is taken as permanent hired laborer so think to be as monthly salary

58. When had you start sesame sowing in 2015? In the _____ week of _____ month and; what about the end period of sowing? In the _____ week of _____ month
59. Do you think that the period explained in #58 is the appropriate time? ____ 0) no 1) yes
60. If your answer to # 59 is 0 what was the reasons that make you to sow at the explained time? ____ 1) Rain was late started 2) Laborers were unavailable before that time 3) The improved seed and fertilizer was unavailable before that time 4) Because of income unavailability 5) other, specify ____
61. By what had you sown your sesame? Using _____ 1) Man power 2) by machine
62. What was the mode of ploughing you used for sowing sesame in 2015? ____ 1) Using our oxen/ donkey/ camel 2) Using our tractor 3) Renting of oxen/donkey/camel 4) Renting of tractor 5) other specify ____

63. Which of the farm ploughing modes and tools had you own? _____

Name	Number	Current price (Birr/unit)	Total value (Birr)	Total Renting value (birr)	Total Repair/medical + food costs	Use or not (1= yes, 0= no	Remark
Oxen							
Donkey							
Camel							
Tractor							

64. If the answer for #62 is by renting, had you get on planned time period? ____ 1) yes 0) no

65. If the answer for #64 is 0, how many days it late relative to the planned day? ____ days

66. How much you had paid for renting to plough your sesame farm in 2015? _____ birr

67. What was the method of sesame sowing you applied in 2015? __1) Broadcasting 2) Row 3) both

Method of sowing	Sown area (ha)	Productivity (Qt/ha)
Broadcasting		
Row		
Total		

68. If you applied row sowing what advantages had you obtain? _____

69. If you applied broadcast only why it was preferred _____

70. What looks like the schedule of performing sesame production activities?

List of activities	2014			2015												Remark
	Oct	Dec	Nov	Janu	Febr	Mar	April	May	June	July	Aug	Sept	Octo	Dec	Nov	
Land clearing																
1 st plough																
2 nd plough																
Sowing																
1 st weeding																
2 nd weeding																
3 rd weeding																
Chem. spray																
Harvesting																
Threshing																
Storing																
Sale																

71. Did you get enough laborers from family to perform sesame sowing (both seed and fertilizer) on planned time? _____ 0) no 1) yes

72. If your answer for # 71 is 0, from where was fulfilled? _____

Source of laborer	Laborer (No) man/ days	Per individual paid Rate (birr)	Food expenses (total)		Other total expenses	Total
			Grain	Cook items		
Family labour						
Hiring of daily laborers						
Hiring of monthly laborers						
Hiring permanent workers						
Providing of contract						
Others, specify						
Total						

*Family labor payment is taken as permanent hired laborer so think to be as monthly salary

73. For how many days had you find laborers who were unfulfilled from family? _____ days
 74. How many labors was remaining/lag yet not obtained in sowing to the end? _____
 75. If you spent to obtain the laborers for sowing how much was that expenditure? _____ Birr
 76. How many times had you removed weeds of sesame in 2015 (frequency)? _____ times
 77. Was your family labor enough for weeding your sesame farm? ____ 0) no 1) yes
 78. If your answer to #77 is 0, in which stage of weeding is family labor not enough? _____

Stage of weeding	Required labor	family labor	Source of covering	No hired labor	Payment /PD	Total paid. Birr	Food expenses		Other expenses	Total expenses
							Grain	Cook		
1 st weed										
2 nd weed										
3 rd weed										
4 th weed										
Sub-total										
Chemical spraying										
1 st										
2 nd										
Sub total										

Hint: Source of covering = 1) Hiring of daily laborers 2) Hiring of monthly laborers 3) Contract provision 4) Leave it from working 5) Others, specify _____

79. In your sesame farm had you seen pests and diseases of sesame? ____ 1) yes 0) no
 80. If your answer to #79 is 1, how you had control it? ____ 1) by chemical application 2) Traditional way 3) By the application of both methods
 81. To control these pests and diseases how much expenses had you spent? _____ birr (payment for the chemical ____ birr + expenses spent for transportation of personal and the chemical ____ birr)
 82. How many days had you required to mature the sesame variety you had sown? _____ days
 83. When did you harvest your sesame? Earliest; In the _____ week of the _____ month; and the late period; In the _____ week of the _____ month
 84. Do you believe that the harvesting time was at its exact period? ____ 1) yes 0) no
 85. If your answer for #84 is 0, is that late or earlier? ____ 1) earlier 2) late
 86. What were the reasons if your answer for # 85 is 1? ____ 1) rain was early stop/ crop burned 2) due to fear of labor absence/unavailability 3) fear of loss by animals 4) fear of pests and diseases 5) to sale early for paying loan 6) others _____
 87. What were the reasons if your answer for # 85 is 2? ____ 1) shortage of laborers 2) not yet seen as matured 3) others _____
 88. In how many days you finish harvesting of matured sesame? _____ days
 89. If you harvest by man power had you get enough power from family labor to harvest in the planned time in 2015? ____ 0) no 1) yes
 90. If your answer for #89 is 0, how many workers were remained? _____ laborers
 91. What were the bases for the payment of laborers in harvesting? ____ 1) piles 2) daily wage
 92. From where was obtained the remained labor force to harvest the matured sesame? _____

Source of laborer at harvesting	Laborer (No)	Total No. piles obtained	Per piles paid Rate (birr)	Total Food expenses		Other total expenses	Total expenses
				Grain	Cook		
Family labor							
Hiring of daily laborers							
monthly laborers							
permanent workers							
By contract laborers							
Total							

*Family labor payment is taken as permanent hired laborer so think to be as monthly salary

93. What was the total sesame production and revenue you obtained in 2015? _____

Crop	Total No. piles obtained	Aver productivity (Qt/ha)	Total obtained production (Qt)	Amount home consumed	Selling price per Qt	Total Loss at diff.t stages	Sack expenses
sesame							

H) Post- harvest Losses of sesame at different stages

94. By which factors was sesame post-harvest loss occurred in your farm during harvesting time? ____ 1) Pests infestation 2) grain dropped from pod 3) Animals consume 4) Wind pushes down to drop 5) Theft 6) Others explain _____
95. By the factors explained in #94 what could be the amount of sesame grain loss during harvesting time? ____ Kg /piles, so that ____ Kg in ha; that leads to a total loss of ____ Kg
96. After harvesting for how many days was the harvested sesame stay in stack (*piles*)? ____ days
97. What were the factors that lead sesame grain to drop/loss in *piles*? ____ 1) Wind to push down grain to drop 2) Animals consume and push the stack 3) Insects and Pests infestation 4) Fire 5) Theft 6) Others please explain _____
98. By the factors explained in #97, how much sesame grain could loss? ____ Kg /piles, so that ____ Kg in hectare; that leads to overall /total loss of ____ Kg
99. During threshing on average for how much meters distance was carry the *piles*? ____ meters
100. On average during *piles* travelling how much of sesame grain could loss? ____ Kg/ *piles*, so that ____ Kg in ha; that leads to a total loss of ____ Kg
101. During threshing which materials had you use to thresh on it? _____
102. How much sesame grain could loss in threshing resulted from lack of good threshing material? ____ /piles. ____ /Qt, so that ____ Kg in hectare
103. Was there any amount of sesame grain remains unthreshed? ____ 0) no 1) yes
104. What amount of sesame grain was remained unthreshed in 2015? ____ Kg/piles, so that ____ Kg in ha; that leads to a total loss of ____ Kg
105. What were the reasons that make not to be unthreshed? _____
106. What material had you use for cleaning threshed sesame? _____
107. What amount of sesame grain loss had you face during cleaning time? ____ Kg/Qt; that leads to a total loss of ____ Kg
108. What could be the average distance from your farm to storage? ____ hr ____ Km.
109. By what mode of transportation was the cleaned sesame grain transported from farm to storage? 1) Caro 2) camel/ donkey 3) man power carry 4) tractor 5) Track 6) other, specify ____
110. Had you paid for the transportation that you explain in #109? ____ 0) no 1) yes
111. If your answer for #110 is 1, how much you have paid for transportation from farm to store? ____ birr/Qt that lead to the total of ____ birr

112. What is the level of road your sesame grain transported from farm to store? _____
 1) Persons/animals road 2) Pista road/Standard road (normal)
113. During transport from farm _ store how much grain could loss? ___Kg/Qt = total ___Kg
114. What was the quality of the packaging sack of sesame grain you purchase? _____ 1) easily tear
 2) medium quality 3) good quality
115. How much grain had lost because of not good quality sack? _____ Kg/Qt totally _____Kg

I) Ownership of home, store at farm and living locality with its related costs

116. Do you have your own living classes (*cambo*) in sesame production site? ____ 0) no 1) yes
117. If your answer for # 116, is 1, then fill the following table

Type	No	Initial cost per single	Current value for single	Repair cost per single	Total costs	Other costs	Remark (1= iron corrugate, 2= hut)
Home of workers							
Prod. Tools store							
Grain & fertilizer store							

118. Do you and your family live in your own classes in your home? _____ 1) yes 0) no
119. If your answer for # 118 is 1, please fill the following table

Type	No	Initial cost per single	Current value for single	Repair cost per single	Total cost	Other costs	Remark (1= iron corrugate, 2= hut)
Classes for family							
Prod. Tools store							
Grain & fertilizer store							
Rented classes							

120. If you do not have your own store where had you stored your sesame? 0) in our living home 1) in rented store 2) in MPP. Cooperative 3) in friends store for free 4) directly soled 5) others
121. How did you have protected the quality of the store? _____
122. How much sesame grain could lose in storage? ___Kg/Qt; that leads to a total loss of ___Kg
123. What were the reasons that make the grain to lose during storage? _____
124. For how many weeks was your sesame stored in 2015? _____ Weeks
125. If you paid for storage renting and related, how much was that payment? _____ Birr

Type of expense	Unit	Quantity	Unit price	Other costs	Total expenses	Remarks

J) Selling decision, buyers, time with its related costs and market information

126. When had you sale your sesame produced in 2015? ____ 1) As it was in the farm 2) Directly after harvest 3) After 1month 4) After 3 months
127. Where had you sold your sesame grain in 2015? _____ 1) At the farm 2) At local market 3) At woreda/district market 4) At zonal market
128. What could be the distance from your farm to storage on average? _____ hr or _____Km.

129. By what mode of transportation had you take your sesame from store to market? ____1) By donkey/camel/Caro 2) By man power carry 3) By tractor 4) By track 5) Other, specify ____
130. Had you paid for the transportation that you explain in #129? ____ 0) no 1) yes
131. If your answer for #130 is 1, how much you have paid for transportation of sesame grain from store to market? _____birr/Qt, so that total _____ birr
132. What was the level of the road your sesame grain transported from store to market? ____ 1) Persons /animals road 2) Pista road / Standard road (asphalt)
133. During transportation of sesame grain from store to market how much sesame grain could lost? _____Kg/Qt; that leads to a total loss of ____ Kg
134. What were the reasons for the loss during transportation from store to market? _____
135. For whom have you sold your sesame grain in 2015? ____0) to Traders at local market 1) to MPP Cooperatives 2) to Investors 3) to ECX 4) to Other similar farmers 5) to Union / Federation 6) to others, specify _____
136. How you could meet these explained buyers of your sesame? By ____1) Ourselves 2) Middle men 3) Buyers themselves 4) Governmental organizations 5) Others, specify _____
137. If you sold for more than one, please fill the following tale

buyers	Supplied amount		Soled amount (Qt)	Selling Price /Qt	transportatio n expenses	Amount of grain loss (Kg)	Sample taken (Kg)	Other expenses
	(Qt)	%						
Traders at local market								
MPP Cooperatives								
Investors								
Other similar farmers								

NB: sold amount is the amount for which you receive return from selling

138. How did you get those explained buyers of your sesame? ____ 1) by going to market center 2) by negotiating as it was in the farm 3) thought friends/ relatives 4) by brokers 5) others _____
139. How much you have paid to the service provided to get the explained buyers? _____ Birr
140. How many days had you spent for finding to get the explained buyers? _____ days
141. From where had you obtain the market information? ____ 1) From neighborhoods 2) By ourselves search the market 3) From radio and television 4) from buyers 5) from governmental organizations 6) Others, specify them _____
142. How much did you spent to get the market information? _____ Birr
143. Who was deciding on the selling price of your sesame? ____1) ECX 2) Buyers 3) Producers 4) Middlemen 5) Government
144. Do you think that the selling price was fair to the production of sesame? ____ 0) no 1) yes
145. In how many batches had you sale your sesame in 2015? _____

No batches	Selling month	Sold amount		Selling price birr/Qt	Return obtained	Buyers
		No of sacks	Amount Kg			
1 st						
2 nd						
3 rd						
4 th						
Total						

K. Value addition on sesame grain

146. Did you make value addition activities for your sesame before selling? ____ 0) no 1) yes

147. If your answer for # 128 is 1, what were the activities, advantages and expenses that you incurred from value addition that you done?

Value addition activities	Advantage of the value addition	Grain loss resulted (Kg)	Expense (birr)	Corrected losses (birr)	Net-Profit from value addition (birr)

L. Livestock resources and income obtained

148. Did you have income obtained from selling of livestock and their products? __ 1) yes 0) no

149. For what purpose had you use the income obtained from livestock? ____ 1) for buying food 2) for crop/ sesame production 3) for health expenses 4) for educational expenses 5) other expenses, specify _____

150. How much income had you obtain from selling of livestock products? _____ Birr

151. What types of livestock had you own and sold in 2015? _____

Herd type	Breed type	Number	Unit price (birr)	Total value (birr)
Oxen				
Cow				
Heifer				
Bull				
Calve				
Sheep				
goats				
Donkey				
Camel				
Poultry				
Total				

Hint: if oxen, Donkey and /or Camel was used for ploughing power these should be deducted

M. Services (extension contact and training)

152. Did you have extension contact from DA? ____ 1) yes 0) no

153. How often did you visit the extension workers/DA? ____ 1) Weekly 2) Monthly 3) Not regularly 4) Others, specify _____

154. How often did the extension workers/DA visit your field? ____ 1) Weekly 2) Monthly 3) Not regularly 4) Others, specify _____

155. Had the extension workers/DA have knowledge and skill that fill/solve your sesame production technical gaps/ problem? ____ 0) no 1) yes

156. If your answer for #141 is 1, what could be the extent? ____ 0) very high 1) high 3) medium 4) low 5) very low

157. Was there any expense you faced for contacting the extension worker? ____ 1)yes 0) no

158. If your answer for # 143 is 1, what was that amount of expense? _____ birr
159. For what activities had the expenses in #144 spent? _____
160. Did you have contact with the woreda agricultural experts? _____ 1) yes 0) no
161. How often did the woreda agricultural experts visit your field? _____ 1) Weekly 2) Monthly
3) Not regularly 4) Others, specify _____
162. Was there any expense for contacting woreda agricultural experts? _____ 1)yes 0) no
163. If your answer for # 148 is 1, what was that amount of expense? _____ birr
164. How many times you obtained training on sesame production? _____ times
165. By whom was that training given? _____
166. Had the training provided based on identifying technical gap you have on sesame production? _____
1) yes 0) no
167. How you evaluate the performance of the training you obtained? _____ 0) Very weak 1) Weak
3) Medium 4) Good 5) very good
168. How much expenses had you face to take that training? _____ Birr

N. Production costs

169. In production of sesame how much had you spent for laborers in threshing?

Activity	Number	Family labour	Payment per individual per (Qt)	Payment for total (birr)	Food expenses (total)		Other expenses (birr)	Total (birr)
					Grain	Cook		
Threshing								

170. How many permanent workers had you employed and what was their job? _____

Job description	Number hired	salary(monthly)		Food expenses		Other incentives	Total	Remark Working months
		Cash	Kind	Grain	Cook			
Manager								
Secretary								
driver								
Herder								
Guarding								
Food worker								
Technical experts								
Total								

171. How you could evaluate the performance of these permanent workers in comparison to the daily/ contract workers? _____ 0) very weak 1) weak 2) equal 3) high 4) very high
172. What types of expenses had you face by the ploughing mode you own in 2015? _____ 1) for herding 2) expenses for repairing of tractors and its accessories 3) for medical care for oxen/donkey/camel 4) for purchasing of agricultural materials 5)others _____

173. What was the amount of expense that you incurred for each of the explained in #153? ____

Type of expense	Unit	Unit price (birr)	Total paid (birr)	Other expenses birr	Purchase year (G.C)	Purchase Price birr	Current price birr	remark
Herding								
Repair /maintenance								
Medical service								
Fuel and lubricants								
Agricultural materials used at farm								
Total								

174. How many sack had you bought for packaging sesame? ____ sacks price per single ____ birr

175. What was the total expenditure that you spent for sack purchasing? _____ Birr

176. How many ropes had you use for packaging in 2015? ____; what was the single rope price? __ birr

O. Income, saving and Credit service

177. How much had you planned to spend for sesame production in 2015? ____ birr; from own ____ birr

178. Was that amount of money fulfilled from your own source of finance? _____ 0) no 1) yes

179. If your answer for #159 is 0, from where had you fulfill the uncovered income for sesame production? _____ 1) From loan 2) no, did not need to cover

180. If the answer for #160 is 1, from which financial source organizations had you get?

Source of loan	Required amount (Birr)	Allowed/received amount (Birr)	Interest (%)	Purpose (*)	Age (years)	Length to get allowed loan (days)
Banks						
Development Bank						
MFIs (Dedebit)						
MPP. Cooperatives						
Buyers						
IMLs						
Parents/Friends						
NGOs						
Others						

Hint: *= 1) For primary basic needs 2) For Medicine 3) For Schooling 4) For input purchase 5) Investment /Agriculture 6) To pay back other loans 7) Other, specify _____

181. Who were the informal sources of credit providers? _____ 1) traders 2) investors 3) other similar farmers 4) relatives/friends 5) others specify _____

182. Had you obtain the allowed amount of credit on the required time? _____ 0) no 1) yes

183. Which time frame is foreseen for the credit repayment? _____ months

184. How would you describe your annual income? _____ it was 1) Low 2) Medium 3) High

185. Do you had saving habit in the past years? _____ 1) Yes 0) No

186. How much do you save per year (in 2015)? _____ Birr.

187. Where did you save? _ 1) at Home 2) Commercial banks 3) Micro finance organizations 4) Other ____

188. How much is the interest rate you obtained? _____ %

189. Who was responsible for collecting fire wood? ____ 1) Use bought fire wood only 2) Male at working age 3) Female at working age 4) Children 5) All family members 6) Other, ____
190. How much you spent for obtaining the fire wood? _____ Birr
191. What were the main sources of off farm income?

S/N	Source of off farm income	Number of people engaged	Number of days worked in month	Income per working day income	Total annual income from off farm
1	Wage				
2	Selling local drink				
3	Petty trading				
4	Selling fire wood				
5	Handicraft				
6	Herding				
7	Renting out tractor				
8	Selling livestock				
9	Remittance				
10	Renting of classes				
11	Others				
Total					

192. Who was responsible for fetching water? ____ 1) Use water fetched by workers only 2) by Male at working age 3) by Female at working age 4) by Children 5) All family members 6) Other, specify _____
193. How much you spent for fetching water? _____ Birr
194. How many people in your family had an illness last year? ____ By Which diseases? ____
195. Where did you cure? ____ 1) At hospital 2) In village infirmary 3) By traditional medicine 4) offerings and worship at home
196. How many days were lost in your family by illness last year? _____
197. How much did you spent to cure (including doctor cost and medicine and other related costs) last year? In _____ birr
198. How often do you or members of your family gone to a health center? _____ Times/year

Thank you for your understanding the Questionnaire and provision of truth data*****

Understanding of the interviewer about sesame in the area _____

Observation of the interviewer _____

Thank you all

7.3.2. Appendix Questionnaires for Sesame Traders

Name of the enumerator: _____ **Questionnaire number:** ____ **Date of interview:** ____

A. Trader Demographic Characteristics

138. Name of respondent _____ Phone number (if available) _____ market center _____
139. Sex of household head: _____ 0=male 1=female
140. Religion _____ 1= for Orthodox 2 = Muslim 3= Others
141. Age of household head (in years) _____
142. Educational level of household head (in years of schooling) _____
143. Marital status of household head 1. Married 2. Single 3. Divorced 4. Widowed
144. Experience of household head on general trading (in years) _____.
145. Experience of household head on sesame trading (in years) _____.

B. Family labor and their participation on sesame trade

146. Number of total family members female = _____, male= _____, Total = _____
147. Number of active and non-active household members in sesame trading: _____

Contribution of family on sesame production	Sex	Age category (in Years)			Number Participated on trade
		0-14	15-64	65 and above	
Number of active family members	male				
	female				
Number of non-active family members	male				
	female				

C. Licensing status of the trader

148. Had you licensed for sesame trading? _____ 0) yes 1) no
149. If your answer for # 11 is 0, when had you get the license? In the _____ month of _____ EC
150. What were the criteria that the license providers use to allow or not for licensing the sesame trade?

151. How much expenses had you spent to obtain the license? _____ birr
152. In how many days had you obtained the license (date of application to handled)? _____ days
153. After once you had obtained the license, how much tax had you paid each year? _____ birr or
_____ % also _____ birr for license re-new
154. Did the licensing have pre-requisites for the payment explained in #16? _____ 0) no 1) yes
155. If your answer for # 17 is 1, what were the pre-requisites for the payment? _____ But, if you are
not licensed how you buy and sale sesame? _____

D. Membership in association/s

156. Had you/ your family participate in any civil association/s? _____ 1) yes 2) no

157. If your answer for #20 is 1, what were the associations participated? ____ 1) traders association 2) Farmers association 3) Youth association 4) Women association 5) Cooperatives 6) Edir/Equib 7) other, specify _____

158. When was you become a member and what was your position?

No	Association	Number of Years of membership	No of family members in the association	Position	Remarks
1					
2					
3					

159. What were the advantages you obtain from being member of the association in #21? _____

160. Had you obtain any additional knowledge because of being member of the explained association? _____ 1) yes 2) no

E. Purposes of sesame bought

161. Did you bought sesame for other purposes other than trade? ____ 0) no 1) yes

Purposes of sesame bought	Amount bought (Qt)	bought Price per Qt (birr)	Total paid (birr)	Transportation cost	Sesame Bought market (name)	% from total
Trade						
Consumption						
Oil extraction						

162. If your answer for # 25 is 1, for what purposes had you bought sesame and what was its price? _____

163. What as the criteria for differentiating the sesame for trade from the other purposes?

F. Sellers of sesame (suppliers of sesame for trade)

164. From whom did you buy sesame? ____ 1) From small scale producers 2) from cooperatives 3) from investor producers 4) others _____

Sesame seller	Amount bought (Qt)	buying Price (birr/Qt) Ave	Total cost birr	Decided the price	% from total bought	Bought month	Standard	Transportation cost
Small scale								
Cooperatives								
Investors								
Small traders								
Exporters								
Others								

Hint: Standard= 1st, 2nd, 3rd, 4th, UG

Who decides the buying price = 1) sellers themselves 2) buyers ourselves 3) ECX 4) governmental organizations 5) others, specify here _____

165. Why did you prefer to buy from the explained suppliers of sesame grain? Because of _____ 1) no other supplier 2) by further negotiation 3) the service it provided 4) the price 5) Quality 6) others, specify _____
166. How did you get the sellers/producers of sesame? ____ 1) sellers come by themselves 2) ourselves go and find the sellers 3) governmental organizations 4) NGOs 5) brokers 6) others, specify _____
167. How much you paid for the negotiators explained in #30? _____ birr total, or _____ birr/ Qt; for the total _____ Qt sold
168. What were the bases for deciding the buying price in #28 paid by the traders? _____
169. Was the price decided in #28 fair or not from the trader's view? ____ 1) not 2) yes
170. If your answer for # 33 is 1, what makes it not fair price? _____

G. Sesame bought market, type of road and means of transportation

171. Where had you buy your sesame grain? ____ 1) in the local sesame market centers 2) at MPP. cooperative market 3) in the production farm 4) others specify _____
172. What was the average distance from the market you bought sesame to your store? _____ Km
173. How much had you paid for total personal transportation to buy sesame grain? _____ birr
174. By what mode of transportation had you transport the sesame grain from the market you bought to store? ____ 1) sellers themselves bring to store 2) by man power 3) by Caro/ donkey/camel 4) by track 5) by tractor 6) others specify _____
175. What was the source of ownership for the transportation mode you explained in # 38? ____ 1) rented 2) ours 3) relatives/friends 4) others, specify _____
176. Had you obtain the transportation mode explained in #39 at planned time? ____ 1) yes 2) no
177. How much had you paid for transporting sesame from the market you bought to your store? _____ birr/Qt for the total of _____ Qt you transported
178. What was the level of road the sesame grain transported from the market to your store (longer distance)? ____ 1) Persons/animals road 2) Pista road/Standard road (normal)

H. Storage Ownership and expenses r related to storing

179. Do you /your family live in your own classes? _____ 0) yes 1) no
180. Do you have your own store? ____ 1) yes 2) no;
181. If your answer for # 44 is 1, what is its storing capacity (in Qt) _____
182. If you had your own store and/or home fill the following table

Type	No	Average Initial cost / single	Current value for single	Repair cost /single	Total cost	Storing capacity	Other costs	Remark (1= build by stone or cement, 2= build by iron corrugate)
Family classes								
Grain storage								

183. If you do not have your own store where had you stored your sesame? ____0) in our living home
1) in rented store 2) in MPP. Cooperative 3) in friends/relatives store for free 4) no need,
directly soled 5) others specify _____
184. If you store in rented storage how much had you paid per month? _____ birr per Qt per month;
for _____ month; for a total of _____ Qt
185. For how many weeks/months was your sesame stored not sold in 2015? For _____ days.
186. What types of management/handling activities had you perform during storage period of sesame
you bought for trade? ____ 1) spraying pesticides 2) fumigating only 3) curing sanitary of the
store 4) others, specify _____
187. If you paid for storage renting and related, how much was that payment? _____ Birr

Type of expense	Quantity	Unit price	Other costs	Total expenses	No months	Remark
Renting store						
Sanitarian tools						
Fumigating chemicals						
Fumigating materials						
Keeping materials						
Others						
Total						

I. Employment of workers

188. Had you employ workers in your sesame trading activities? ____ 1) yes 2) no
189. If your answer for # 53 is 1, what was the employing status? ____ 1) permanent 2) temporarily
3) daily 4) others, specify _____
190. If your trading activity was done by the hired workers in how many days had you visit the market?
____ 1) daily 2) 4 days a week 3) 2 days a week 4)once a week 5) not regular
191. If your storage management was done by the hired workers in how many days had you visit the
store? ____ 1) daily 2) 4 days a week 3) 2 days a week 4)once a week 5) not regular
192. How many permanent workers had you employed and what was their job in 2015? ____

Job description	Number hired	salary(monthly)		Food expenses monthly		Other incentives	Total	Remark Working months
		Cash	Kind	Grain	Cook			
Manager								
Store expert								
Secretary								
driver								
Accountant								
Guarding								
Food worker								
Sanitarian								
Marketing expert								
Total								

J. Value addition activities and Standardization with related sesame grain losses

193. Did you make value addition activities on the sesame bought for trade? ____ 1) yes 2) no

194. If your answer for # 57 is 1, what were these value addition activities? ____ 1) cleaning 2) changing sack only 3) others, specify _____

V. Add activities	Total Qt	Frequency of V. Add	Load /Unload cost total	V. Add cost/Qt	Total Sack cost (changed)	Loss V. Add /Qt (Kg)
Cleaning						
Sack change						

Hint: v. Add = value addition, Qt= quintal

195. How many labor had you use to achieve the value added activities? _____ man day

196. Was your family labor enough to make the value addition activities? ____ 0) no 1) yes

197. If your answer for # 60 is 0, from where had you fulfill the remaining labor? _____

Source of laborer	laborer (No) man day	Per individual paid Rate (birr)	Food expenses		Other expenses	Total
			Grain	Cook		
Family labour						
Hiring of daily laborers						
Hiring of monthly laborers						
Contract provision						

198. Had you obtain the laborers at the required time period? ____ 1) yes 2) no

199. If your answer for # 62 is 2, how many days had you stay to get the laborers? _____ days

200. How many birr had you spent to get the laborers explained in # 63 (for searching only)? ____ birr

201. By the value addition activities you done, what were really improved? _____

202. By how many was the selling price of sesame grain increased after the value addition (outcome of value addition)? By _____ birr / Qt; that lead to the total of _____ birr

203. While buying sesame grain, had you use any standardization criteria? ____ 1) yes 2) no

204. If your answer for # 67 is 1, what were the standardization criteria? _____

205. Is the buying price based on the standard you observed? ____ 1) yes 2) no

206. What were the standard estimation tools you use while buying? _____

207. While you sale, had you based on the standardization for the price setting? ____ 1) yes 2) no

208. If your answer for # 71 is 1, who makes that standardization activity? ____ 1) ECX 2) traders ourselves 3) buyers themselves 4) NGOs and GOs 5) others _____

209. What tools had the standard estimator/s use for leveling the standard of the sesame grain? ____

210. How did you evaluate the standardization for its reality/ truthfulness? 1) not fair 2) truth

211. If your answer for # 75 is 1, what makes it not truth? _____

212. How much had you paid for the service you obtain in standardization of your sesame? _____ birr/Qt ____ % from total; that contributes _____ birr totally for the total bought

213. For facilitation activities how much birr had you paid for the standardization workers in 2015? _____ birr

214. What case could achieve (what were improved) because of providing the facilitation payments explained in #77? _____
215. By the cases improve/ explained in # 78, how much could you benefited? _____ in birr and / or _____ Kg in sesame grain total (Due to grade _____ birr; no re- cleaning _____ birr and _____ Kg not lost sack unchanged _____ birr ; load/unload _____ birr)
216. By the activities practiced in standardization how much sesame grain had lost? _____ Kg/Qt; so that _____ kg for the total of _____ Qt sold
217. If your standardization activity were done by the ECX, how much sesame grain was taken for the laboratory for sample? _____ Kg/Qt ; for _____ total Qt sold
218. If there were other expenses other than the explained in # 77, what were these expenses in birr? _____ Kg/Qt or _____ birr/Qt for the total of _____ Qt sold
219. For how many maximum months was permitted to stay in the store of ECX for standardization process (no punishment)? _____ days
220. Had you r sesame stays more than the allowed time in ECX storage in 2015? 1) yes 2) no
221. How much was the punishment you paid in 2015? _____ birr/Qt, for the total amount of _____ Qt for _____ months; so for the total punishment of _____ birr

K. Sesame grain loss at different trading stages (from buying to exporting)

222. Was there any sesame grain loss you faced during sesame trading? _____ 1) yes 2) no
223. If your answer for # 86 is 1, in what stages of trading had you face the losses? _____ 1) at storage 2) at value addition 3) at transportation to storage 4) at transportation to market 5) at standardization 6) others _____
224. What could be the amount of sesame grain loss during transportation from the market you bought to your store? _____ Kg/Qt that leads to the total of _____ Kg from total bought
225. What could you think about the factors that makes the sesame grain to loss during transportation? _____
226. If there was loss during storage, what were the factors for the loss? _____ 1) pests 2) theft 3) fire 4) others specify _____
227. Due to the factors explained in # 90, how much sesame grain had lost during storage? _____ Kg/Qt; for the total of _____ Kg from total bought Qt
228. Was there an opportunity/case that the sesame bought for trading stays longer (late, yet not sold)? 1)yes 2) no
229. If your answer for # 92 is 1, when was the sesame you had bought for trade stays late not sold? In the months of _____
230. What were the reasons that makes sesame grain bought for trade to stay late not sold _____
231. If your answer for # 92 is 2, when was the sesame you had bought for trade immediately sold? In the months of _____
232. What were the reasons that make sesame grain bought for trade to immediately sell? _____

233. What was the amount of sesame grain loss by the value addition activities? _____ Kg/Qt that lead to the total loss by value addition activities of _____ Qt from the total bought
234. What were the reasons for the loss in # 96? _____

L. Buyers of sesame from the traders and the selling price

235. For whom had you sold the sesame grain you bought for trade? _____ 1) MPP cooperatives 2) other large traders 3) union/federation 4) directly export 5) others, specify _____

Buyers	Soled amount (Qt)	Soled amount (%)	Selling price (per Qt)	Selling market	Selling market distance from store (Km)	Transportation expense (in birr)	Selling month
MPP coop							
Other traders							
Union							
Federation							
processors							
Direct export							
Exporters							

236. Why you select the explained buyers of your sesame? _____ 1) these were the only buyers in the market 2) the service provider connects with them 3) other specify _____
237. Was the price of sesame you trade raises or fail in 2015? 1) yes 2) no
238. If your answer for # 101 is 1, in which months was the price raise? _____ and in which months was it fail _____
239. What were the reasons that make the price to rise? _____
240. What were the reasons that make the price to fail? _____

M. Materials bought and its costs

241. What materials were important for sesame trading? _____
242. From the materials explained in # 104, which one had you use in 2015? _____
243. What looks like the expenses for the explained materials? _____birr

S. No	Materials name	No	Initial cost in birr / unit	Purchasing year	Current value in birr	Repair cost in birr	Remark

N. Market information

244. What is the distance of your living home from woreda town? _____ Km or _____ hrs. by bus
245. By what did you transported to the woreda town? _____ 1) by bus 2) on foot
246. From where had you obtained the market information of sesame? _____ 1) searching market ourselves 2) radio and TV 3) neighborhoods 4) GOs and NGOs 5) others, specify _____
247. Who helps you to meet the buyers of sesame grain? _____ 1) ourselves go to them 2) ECX, commission agent 3) buyers by themselves come 4) brokers 5) GOs and NGOs 6) others, specify _____
248. How much had you paid for the service provided by those in #114 in 2015? _____birr _____ %

249. How many days had you spent to get those explained in #114? _____ days
 250. After how many days had you sold your sesame grain bought for sale? _____ days
 251. What makes you to sale in the explained time? _____

O. Sources of Income for sesame trading

252. How much birr had you planned to the sesame trading activity from the starting to end in the year of 2015? _____ birr
 253. How much you had in your own source from the plan explained in # 119? _____ birr
 254. Had you face shortage of money for sesame trading in 2015? ____ 1) yes 2) no
 255. If your answer for # 120 is 1, from where had you fulfill? 1) from loan 2) no, did not
 256. If your answer for # 120 is 1, from where had you obtain the loan? ____ 1) micro finance
 institutions (MFIs) 2) multi-purpose primary cooperatives 3) NGOs 4) friends/ relatives 5)
 informal money lenders (IML) 6) banks 7) others, specify _____

Source of loan	Collateral	Max allowable loan (birr)	Interest rate (%)	Age of repayment	Days to get the allowed loan	Expenses to get the loan in birr
Bank						
MFIs						
MPP Coop						
Friends/relatives						
IMLs						
NGOs						

257. Was the finance planned to fulfill from the different loan sources fully obtained? 1) no 2) yes
 258. If your answer for # 123 is 1, so what were the opportunities to done? _____

**Thank you for your understanding the Questionnaire and
 *****providing of truth data*******

Understanding of the interviewer on the respondents' comment on
 ECX _____

Market information _____

Governmental contribution _____

Market performance _____

Value addition _____

Market chain _____

Others _____

*******Thank you All*******

