Determinants and Welfare Effect of Improved Seed Adoption: A Case of Smallholder Farmers in Sokoru Woreda, Jimma Zone

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CERTIFICATE

This is to certify that the thesis entitles "determinants and welfare effect of improved seed adoption: A case of smallholder farmers in Sokoru Woreda, Jimma Zone", submitted in partial fulfillment of the requirements for the degree of Master of Science in economics (economic policy analysis) prepared by Getahun Yigezu under our guidance and supervision.

Therefore, we hereby declare that no part of this thesis has been submitted to any other university or institutions for the award of any degree or diploma.

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DECLARATION

I hereby declare that this thesis entitled the the determinants and welfare effect of improved seed adoption: A case of smallholder farmers in Sokoru Woreda, Jimma Zone, has Carried out by me under the guidance and supervision of principal advisor Tesfaye Melaku (Ass. Professor, PhD fellow) and co-advisor Teklu Taddesse (Ass. Professor).

The thesis is original and has not been submitted for the award of degree of diploma any university or instructions.

Researcher Name: _____

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ACRONYMS AND ABBREVIATIONS

GDP	Gross Domestic Product
ATA	Agricultural Transformation Association
Ha	Hectare
DSM	Direct Seed Marketing
MLSM	Multi-level seed marketing
ESE	Ethiopia Seed Enterprise
RGE	Regional Seed Enterprise
RBOA	Regional Bureau of Agriculture
MOA	Minister of Agriculture
WOA	Woreda Office of Agriculture
OSE	Oromia Seed Enterprise
NSC	National Seed Council
NGO	Non-Governmental Organization
FAO	Food and Agricultural organization
HH	Households
OLS	Ordinary Least Square
NCIC	National Crop improvement committee
FGD	Focus Group Discussion
BOARD	Bureau of Agriculture and Rural Development
JCU	Jimma Cooperative Union
CF	Contract Farming
EIAR	Ethiopian Institute of Agricultural Research

MOARD	Ministry of Agricultural Research Development
FBSM	Farmer Based Seed Multiplication
ETB	Ethiopian Birr
PSM	Propensity Score Matching
OCSSCO	Oromia Credit and Saving Share Company
EIAR	Ethiopian Institute of Agricultural Research

Abstract

Maize was the most productive cereal crops, produced and consumed by most people in Ethiopia especially in the study area; however, its productivity and life standard of the community in the study area was not much improved because of supply shortage of hybrid maize seed. To overcome such problem, seed producers multiply seed in farmer's farm by contract farming means. The main objective of this study was to analyze the determinants and welfare effect of improved seed adoption: A case of smallholder farmers in Sokoru Woreda, Jimma Zone. Specifically, analyze the factors that affect farmers' seed multiplication adoption, to analyze the impact of maize seed multiplication on the participants and assessing performance of market participants in maize seed multiplication. Multistage purposive sampling procedure used to draw samples from the total population. In hence, 294 maize grower farmers selected randomly, from those 109 households are those who participate in maize seed multiplication and considered as treated group. A questionnaire, FGD with farmers in each kebeles and interviews with the key stakeholders and secondary data collected from unpublished and published sources used for the study. Primary data collected from farmers who use improved maize seed in 2011EC cropping year. Descriptive statistics, such as graphs, tables, mean, standard deviation, and percentage as well as t-test, and chi-square test employed. PSM (logit estimation) applied to analyze the impact of maize seed multiplication on households yield and annual income by using computer software called "STATA" version 14.0. The study's finding indicates that farmers maize seed multiplication adoption was determined by; family size, education level of farmers, land allocated to maize, having livestock, accessibility of commercial fertilizer, access to maize seed, experience on hybrid maize plant, price of hybrid maize seed, frequency of contact with DA and having information on maize seed. The ATT at matching algorithm of kernel bandwidth 0.25 show that maize seed multiplication has positive and significant impact on yield and annual income. From marketing margin analysis, farmers' gross and net marketing margin was 55.72% and 74.2% respectively, while JCU share was 44% and 33.9%. This shows that seed multiplier farmers have higher share in consumer price. The study recommends; wisely and timely demand assessment, responsible based stakeholders management, supply of modern farming instruments and create crop insurances to mitigate risks.

Keywords: *Hybrid maize, Maize seed multiplication, Marketing Margin, PSM*

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Ethiopia is one of the most populated countries having estimated population size of the 113.56 million, accounting for 1.47% of the world population; from those 78.9% of the Ethiopian communities live in rural area and directly involved in agricultural production. The total land coverage of the country was 1.14 million square kilometer, from this 10,358,000 hectares covered by cereal crops. Agriculture was the core sector for Ethiopian economy; it has share about 33.3% in GDP, provides employment opportunity for 79% population directly or indirectly and 79% of the foreign exchange earning of the country (Getachew, 2020; NBE, 2020).

Ethiopia is the third largest maize producer in Africa, after South Africa and Nigeria (FAO, 2015). In Ethiopia, annual maize production is 7.8 million tones with an average yield of 3.6 tons per hectare in 2016 (FAO, 2017). Currently, 66% of cereal-farming households in Ethiopia cultivate maize on 2.1 million hectares, making it the second most widely cultivated cereal in the country after teff (Birhanu et al, 2019). It shows that, each household owns one hectare of land, of which half devoted for maize cultivation. Subsistence maize farming accounts for more than 95% of the total maize area and production, with 75% of all maize produced being consumed by the farming household (Abate et al, 2017).

In Ethiopia, most farmers are smallholder, those having limited land and those smallholder farmers cultivate more maize among other cereal crops. In Ethiopia more than 86% of households has land less than two hectares (CSA, 2017). The smallholder farmers that form about 80% of the population are both the primary producers and consumers of maize in Ethiopia (Teferi et al, 2015). Smallholders are fewer technology adopters and constrained with agricultural inputs (Tesfai, 2019).

The seed is a carrier of many technologies and is essential to increase agricultural production. The formal seed sector started some five decades ago; it remains limited to a few major crop varieties developed by agricultural research and the long chain of seed marketing and distribution (Dawit et al, 2014). Whereas the seed marketing system in the informal seed system is short and simple, without any regulation, and found to effective in quickly reaching

farmers. The use of quality seed from formal sources was at less than 10% (Abebe and Lijalem, 2011; ATA, 2015).

The improved seed is a critical input for improving agricultural production and productivity, which eradicate food and nutrition insecurity and poverty in Ethiopia (Benson et al, 2014; Kumlacho, 2015). One of the key tasks for the success of agricultural productivity was the production and marketing of certified quality seed to farmers based on their demand and in the required time near to their house.

Study taken by Antrisic, 2015 in sub-Saharan Africa of Mali and Kenya show that in Mali seed production was by contract agreement of seed companies and large-scale farmers, while; in Kenya, between seed companies and small-scale farmers. In both countries' collaboration between seed breeder and farmer was critical challenge. In Ethiopia, formal seed produced by public seed enterprises, cooperative union, farmer's cooperative and private seed enterprises on the state farm and farmer's farm (contract agreement between farmers and seed producers). The formal seed; mainly hybrid maize produced and distributed to farmers 60% by public seed enterprises and 40% by private seed enterprises (Mujaju, 2018).

In most developing countries such as Ethiopia, the most widely discussed seed system is seed production and marketing. Ethiopian seed system not programmed until the end of 1970s. In 1976, the National Seed Council (NSC) set up to formulate recommendations for organized seed production and supply of released varieties from the national program. This led to the establishment of ESE in 1979 and institutionalized seed production, processing, marketing, distribution, and quality control of cereals, legumes, and oilseed crops (Getinet et al., 2009; Abebe et al, 2017). The inefficiency of seed production and marketing was from the demand and supply side constraints. Challenges in supply sides are; non-availability to seed, insufficient supply when available, late delivery to seed and price competitiveness (ATA, 2014; ATA, 2015).

For the success of seed system in Ethiopia; Various stakeholders such as research organization, extension services, seed enterprises, and civil societies such as NGO, communities and each farmer takes part (Dawit, 2008). Improved seed produced by public seed enterprises, private seed producers, cooperative union, and farmer's cooperatives in state farms and farmer's farm by contract agreement with seed producers and farmers (Dawit et al, 2017), and distributed to farmers either DSM (direct contact of seed enterprises and farmers) or MLSM (cooperative union and farmers cooperatives) (Dawit 2008; Benson et al, 2014).

Public and private seed producers interested in farmer based seed multiplication to over-come supply shortage and availability of improved seed to farmers by contract agreement in which basic seed supplied to farmers within advanced technical support and grain yield sold to seed producers (Dawit, 2011). In the seed multiplication program, both seed producers and farmers are beneficiaries; seed producers efficiently sell their products within less seed left in stores because of effective demand assessment and farmers get quality seed at the right time, quantity and around their house and having guarantees in selling their outputs (FAO, 2018).

West Gojjam, Jimma, east Wollega, west Wollega and east Gojjam were the top five maize producing zones of Ethiopia (as cited by Tsedeke et al, 2015 from CSA,2011 p,3). Sokoru Woreda was one of the Jimma zone woreda that mostly cultivate maize among other cereal crops (Dubale et al, 2014), and maize seed multiplication involved in. In Sokoru Woreda, there was the seed multiplication program started since 2010 by contract agreement with JCU. Therefore, this study aims to analyze the determinants and welfare effect of improved seed adoption: A case of smallholder farmers in Sokoru Woreda.

1.2. Statement of the Problem

In any agriculture-dependent economy, formal Seed production and marketing was the catalyst in increasing agricultural production and productivity. The inefficiency of the seed production and marketing was from; supply shortage of improved seed, poor quality of seed, weak linkage among stakeholders, low extension services, lack of infrastructures such as road, store, poor access to stock, laboratories shortage for seed certification, lack of seed multiplication capacity were the serious challenges for seed system (Nyamia, 2010; Urgesa, 2014; Fasikaw, 2019). Because of those challenges, the coverage of formal seed was low and 75% of agricultural land of the country covered by informal seed (Nigussie et al, 2018).

Formal seed production and marketing were necessary to take new varieties to many farmers as possible. Seed marketing is the process by which seed exchanged between seed producers and farmers (FAO, 2015). Thus, producers have to promote and market the product to farmers in quantity and site near their place of residence that will give to the enhancement of farmers' adaption of improved varieties coming to satisfy the demand and buy their preferred brand.

In Oromia Regional state, 84% of the people live in rural area and directly dependent on agriculture. Improved seed covered only 15% of cultivable land in the region. The OSE,

cooperative unions including JCU, farmers' cooperatives and private seed enterprises were actively participates in improved seed production to overcome supply shortage in the region (Abdo et al, 2019). JCU was one of the licensed hybrid maize producers in the region by contract agreement of clustered woreda including Sokoru, Omonada and Tiroafeta. JCU produce 8,792 quintal of hybrid maize seed in 2011 and distribute to Jimma Zone woreda either directly or through their multipurpose farmers cooperative means (JCU, 2020).

Seed multiplication was one part of seed system in which licensed seed producers, produce seed in the farmers farm by contract agreements with farmers by supply basic seed to farmers either directly or through cooperative union (Endashew et al, 2018). In seed multiplication every stakeholders from research center to farmers actively engaged in production of quality seed to over-come supply shortage of the country (Dawit, 2011). Core challenges in the seed multiplication were shortage of basic seed, high price of basic seed and weak working together among stakeholders (Abula et al, 2018; Sisay et al, 2018).

Most empirical studies show that seed multiplication increase income and yield of participants due to best management and advanced extension services (Gezahgn, 2008; Endashew et al, 2018). However, as indicated by (FAO, 2004) hybrid seed production requires isolating seed production fields and unsuitable for smallholder community. Moreover, as information from Sokoru Woreda Agriculture office concentration of stakeholders was mainly on quality of seed. This shows there was no uniform idea among researchers on the impact of seed multiplication.

There is no clear criteria for selecting farmers who take part in the seed multiplication (Endashew et al, 2018). Program adoption was demographic, socioeconomic and geographic dependents. Most research on the seed multiplication analyzed by descriptive statistics (Dawit, 2011; Gebremedin, 2015; Abule et al, 2018). Econometric data analysis not well adapted in analyzing seed multiplication and few pieces of researches as, Gezahgn, 2008, apply econometrics statistics of the Tobit models on determinants and intensity land allocation to seed multiplication. In addition, seed multiplication program started since, 2010 in the study area, and researcher have not research done on the issue at hand. Therefore, the problems mentioned above beg me to research determinants and welfare effect of improved seed adoption: A case of smallholder farmers in Sokoru Woreda, Jimma Zone by applying Propensity Score Matching (PSM).

1.3. Objectives of the study

1.3.1. General Objective

The general objective of the study was to analyze determinants and welfare effect of improved seed adoption: A case of smallholder farmers in Sokoru Woreda, Jimma Zone

1.3.2. Specific Objectives

The specific objectives of the study were:

- To analyze the factors that determine smallholder farmer's willingness to participate in seed multiplication in the study area.
- To analyze the impact of maize seed multiplication program on household's yield in the study area.
- To analyze the impact of maize seed multiplication program on household's annual income in the study area.
- To analyze performance of marketing participants for maize seed multiplication in the study area.

1.4. Research Hypotheses

For specific objectives one to three above the following hypotheses raised

1. Demographic, socioeconomic characters of households and institutional services have no influence on farmer's willingness to participate in maize seed multiplication in the study area.
2. Seed multiplication program have no impact on household's yield in the study area.
3. Seed multiplication program have no impact on household's yield in the study area.

For objective four the following question answered

1. Who get highest share of marketing margin from market participants of maize seed multiplication in the study area?

1.5. Significance of the Study

Smallholder farmers who have limited land coverage and agricultural inputs such as improved seed at right time, around their house, and required quantity of seed within a

reasonable price requires an empirically justified alternative to increase their overall agricultural production and improve their livelihood.

The findings of this study were to understand, how effective maize seed multiplication and its market chain in increasing agricultural production by identifying factors that limit smallholder farmers to participate in seed multiplication. All concerned stakeholders inter-linked in smoothing hybrid maize seed production and marketing. Impact evaluation was to analyze whether the program worth supporting to be expand or disband (Sharuk et al, 2009). In hence, seed multiplication program was one type of contract farming that initiates farmers actively participate in every new coming program and improve their life standard by achieving extra yield and income.

Additionally, the issue under-researched with paucity of literatures, the study attempted to fill the gap and will serve as reference for researchers to conduct further study in the area of seed multiplication. The research also used by the MoA working on the issue of formal seed production and marketing to set frameworks on how to improve and better formal seed production and marketing.

1.6. Scope of the Study

This study carried out on determinants and welfare effect of improved seed adoption: A case of smallholder farmers in Sokoru Woreda of Wolmera, and Gengelata kebeles. Sokoru Woreda was one of woreda introducing maize seed multiplication by contract agreement with JCU. The central attention of the study was mainly on performance of hybrid maize seed production and marketing in improving supply shortage and life standards of seed multiplier farmers. Thus, lack of research conducted in the area was a limitation for reviewing empirical literature. Therefore, the study uses more qualitative information generated through focus group discussion and interview to understand maize seed multiplication due to lack of quantitative data. PSM applied in analyzing the impact of maize seed multiplication on annual income and yield of participants.

1.7. Organization of the paper

The paper encompasses five major chapters. In the first chapter background of the study, statement of the problem, objective of the study, scope and significance of the study briefly discussed. The second chapter deals with reviewed literatures on theoretical, empirical and

conceptual framework of the study. The third chapter is all about the research method; Physical features of the study area, research design, data requirement and sources, data collection methods, target population, sample size, data analysis method, and ethical consideration. In chapter four the result and discussion were briefly explained. In chapter five summary, conclusion and recommendation discussed.

CHAPTER TWO

LITERATURE REVIEW

This chapter gives a theoretical review on the issues of seed system, stakeholder's roles and responsibility in maize seed multiplication, challenges in the seed system, seed marketing and method of evaluating marketing performance, empirical review, maize history and production, hybrid maize seed production and conceptual review of literature related to the study.

2.1. Theoretical review

2.1.1. Seed

Seed is the means of sexual reproduction that produce remixing of genetic material and phenotypic variability on which natural selection act and plant breeder used. Seed determine the potential for quantity and quality of the final crop. Seed contain the genes that can provide resistance to other pests and disease of the plant, so plant healthy concerns to consideration of seed system.

The seed was the most important agricultural input; it is the basic unit for the distribution and maintenance of plant population. Without seed, there would be no agriculture. This shows how seed was important in any agricultural production.

The seed was the critical inputs for increasing every crop production and productivity. Most farmers in Ethiopia are smallholders those having limited land coverage. To improve their livelihood, production, productivity, and insuring food security, they seek to improved certified seed at the right time, right quantity, at the reasonable prices near their houses (Gebremadin, 2015).

2.1.2. Seed system in Ethiopia

The seed system in Ethiopia represents the entire institutions, and individual's operation in the development, multiplication, processing, storage, distribution, and marketing of seed in the country. Farmers are involved in multiple kinds of seed systems, which can guarantee them in obtaining the quantity and quality of seeds at the right time within right quantity and market their product to seed supplier (Abebe et al, 2017). The Ethiopian seed sector is the

combination of formal and informal seed system. The formal sector is the formally organized institutions those takes place in the seed systems, includes federal and regional agricultural research institutions, universities, the public and private seed producers federal up to woreda agriculture offices and DA, cooperatives, plant breeders and farmers (Christinck et al, 2018).

The informal sector is un-organized and uncertified and non-regulation-based sectors those takes part in seed system, includes NGOs, relief organizations, and so many farmers who continue to practice seed selection and preservation just as their ancestors did centuries ago (Abdisa et al., 2001). These sectors play a role in supplying seed for the farmer in a simple way. However, the seed supplied by this system has its limitations of low productivity but farmers still depend on this source because they cannot able to access from other formal sources and the formal source lacks consideration of farmers' seed criterion. Formal seed system was inefficient and more than 90% of farmers in the country ware dependents on informal seed (ATA, 2015)

2.1.2.1. Formal seed system

The formal or commercial seed sector, improved seeds with higher yield than informal seeds, sold to farmers through farmer cooperatives, and input suppliers. The formal sector includes research institutions, MOA, Regional Bureaus of Agriculture, development projects, and public and private seed enterprises, cooperative and farmer those take place in seed supply, demand, and regulation (Dawit, 2010).

Formal seed system established in 1950s with the breeding programs at the Jimma and Alemaya Agricultural Colleges. Breeding and multiplication was ad hoc until the 1970s. In 1976, the National Seed Council (NSC) set up by the National Crop Improvement Committee (NCIC) to formulate, recommendations for seed production and supply of released varieties from the national research programs. In 1979, ESE established and takes part in seed production, processing, distribution, and quality control (Sperling et al, 2007).

As indicated by Sperling et al, 2007, national seed policy established in 1992, with including seed sale, requiring vendors to meet households and current policy development was in increasing seed production. In Ethiopia, there are five public seed enterprises; Ethiopian Seed Enterprise (ESE), Oromia Seed Enterprise (OSE), Amhara Seed Enterprise (ASE), South Seed Enterprise (SSE), and Somali Seed Enterprise (SoSE). ESE, OSE, ASE, and SSE are all largely involved in production of cereals, pulses, and oilseeds production while Somali Seed

Enterprise (SSE) largely in production of forage crops (cited by Gebremedhin, 2015 from Amsalu et al, 2014).

The formal seed system is easier to characterize, simple to manage than the informal one, it can be characterized by a clear chain of activities are carried out from variety release to end users. Formal seed system was regulation based and applied by varies stakeholders. While in Ethiopia the formal seed system developed more than 50 years ago to increase agricultural productivity and improve food security, its penetration is relatively weak (Dawit et al., 2014).

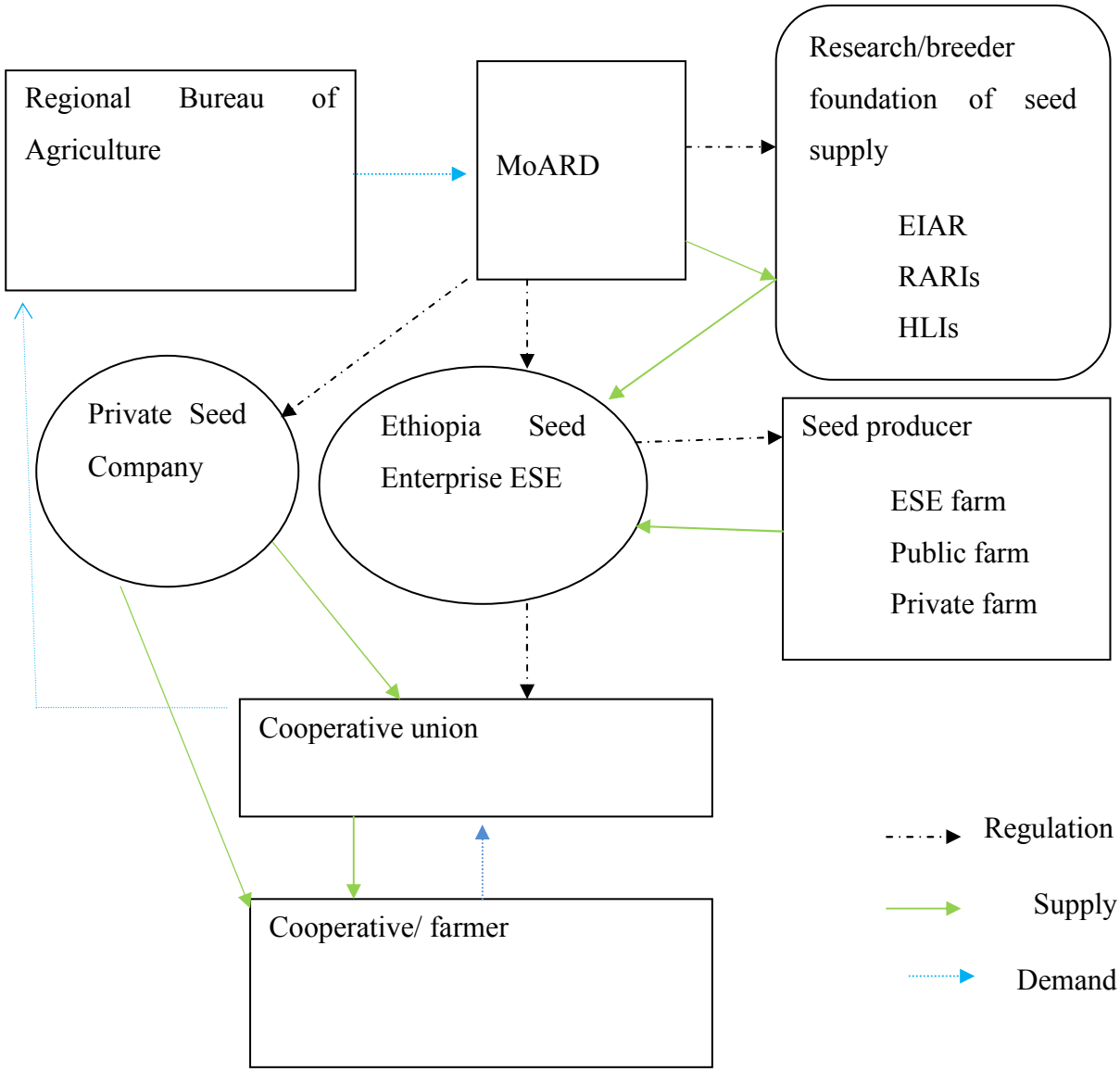

Figure 1: Organization of formal seed system in Ethiopia

Source: - Dawit et al, 2008

2.1.2.2. Informal seed system

The traditional or informal seed sector is seeding that farmers save from their crops and use it for the following planting seasons, or traded informally and their sources include other farmers, commercial seed dealers, NGOs, national research institutes, or other public agencies. Seed may be brought into the farm to cover deficits following harvest failures; introduce new varieties; and provide seed of better quality, either physiologically or genetically (Dawit, 2010). This system provides multiple benefits to individual farmers who select and save their seed or exchange seed with others through traditional means such as gifts, barter, labor exchange, cash transactions (Sperling et al., 2013). According to Dawit (2010), the informal seed system under the Ethiopian context defined as seed production and distribution along with the different actors where there is no legal certification in the process. This includes seed promoted by farmers, farmer-to-farmer seed exchange, cooperative based seed multiplication, and distribution.

Farmers' uses indigenous system for flow and exchange of products and its informal nature makes it more flexible than the formal sector. Informal seed system operates at the community level between households within a small number of communities, so farmers have easy access to seed and often know the farmer from whom they obtain. Availability further enhanced by the wide variety of exchange mechanisms that used to transfer seed between individuals and households, such as cash, exchanges in kind, barter, or transfers based on social obligations. This is especially important for households that have limited access to seed and resources poor community. The importance of informal seed system is that farmers can get seed based on their demand with low price (Abdisa et al., 2001).

As indicated by Abebe and Lijalem, 2011, the informal seed differ from formal one by; informal seed was traditional, semi-structured, wide range of exchange mechanism was applied and deals with small quantities and demanded by farmers.

2.1.2.3. Stakeholders in Seed System

At national, regional, and international scales seed system actors were; farmers, international agricultural research centers, public Seed Enterprise, private seed companies, multinational seed companies, research institutions, farmers associations and cooperatives, banks and credit institutions, trade associations, local governing bodies, donor agencies, national agencies and ministries, community groups (social, religious, etc.), agricultural universities and NGOs.

These actors have multiple roles in the process of seed provision, performing one or several activities (Sperling et al., 2013; Benson et al, 2014; Kumlacho, 2015).

2.1.3. Contract Farming

Contract farming is standardized farming method applied by agreement between buyers and producers, whereby producers agree to produce and supply of inputs according to the agreed quantity, quality, variety, grade, types of packaging, and time of delivery. Both parties will mutually agree on the price or market price (Solomon, 2011). Contract farming defined as agricultural production carried out according to a prior agreement in which the farmer commits to producing a given product in a given manner and the buyer commits to purchasing it (Samuel, 2016).

As stated by (FAO, 2015) contract farming was the contractual arrangements between farmers and companies, either oral or written, specifying one or more conditions of production and/or marketing of an agricultural product. Two types of contracts namely bailment coupled with the contract to produce, supply, and contract to produce and sell. The researcher also evidenced that the processors provided a variety of services other than technical support. The growers found to maintain a better relationship with the extension worker of the company. The growers had problems with the grading of the product in some areas.

Contract farming in agricultural production takes place between producer and contractor. As indicated by (FAO, 2015) in CF contractor; supply inputs such as seed, fertilizer, pesticide, and all inputs that producer use for production and financial support such as credit, loan, and guarantees to producer and technical support such as monitoring, evaluation, instruction, advising and training to producers. Seed supplier in CF getting advantages in reduction of price uncertainty and reduction of risk in covering production cost, because of price of seed, quantity demand, and time was limited before seed delivery (FAO, 2018). In Sokoru woreda, maize seed multiplication was one of CF that JCU supply basic seed to farmers and take yield from farmers based on their written contractual agreements.

2.1.4. Seed Marketing and Market channel

Marketing channel as a set of interdependent organizations involved in the process of making a product or service available for consumption or use. In a distribution or marketing channel,

firms and individuals take title or help in transferring title, to a good or service as it moves from the producer to the last consumer. The channel follows standardized structure where products flow from producer to the final consumer by contribution of some actors. Producers, wholesalers, and retailers as well as other channel actors exist in channel arrangements to do marketing functions. Maize seed market channels are channels through which farmers access maize seeds and include own stocks, exchange with other farmers, and buy of grain maize as seed through local markets that combine informal channels. Commercial seed suppliers, government or research institution, and relief supplies on the other hand constitute formal channels (Nyamai, 2010).

Improved seed in Ethiopia marketed by public seed companies (60% market share), local private seed companies (10% market share) and multinational seed companies with (30% market share); Public seed companies dominate the market due to incentives from the Government that include royalty-free licensing of public hybrids and access to land for seed production (Birhanu et al, 2019).

Seed sale in local markets and by small-scale vendors depends on appropriately sized seed packages. Making seeds available in smaller pack sizes is a simple and effective way to make quality seeds of various types accessible pursued by private companies as well as non-commercial initiatives (Westebgen et al, 2018). Hybrid maize seed supplied to farmers and sold in cash. Price of seed limited by seed producers, MoA and BoA's jointly before planting based on varieties (Benson et al, 2014).

Seed marketing was in multilevel seed marketing and direct seed marketing. In multilevel seed marketing seed marketed from seed producers to end-users through chain of public organizations, in which seed producers supply seed to MoA, then to BoA, zones and woreda offices based on their demand and reach farmers through DA and cooperatives at their kebeles. Most seed produced by public seed enterprises distributed to farmers through MLSM. Problems such as shortage of quality seed to farmers at right time, right place and right quantity documented in MLSM. DSM was seed marketing in which seed producers market their seed by direct contact with farmers (Shimalis, 2015). EAE, RSE, private seed producers and cooperative unions market their product to farmers directly by renting the farmers house, in local kebele stores and by other means (Benson, et al, 2014).

2.1.4.1. Performance of the market

Performance of the market shows the impact of structure and conduct of the market on price, costs, quantity and quality of the output. Monopoly market structure expects poor market performance than competitive one. Market performance refers to the results of firms in the dimension of price, output production and selling cost, product design and so forth (Solomon, 2011).

2.1.4.2. Methods of Evaluating Marketing Performance

A commonly used measure of system performance is the marketing margin or price spread. Margin or spreads can be useful descriptive statistics used to show how the consumer's price divided among participants at different levels of the marketing system (Getachew, 2002).

Marketing costs refers to those costs, which incurred to perform various marketing activities in the exchange of goods and services from producers to consumers. Marketing cost includes handling cost (packing and unpacking, loading and unloading putting in store and taken out again), transport cost, product loss (particularly for perishable fruits and vegetable), storage costs, processing cost, and capital cost (interest on loan), market fees, commission and unofficial payments (Kating et al, 2011; Solomon, 2011).

2.1.4.3. Seed certification and quality control

Seed certification is a regulatory process designed to maintain and make available to the standard of seed quality involving germination, physical purity, genetic purity and seed healthy. In Oromia regional state seed certification was the responsibility of Bureau of Agriculture and natural resources by using seed quality laboratory centers including Assella, Ambo, Shashamanne, Nekemt and Chiro (Abdo et al, 2019). Seed quality generally defined as whatever the customer expects from supplier. One way of achieving high agricultural productivity is by using cultivars that have high yield potential and are adapted to local environmental conditions. Therefore, production, processing and storage of seed must carefully plan and controlled in order to ensure that the quality of the seed is as high as possible.

2.1.5. Preference of farmers to the improved seed

In Ethiopia farming carried out by farmers, and those farmers prefer to improved seed on time, quantity, decide to the source of the seed within their willingness and accessibility. They might get seed in the market or from their own saved seed, local market and exchange

with neighbors. Use of certified seed may inevitably lead to costly changes in the mix of other productive inputs such as land and labor, thus making invest in improved seed is more costly and riskier than is often perceived. Facing nontrivial costs and risks, farmers must choose between buying and not buying seed in a manner that maximizes their utility. A study by Bedru (2011) indicate almost all farmers considered access to better seed quality as being most important and that they were willing to buy more quality seed for more yields. Seed supply seemed to be seed supplied with other inputs like fertilizers, price of seed followed by access to credit. Farmers' willingness to buy improved seed based on variety that was more adapted to local agro-ecologies and more yield provider with the right quantity and right time by reliable price and near to their house (Robert, 2009).

Under the dominant system of seed distribution, in Amhara and Oromia, local agricultural cooperatives generally are the locations where farmers purchase their seed, like that used to distribute inorganic fertilizer to farmers. Rather, the woreda office of agriculture receives seed from producers and manages its distribution to the DAs, who then distribute it to farmers at the kebele level on payment by those farmers. Problems relating to the timeliness of seed delivery and the quantity and quality of seed provided are well-documented shortcomings of this system.In general farmer preference to seed was depends on:

- Availability: Sufficient quantities of seed of adopted crops within the reasonable proximity and in the critical time.
- Access: peoples have adequate income or resources to purchase or exchange of the required seeds.
- Quality: seed is acceptable qualities within the desired varieties and adoptable with the local agro-ecologies.

Most farmers frequently mention lack of credit as a constraint to the use of improved maize seeds. Credit accessibility enhances farmers in purchasing, and this in turn may increase purchases of improved seeds. A large proportion of farmers citing lack of credit as the reason for not using improved maize seeds may, however, not use for the purpose, even if provided. In most cases, these results from an unwillingness to risk the consequences of being unable to repay credit from the income generated from the sale of maize (Nyamai, 2010).

Farmers preference to improved seed increased from time to time to get more yield, for the reason of pest and disease and suitability to local agronomic traits (Dagne, 2016).The supply

shortage to improved seed is the aggregate concern and 75% the farmers constrained to use informal one from a neighbor or saved seed by themselves (Nigussie et al, 2018).

2.1.6. Determinants of Farmers Seed Demand and Supply

Seed demand estimation was important in managing government and seed producers. Demand forcasting is essential in determining type of crop within varieties and quantity, estimating availing production, strengthening seed quality control, knowing potential demand and design appropriate extension method that convert potential demand to effective demand and formulation of policies regarding seed use and production (Mokonnen, 2012).

Farmers seed demand assessment was by combinations of actors involved in seed business starts from farmers and ends at seed producers. Among others, establishment of regional public seed enterprises and offering special supports to the private seed sector can mentioned as typical examples. The majority of actors, however often involved in seeds of crops that can offer those profit margin and some of useful crop varieties demanded by farmers were remain neglected. In order to balance demand and supply gaps the government launched a program called 'crush seed multiplication' since 2009 (FAO, 2015). The program can be executed by the coordination of Ethiopian Institute Agricultural Research (EIAR), ESE and MOARD on three strategic crops (maize, wheat and rice) as a result of this initiative, there have been tremendous contributions to the formal sector and the huge gap between demand and supply of initial seed has been narrowed down (Abebe and Lijalem, 2011)

For marketing and distribution of seed, appropriate demand analysis was important. In seed demand assessment collect farmers seed demand directly from farmers by DA's, analysis of previous year actual seed demand and area of land to be covered by fertilizer and improved seed and amount of seed and fertilizer. Seed demand assessment is a load task and time consuming and be in systematic ways.

Estimates of revealed demand for improved seed in Ethiopia are based entirely on official projection that are developed at the local (kebele level) and then transmitted through official channels to zone and regional levels, after which they are aggregated nationally to produce estimates of the type and quantity of that needs to be supplied in the coming season (FAO, 2010).

Inconsistent and uneducated demand analysis was the great crises for both seed supplier and consumers. Farming system in the country is rain based and ones in a year and seed producers have only one chance to sell their products. If their product not sold efficiently, seed producer has become disincentive in seed production for the following year and the farmers chance to get seed is low.

In any agriculture-based country seed demand and supply was interrelated term; means without demand supply is meaningless and the inverse is true. Demand is desire and willingness of farmers to buy seed and supply is a behavior in seed producers produce and market their seed. At the country level, supply shortage was critical challenges in boosting agricultural production. To fill this gap public and private seed producer activate production by applying several means, such crush seed multiplication program. The other challenges in seed system were low quality of seed, knowledge gap in usage and access to seed in time and quantity. In Ethiopia 60% of hybrid maize was produced and marketed by public seed enterprise and remaining 40% was by private (Dawit et al, 2010; Mujaju, 2018).

Seed supply is influenced by factors such as price of seed supplied to end users, number of seed suppliers in specific area, production cost (including, labor, capital and land), weather conditions for seed system and accessibility to alternative seed source, example, imports (FAO, 2018)

2.1.7. Challenges in Hybrid Maize Seed production and Marketing

Hybrid maize seed produced by licensed seed producers and distributed to smallholder farmers based on their demand. Seed was the sensitive item, seek advanced treatment and cares in production, and exchange time. This can be by the chain of varies actors. By its nature, seed production and marketing were vulnerable to various challenges. As stated by (Nyamai, 2010) unavailability of improved seed to farmers was from poorly developed and inefficient distribution networks, long-distance between seed outlet and difficult transportation facility make it costly to farmers to obtain the desired seed. Even seed reach the farmers timing in terms of sourcing, supply and distribution in cropping calendar or the types of seed available may not be the desired one. As discussed by (Abebe and Lijalem, 2011), during intervention activities made so far, the following challenges manifested in the seed system at the country level.

- Lack of proper linkage between different actors involved in seed systems

- Inadequate supply of good quality seed at affordable prices
- Low level of private sector involvement in the formal system
- Inefficient seed promotion, distribution, and marketing mechanisms
- Weak variety release and seed quality assurance system

The challenges faced on seed producers are; lack of skilled labor, financial constraint, machineries, infrastructures such as warehouse and access irrigation, land shortages for production of seed (Dagne, 2016). The major challenge to the public seed enterprises is that they are not free in producing and marketing seed. They heavily depend on government structure, particularly BoA for production and cooperative union for distribution of seed. The critical challenges in seed marketing and distribution was the knowledge gap (price of seed, source of seed and variety) and lack of working to gathers among stake holders from the seed producers to farmers (FA0, 2010).

2.1.8. Maize History and Production in Ethiopia

Maize originated in Central America and introduced in West Africa in 1500's by Portuguese traders (Ashanafi, 2010). Maize introduced in Ethiopia in the 16th or 17th century; however, the existence of some local cultivars, the genetic diversity of those cultivars was insufficient for establishing suitable source populations. In 1967, Ethiopia has systematically participated in the East Africa Cooperative Maize Trial, which has resulted in the evaluation of several promising varieties (Abdisa et al., 2001).

Maize is the second most widely cultivated crop in Ethiopia and grown under diverse agro-ecologies and socio-economic conditions typically under rain-fed production. The maize agro-ecologies in the country divided into six major categories, including Moist and Semi-moist mid-altitudes, Moist upper mid-altitudes, Dry mid-altitudes, Moist lower mid-altitudes, moist lowlands, and Dry lowlands. The moist and semi-moist mid-altitude zones include the bulk of the national maize area in Ethiopia. These are mostly in the southwest and West Oromia including Jimma zone, West and North West Amhara, parts of the Southern Nations Nationalities and Peoples Region (SNNPR), and BeniShangul-Gumuz (Tsedeke et al, 2015; Dagne, 2016; FAO, 2018).

Farmers commitment in maize production increment was, availability of improved varieties, enhancement of farmers in accessibility and using of improved inputs through research-extension linkages, more adaptability of improved varieties, better production and low

production cost and risk and, growing consumptions demand, and market access for maize producers (Tsedeke et al, 2015).

The production and productivity of maize in Ethiopia constrained by; drought, surface water lodging, floods, soil erosion, traditional planting, the poor state of infrastructure, repeated cultivation of land, lack of credit facilities, lack of improved seed, and weak extension support, and high price and shortage of improved inputs (Dawit et al., 2008; Mangistu, 2016; Habtamu and Kelemu, 2018).

In Ethiopian, agricultural extension services and seed politics is highly associated with maize specifically hybrid maize. Policymakers consider maize as a crop where huge productivity gains can get to boost agricultural production of the country. In addition, because it cannot be recycled, there is a huge demand by farmers, and all public and private seed companies participated in its multiplication by creating competition among these actors (Dawit et al, 2010). Availability of improved seed in the country was through improved seed production from Farmer Based Seed Production and Marketing Schemes (FBSPMS) and imports (Gebremedin, 2015).

In Ethiopia, most farmers are smallholder and 80% maize produced and consumed by those smallholders (Teferi et al, 2015). Maize used for home consumptions (eating and drink) and source of income. From this income, farmer adequate their children, buying clothes, pay government tax, participating in infrastructure such as road, potable water, health service, farmers training center (FTC) and every total participation financially and buying agricultural inputs such as improved seed, commercial fertilizer, insecticide and pesticide. In addition, maize was use for industries input and animals feed (Dawit eta al, 2014).

In Oromia Regional state from 4,852,056 ha covered by cereal crops 27.29% was devoted to maize, this make maize was the second most cultivated cereal crops after teff in the region (Abdo et al, 2019).

2.1.9. Hybrid Maize Seed Producers in Ethiopia

Hybrid maize seed started in Ethiopia during Derg regimes from 1974- 1991, farming was takes place in large mechanized farms, and seed for these farmers obtained from Kenya. In Ethiopia, hybrid Maize Seed producers are both public and private. Ethiopian Seed Enterprise (ESE) dominates the public seed production and since 2008 regional seed enterprises (RSES),

Oromia Seed Enterprise (OSE), Amhara Seed Enterprise (ASE) and South Seed Enterprise (SSE) come in to pictures and in 2009 and in 2010 starts to supply their product to farmers (FAO, 2010; Abebe and Lijalem, 2011; Benson et al, 2014). Generally, now there are about 30 licensed private seed enterprises and cooperative union produce hybrid maize seed. Those seed producer produce seed either in state farms or in farmer's farm by contract agreement. The role of cooperatives in seed multiplication is increasing from time to time. They are already engaged in seed production, cleaning, and grading of Quality Declared (QDS) of OPV varieties with technical support from woreda office of agriculture. However, the supply of basic seed of adapted improved crop varieties is in shortage for such programs. The ESE produces certified seed through contract arrangement on state and private commercial farms, on farmers' fields along with the production on own farms. A similar approach followed by the newly established regional seed enterprises. It expected origination of regional seed enterprises would promote the production of seed for crops that not so far produced through the formal system. Another alternative in increasing the seed production capacity, the public seed enterprises are promoting farmers-based seed production and marketing schemes and many achievements have made. For instance, the Oromia Seed Enterprise (OSE) has promoted Farmers' Based Seed Multiplication Scheme (FBSMS) immediately, with a focus on potential areas for seed multiplication and clustering approach. The focus on potential areas helps to minimize the cost of production and helps to get the quality seed and clustering was to management.

In Ethiopia several types of hybrid maize seed varieties produced and distributed by public and private seed enterprises; BH-540, BH-543, BH- 660 and BH- 661 were produced by public seed enterprises and PHB-3253 (javi), PHB-30G19 (shone), PHB-30D79 (agar), PHB-3812 (limu) and SC-627 (Abaraya) were produced by private seed enterprises (Benson et al, 2014).

2.2. Empirical Reviews

Maize was the most cultivated cereal crop after teff in area coverage and most productive in Ethiopia. Most empirical studies show that most farmers in the country and study area were smallholder and in subsistent life standard. To improve life-standard of smallholder's farmers and overall GDP of the country, improve seed production and marketing was paramount.

Most studies show hybrid maize seed adoption affected by education, family size, livestock wealth, access to output market, credit access, distance from market, fertilizer, land owner,

price of seed, households age, extension service, income and farming experience (Mwangi, 2000; Abaje, 2012; Abadi, 2015).

Public and private seed producer produced hybrid maize. The produced seed marketed and distributed to farmers by MLSM (chain of agricultural offices) and DSM (direct contact of seed producers and farmers). Most public seed producers (ESE and RSE) distribute their seed by the chain of agricultural offices and constraints such as; real gap between supply by seed producer and farmers demand, low knowledge access and lack of integration among stakeholders documented (Benson et al, 2014).

The finding by (Teferi, 2018), show that the two controversial issue raised means supply shortage of hybrid maize seed and ineffective marketing in Oromia Regional state; this can be from inefficient, ineffective, and unresponsive improved seed technologies marketing and accessing operating systems hindered meeting the farmers' real demand by factors infrastructure, distance, seed package, and market competitors.

(Elleni, 2014) study by applying the econometric model of multiple linear regression (OLS estimation) method, quantity of hybrid maize utilized is affected by family size, amount of annual income, commercial fertilizer used, total land product access to right seed variety, experience in the use of hybrid maize, market information, access to credit, tropical livestock unit, and market channel. challenges (weakness) in seed marketing and distribution were long distance from farmer's residence, less varietal choice, unable to meet the estimated demand seed exchange, poor promotion and advertisement seed purchase, failure to provide alternative package size, absence of credit access to purchase seed storage and dealer doesn't have a permanent place to sale seed.

In Kenya, study by Nyamia, 2010 on determinants of choosing improved maize seed affected by factors such as extension contact, access to credit, membership to farmers group, experience with maize seed, price of seed, distance to output market and farm land. Shortage of market channel to seed and poor coordination among stakeholder were limit smallholder farmers to adopt improved maize seed.

As stated by (Tsedeke et al, 2015); Maize is the most cultivated crop in Ethiopia and grown in diverse ecologies. More than nine million smallholder growing maize and yield gained is 3 metric tons/hectare. The maize production increments were from; increase availability of modern varieties, commitment to enhancing access to and use of modern input through better

research extension, wider adaptability of the modern varieties, better production condition, and low productivity risk and growing consumer demand market for producers to support market-based production to absorb the surplus supply.

In Oromia Regional State farmers demand to improved seed was influenced by factors such as land for cultivation, seed accessibility, extension support, input-output relationship, seed sold in the previous year, adoption of complementary inputs, accessibility of agricultural inputs, distribution efficiency and credit accessibility (Teshome et al, 2012).

As stated by (Bedru, 2011), there are several reasons why farmers prefer to seed. Farmer demand for improved seed can arise from their desire to replace retained seed of an existing variety that is no longer genetically pure or to obtain a new variety that is higher yielding or is more pest or disease resistance.

According to (Abebe and Lijalem, 2011), most of Ethiopian farmers depend on the informal seed because of cheaper and readily available in the farmer's villages just at the time of seed needed, it allows the use of seeds after testing on primary adopter farmers, it is more reliable, and its sustainability more guaranteed than the formal system.

A study made by (Abera et al., 2001) signifies that the supply of seed constrained by the inefficiency of public seed enterprises, poor seed promotion, poor transportation, and inappropriate agricultural and pricing policies. Moreover, because high-yielding varieties perform well with fertilizers, the limited availability of fertilizers constrains demand for improved seed.

Study by Kating et al, 2011 in Kenya on cost-benefits analysis of common bean farmer based seed production shows that, common bean production was profitable company and less sensitive to price fluctuation. From marketing margin analysis certified common bean based seed producer five times higher in net profit margin than farmer based seed producers, this can be from more productivity by using of irrigation and high price of certified common bean.

The study taken by (Yetbarik, 2017) on adoption of legume technology and its impact on the farmer's income analyzed by logit model for PSM and OLS. The results presented that technology access for improved farm inputs, credit accessibility, wealth status, education level of the household head had a significantly influenced on the adoption level of both improved seed, and fertilizer technology and the high price of improved technology and

family size had negatively affected the adoption level of improved farm inputs. Impact assessment showed that farmers who had adopted improved technology could enhance their annual total income level by 2.8% and the crop income particularly from grain legume been increased by 41%.

Study taken by Jerena, 2014 on factors that influencing participation of smallholder farmers red bean marketing and extent of production analyzed by two-stage heckman model show that, market participation was influenced by price, ownership of transport, number of extension visit, amount of red bean produced, awareness on quality of seed, market information, access to credit and gender. Urban collectors, rural assembler, primary cooperatives and whole sellers purchased the product from producers. Jerena's finding was mainly concentrated in grain yield and there was no organized market channel (they can sell grain by whatever opportunity).

Study taken by Abule et al, 2018 on forage seed multiplication in rift valley area of Oromia Regional State, shows that highly inter linkages among stake holders improve poor farmers livelihood by selling their outputs by better prices and the main challenges were supply shortage and high price of seed that limit their production capacity. However, for seed multiplier farmers there was no organized market channel to sell their out puts.

Study taken by Solomon, 2011 on local hybrid maize seed production and marketing in Amhara Regional State; on the factors affecting quantity of local hybrid maize seed production analyzed by multiple linear regression model OLS estimation method. In hence, amount of UREA fertilizer, access to credit, Experience in contract maize seed production and Time of seed supply significantly affect quantity of hybrid maize seed supply. Constraints identified in production and marketing of hybrid maize are lack of seed supply, lack of provision of seed processing technology, low price of locally produced maize seed, lack of fund for hybrid maize production and marketing, lack of training for seed producer limited access to technical support, lack of motivation and organizational support to seed producer cooperative. From gross margin analysis, local hybrid maize seed producer share marketing margin 52.12% and net marketing margin share 65.76% of the consumer prices.

Other study taken by (Gazahgn, 2008) show that ESE agrees with some woreda to multiply wheat, coffee, apple and potato seeds. Participants increasing their production through productivity increments, increase smallholder's income and improve life standards of rural community. Farmer's seed multiplication adoption and intensity analyzed by Tobit model.

Current study was the contract farming in which JCU have the contract agreements with Sokoru Woreda farmers to multiply maize seed. Various stakeholders such as research center, agriculture offices, JCU, DA, farmers themselves were highly interlinked for the success of the program. The contribution of those stakeholders was for produce quality seed and simultaneously its impact on smallholder farmer's welfare analyzed by PSM. PSM was a model that required in minimizing selection bias and overcoming appropriate average treatment effect of treated and control groups.

A study taken by (Samuel, 2016) on the impact of contract farming on chickpea producers by PSM of logit model estimation finding shows that contract farming participants get more revenue and participants attribute net income to improved seed, stable product price, more yield, and market guarantee.

2.5. Conceptual Framework of the Study

Smallholder farmer's willingness to participate in maize seed multiplication influenced by several factors and in their relationships. Demographic characteristics of households, socio-economic and institutional factors were the major factors those determine maize seed multiplication. Different empirical studies show that magnitude and direction of the independent variables on determining farmers willingness to participate in seed multiplication dynamic by its nature and geographic dependent.

The seed multiplication was the program that performed by varies stakeholders and market participants. During its progress seed multiplication was vulnerable to a challenge which was location dependents. The following diagram shows the process framework of the maize seed multiplication.

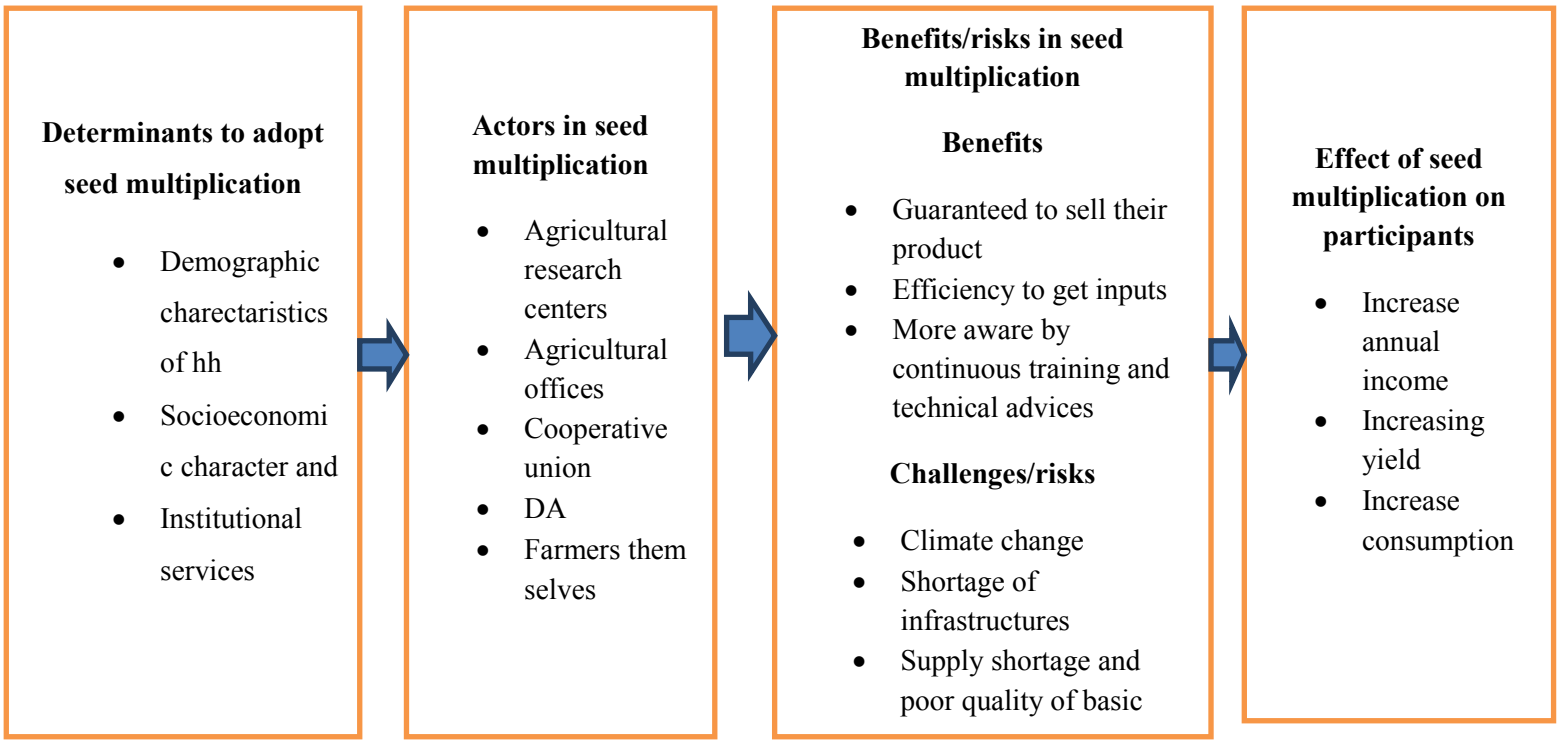

Figure 2: conceptual frame works in seed multiplications

Source: -own sketch from literature

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter discusses the research methodology used in the study including description of the study areas, research design, types of data and source, target population, sampling method, method of data collection and analysis, model diagnostic testing and ethical consideration.

3.1. Description of the Study Area

The study conducted in Oromia Regional state Jimmaa Zone of Sokoru Woreda. The Oromia region is organized in 20 administrative zones and 265 woredas that extended from central and western to southeastern part of the country. Sokoru Woreda was one of the 21 woreda and 1 administrative District of Jimma zone; located at about 250 km away from the capital of Oromia Regional State, Addis Ababa in the southwest and 100 km far from Jimma zone, Jimma. Sokoru Woreda contain 39 rural and 3 urban kebeles administrations and bordered by Southern Nations Nationalities and Peoples Region (SNNPR) in north and west, Omo nada woreda in south and Tiroafata woreda in the east. The woreda covers an area of 92,744 hectare around 5.1% of Jimma zone. The altitude of Sokoru Woreda ranges from 900-2300 meter above sea level (Sokoru Woreda FEDO, 2018).

According to (Sokoru Woreda FEDO, 2018), the estimated population size of the woreda was 186,926 with 93,770 female and 93,156 males. The age distribution of the population revealed that, the young (1-14 age) and the old age (65 and above years) account for about 91,938 (49.2 %) of the population and 94,938 (50.82%) were in productive age means (age group 15-64).

Most part of the district belongs to desert (gamoji), sub-tropical (bada-dare) and cool (baddaa) agro-climate and this respectively constitutes 30%, 60% &10% of the district (Sokoru district Agricultural and rural development office, 2018).

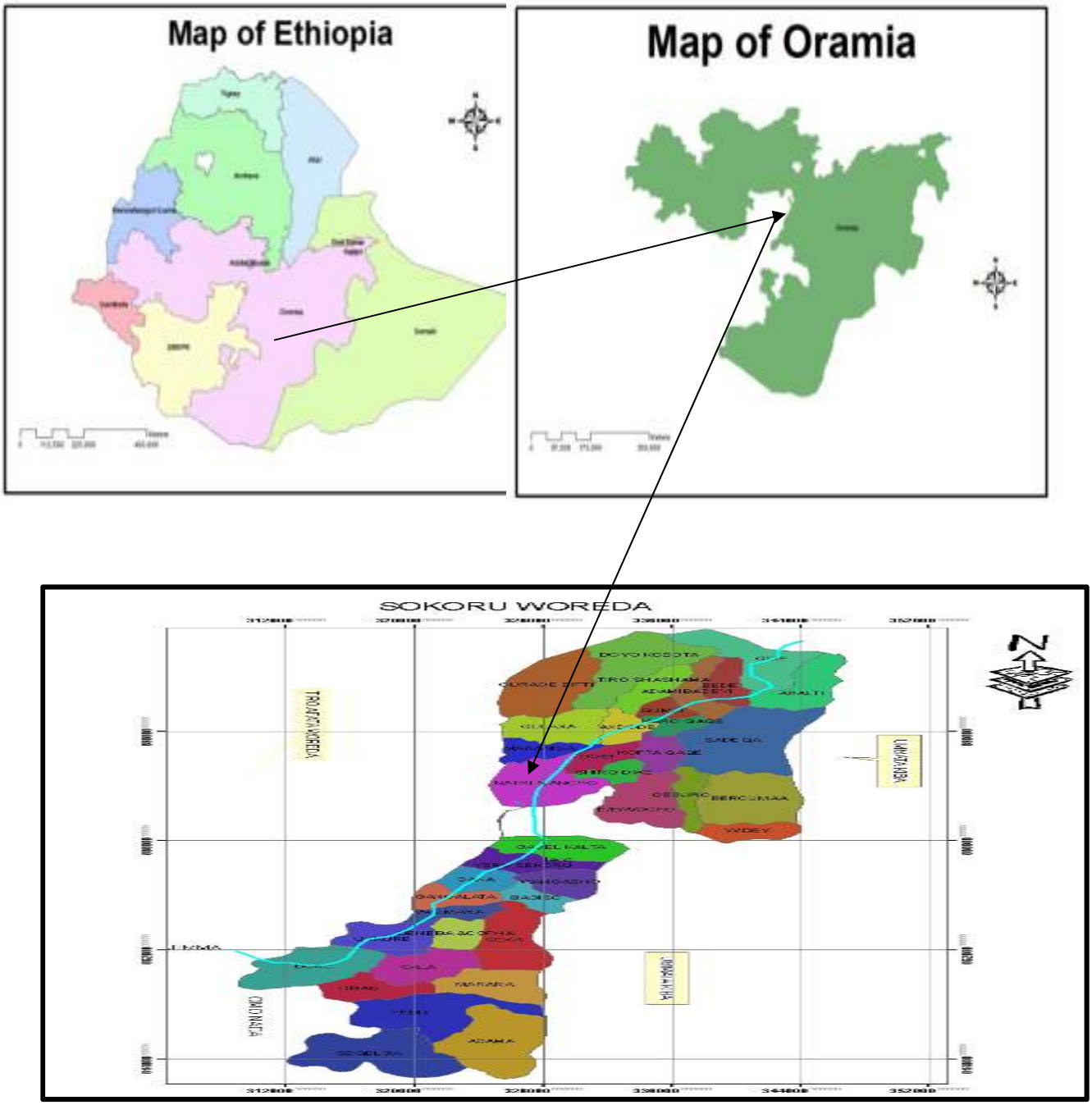

Figure 3: Map of Sokoru Woreda

Source: Sokoru Woreda FEDO, 2018

Agriculture is the main economic activity of the district and hence it provides almost the largest shares of livelihood of the population. However, it is characterized by lack of access to modern technology, market, low productivity, dependency on rainfall and lack of irrigation practice, etc. as a result the sector is remained subsistence in its nature.

Despite of this fact the district is potentially rich particularly for farming practice. The district does have ideal agro-climatic condition (dominates by sub-tropical and cool) that suitable for production of cereal crops.

Mixed farming is a common practice prevailing in the district. As a result, the livelihood of the rural people is dependent on both crop farming and livestock rearing. Farmers' association is the lowest level of rural government structure.

The district has a total area of about 92,744 hectares Based on the general view, the current land use pattern of the district, about 49.34%, 17.84%, 10.58%, 6.47%, 6.17% and 9.59% consist of the land are cultivation land, forest land, arable land, pasture/gazing/land, degraded land and Others respectively (Woreda Agriculture and Rural Development, 2018).

Table 3.1: Area coverage and production of major crops in the woreda during 2010/11 E.C

T/L	Type of crop	Area in hectare	Yield gained in quintals
1	Teff	15,005	21,568
2	Barley	966	2,276
3	Wheat	760	26,068
4	Maize	13,312	763,851
5	Sorghum	5,031	134,517
6	Rice	8	176
7	Faba beans	715	1,260
8	Haricot beans	215	6,325
9	Lentils	93	930
10	Pease	395	5,495
11	Neugh	1,881	11.526
12	Linseed	172	866
13	Sesame	1,449	6,334

Source: Sokoru Woreda FED office 2018

Farmers in the woreda have been utilizing different agricultural inputs that increase the productivity and production of their small plot of land to assure their food security and increase household income. Even though different types of agricultural inputs can increase the production and productivity of crops and livestock, the dominant inputs utilized are seed and fertilizer. Different organizations and companies carry out the distribution of those

inputs. Mainly primary cooperatives and unions distribute improved seed and Fertilizer (Woreda Agriculture and Rural Development, 2018).

3.2. Research Design

Research design is about how to relate the research question with the data. The study by (Daniel, 2016) explains qualitative and quantitative research as follows; Qualitative research is a method of data collection by observation, open-ended questions, in-depth interview and focus group discussion. The methods employed in data collection give a full description of the research to the participants involved. Quantitative research is the use of the statistical tool for saving time and resources and scientific methods for data collection and analysis generalize possible with this type of approach. (FAO, 2018) describe qualitative and quantitative data as; quantitative data is a numeric based data and qualitative data is non-numeric data and the feeling and idea of the respondents. For this study, both qualitative and quantitative designs applied.

3.3. Data Requirements and Sources

The study used both primary and secondary data. Primary data; by administering a structured questionnaire to sample respondents (maize producer farmers') and interviews with Sokoru Woreda agriculture office, Sokoru Woreda cooperative promotion office, JCU and Sokoru branch Oromia credit and saving share company on credit provision, DA at their office in each kebeles, and focus group discussion within farmers in each kebeles by selecting 6-8 farmers. To generate necessary and accurate data from the primary source first translate the question to Afan Oromo and data collected by enumerators since most farmers cannot read and write. Enumerators are DA those having experience in data collection. Those enumerators take training on how to collect data and the nature of the research.

Secondary data collected from reports of public institutions, journals, and books. Moreover, different bulletins and websites visited to strengthen the data. Most of the data were from unpublished reports from Sokoru Woreda Agriculture office, Sokoru Woreda rural land management office, Sokoru Woreda cooperative promotion office, Sokoru Woreda finance, and economic development office and JCU.

3.4. Target population

The target population for this study was, Sokoru Woreda of Wolmera and Gengelata kebeles smallholder farmers.

3.5. Sample Size, Sampling Procedure and data collection

This study was to compare maize seed multiplier and others in their yield gained and income. Sampling frames for the study were seed multiplication participants and non-participants. Zero participants to maize seed multiplication programs were farmers those who have willingness to participate in the program and constrained by isolation of farm land (maize required for the program must far from other maize more than 80 mater in farm field) and limited with un-availability of infrastructure.

The survey used cross-sectional data. Under this study, Multi-stage purposive sampling method applied in drawing samples from total population. In the first stage, Sokoru Woreda selected purposively from Jimma zone woreda have a contract agreement with JCU to multiply maize seed and potential maize cultivation. In second stage, two kebeles in Sokoru Woreda purposively selected; kebeles those involved in maize seed multiplication. And in the third stage by simple random sampling, select 294 households from selected kebeles, from those households 185 of them considered as control groups (farmers those who do not participate in maize seed multiplication).

For this study, both probability and non-probability sampling applied. Probability sampling was the simple random sampling in selecting household for the survey and non-probability sampling was the purposive sampling, choice of woreda and kebeles. The sample size for this study determined by a simplified formula suggested by Yamane (1967) as follows:

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

$$n=\frac{1108}{1+1108(0.05)^2}=294$$

Table 3.2: Sample selection from the population in each kebele

Kebele	Total household	Sample
Wolmera	628	628*294/1108 = 167
Gengelata	480	480*294/1108 = 127
Total	**1,108**	**294**

Source: Sokoru Woreda rural land management office, 2019 and own calculation

Where **n** is the sample size, **N** is the total households and **e** is the level of precision assumed 5**%**. When this applied to equation (3.1)

For the accomplishment of the current study, data gathered by preparation of structured questionnaire, focus group discussion within households and interview with formal public institutions involved in the success of maize seed multiplication in the study area and their market participants.

For this study data was collected from 294 randomly selected households those who planting maize seed in 2011 EC by apply structured questioner and FGD within those farmers.

A three-stage sampling technique used to select a representative sample of respondents for the study. At the first stage, from Jimma zone Sokoru Woreda was selected, in the second stage two kebeles were selected from Sokoru Woreda purposively in participating in maize seed multiplication and at the third stage, 294 households were selected randomly from those selected kebeles.

3.6. Methods of Data Analysis

The study analyzed by descriptive statistics and econometric model. The details of the methods of data analysis are as follows.

3.6.1. Descriptive statistics

The study used descriptive statistics such as graphs, frequency, percentage, mean, and standard derivation to analyze both primary and secondary data that was collected from the farm households and other stakeholders. Moreover, differences between maize seed multiplier and other farmers to some selected variable will be tested using chi-square and t-test statistics.

Maize seed produced was reach to final consumers through chain of market participants. The price paid by final consumers including production cost and price of marketing products analyzed by marketing margins. Marketing margin exist as the price differences between chain of market participants (Solomon, 2011). The percentage share of final prices which taken up by marketing function known as marketing margin (cited by Solomon et al, 2018 from Mendoza, 1995).

The margin analysis was from each market participants including farmers, farmer's cooperatives and Jimma cooperative union discussed as:

Computation of Total Gross Marketing Margins (TGMM)

This was to analyze the profitability of market participants by applying the following formulas (Solomon, 2011)

$$TGMM = \frac{\text{End buyer price} - \text{First seller price}}{\text{end buyer price}} * 100$$

Were, TGMM = Total gross marketing margin

Computation of Producer's Gross Margins (GMMP)

Producer's gross margin (GMMp)is the part of the price paid by the consumer that goes to the producer.

$$G_{MMP} = \frac{\text{end buyer price} - \text{marketing gross margin}}{\text{end buyer price}} * 100$$

Where G_{MMP} was producers share in consumer price

Computation of Net marketing margin (NMM)

Net marketing margin is the percentage of the final price earned by the intermediaries as their net income after their production and marketing cost deducted (Solomon et al, 2018).

$$NMM = \frac{\text{Gross margin} - \text{Marketing cost}}{End\ buyer\ price} X \quad 100$$

Where, NMM= Net marketing margin

3.6.2. Econometric analysis

3.6.2.1. Propensity score matching (PSM)

PSM is the method that applied in the alternative matching algorithm and minimizing bias to overcome appropriate ATT. Some researches on contract farming were analyzed by PSM (Samuel, 2016; Katrean, 2017), this study also familiar with those papers on analyzing the impact of maize seed multiplication on household's yield and income in the study area. Propensity scores are an alternative method to estimate the effect of receiving treatment when the random assignment of treatments to subjects is not feasible. Propensity score matching (PSM) refers to the pairing of treatment and control units with similar values on the propensity score, and possibly other covariates, and the discarding of all unmatched units (Rubin, 2001).

General Method for Calculating Propensity Scores

As indicated (Thavaneswaran, 2008) propensity score value was unknown and can be analyzed by the Logistic regression method. The logistic regression model is the most commonly used method for estimating propensity scores. It is a model used to predict the probability that an event occurs or not. Hence, probability of participating on maize seed multiplication or not was discussed as (Obajie et al, 2012):

$Y_i = \beta o + \sum_{i=1}^{n} \beta iXi + \mu i$….. eqn. 3.2

In equation above, Y_i was a dummy variable having 1 and 0. Dummy variables were (1 for maize seed multiplier and 0 for others).

Pi = Probability that Yi = 1 that a household participate in maize seed multiplication.

1-Pi = Probability that Yi = 0, that household was not maize seed multiplier.

$Pi = F(Zi) = F(\alpha + \sum_{i=1}^{n} \beta iXi) = \frac{1}{1+e^{z}}$….. eqn. 3.3

Where $Z = \alpha + \sum_{i=1}^{n} \beta iXi$

If Pi, the probability that a household participate in maize seed multiplication, is

$Pi = \frac{e^{z}}{1+e^{z}}$

Then 1-Pi, the probability of not participates in maize seed multiplication, is

$1\text{-}pi = \frac{1}{1+e^{z}}$

Thus $pi/1 - pi = \frac{\frac{e^{z}}{1+e^{z}}}{\frac{1}{1+e^{z}}} = e^{z}$

Where $pi/1 - pi$ was Odds ratios in household participate in maize seed multiplication to the probability that it will not. To estimate the logit model, the dependent variable transformed by taking the natural logarithm to "log odd" as follows:

$Ln(pi/1 - pi) = Z = \alpha + \sum_{i=1}^{n} \beta iXi$

After simplifying the above formula, the equation can represent in the linear form as:

$Z = Ln(pi/1 - pi) = \alpha + \sum_{i=1}^{n} \beta iXi = Li$….. eqn. 3.4

Where

Yi= Dummy variables were (1 for maize seed multiplier and 0 for others).

X1 = Sex of the household head

X2= marital status of the household head

X3= Educational level of the household head

X4= Age of household head

X5= Family size

X6=land allocated to maize

X7 = Access to credit

X8= Total land holding

X9= Distance from delivery point

X10= Livestock

X11= number of Ox

X12= Commercial fertilizer

X13= Access to seed on time

X14= Price of hybrid maize seed

X15= Yields from previous year

X16= Experience in use of hybrid maize seed

X17= Frequency of contact with DA

X18 = Seed information

$\beta 0, \beta 1, \beta 2 \ldots, \beta 18$ represent estimation parameter

μi= represent the error term

e = base of natural logarithm

Li = is called logit as it follows logistic regression.

Propensity Score Matching Methods (matching algorithms):

After the propensity score estimated; an appropriate matching technique implemented. The followings are types of propensity score matching algorithms.

Stratified Matching: - The propensity scores classified into intervals based on the range of their values. Each interval consists of treatment and control subjects that on average have equivalent propensity scores. The differences between the outcomes of the treatment and the control group calculated to obtain the average treatment effect.

Nearest Neighbor Matching: In this method, the absolute difference between the estimated propensity scores for the control and treatment groups minimized.

Radius Matching: In this method, every treated subject matched with a corresponding control subject that is within a predefined interval of the treatment subject's propensity score. Treatment subjects must matched with a control subject with a given interval, only a certain number of comparisons will be available.

Kernel matching: In this method, every treated subject matched with the weighted average of the control subjects. The weights are inversely proportional to the distance between the treated and control groups.

Mahalanobis Metric Matching: In this method, the subjects are ordered randomly and then the distance between the treated and control subjects is calculated.

Treatment effect on the treated:

To estimate the effect of participating on maize seed multiplication program on given outcome (yield gained and income) specified as:

ΤATT = Yi (pi =1) - Yi (pi =0) ……. Equation 3.5

Where ΤATT is treatment effect (effect due to participate in maize seed multiplication) Yi is the yield gained and annual income of household i, pi is whether household i have participate in maize seed multiplication or not. However, one should notice that Yi (pi=1) and Yi (pi=0) cannot be observed for the same household at the same time. Depending on the position of the household in the treatment either Yi (pi=1) or Yi (pi=0) is an unobserved outcome

(counterfactual outcome). Due to this fact, estimating individual treatment effect τi is not possible and one has to shift to estimate the average treatment effects of the population than the individual one. Average Treatment effect (ATE) and Average Treatment effect on Treated (ATT) are two treatment effects frequently estimated in empirical studies (Li, 2012, p3). The Average Treatment Effect (ATE), which is simply the difference in the expected outcomes after participating in maize seed multiplication or not:

$\Delta YATT = \Delta Y = E(Y1) - E(Y0)$ ……. Equation 3.6

This measure answers the question of what would be the effect if households in the population randomly assigned to treatment. Therefore, the most important evaluation parameter is the Average Treatment Effect on the Treated (ATT), which concentrates on the effects on those for whom the interventions actually introduced. In the sense that this parameter focuses directly on those households who participated in the program called maize seed multiplication, it determines the realized impact of participating in maize seed multiplication is successful or not. Given by:

$\tau_{ATT} = E(\tau / p=1) = E(Y1/p=1) - E(Y0/p=1)$ ……. Equation 3.7

This answers the question; how much yield gained for and annual income difference between farmers those participating in seed multiplication or other. Data on E (Y1/p=1) are available from seed multiplier. An evaluator's classic problem is to find E (Y0/p=1). So, the difference between E (Y1/p=1) - E (Y0/p=1) cannot be observed for the same household. Due to this problem, one has to choose a proper substitute to estimate ATT. The possible solution for this is to use the mean outcome of the comparison individuals, E (Y0/p=0), as a substitute to the counterfactual mean for those being treated, E (Y0/p=1) after correcting the difference between treated and untreated households arising from selection effect. Thus, by rearranging, and subtracting E (Y0/p=0) from both sides of equation (3.6), one can get the following specification for ATT.

$E(Y1/p=1) - E(Y0/p=0) = \tau_{ATT} + E(Y0/p=1) - E(Y0/p=0)$ ……. Equation 3.8

Both terms in the left-hand side are observables and ATT can be identified, if and only if E (Y0/p=1) – E (Y0/p=0) =0. i.e., when there is no self-selection bias. This condition can be ensured only in social experiments where treatments are assigned to units randomly i.e., when there is no self-selection bias (Dillon, 2008).

Assumptions:

As indicated by (Rosenbaum and Rubin, 1983; Heckman, 1997) two influential assumptions must fulfilled in impact analysis:

Assumption 1: conditional independence (un-confoundedness)

All estimators in treatment effect require that potential outcome was independent of treatment after conditioning on covariates. The CI assumption says that only the covariates x affect both the treatment and the potential outcomes, any other factors that affect the treatment must be independent of the potential outcomes and any other factors that affect the potential outcomes must be independent of the treatment.

Assumption 2: Common support (Overlap):

This assumption rules out perfect predictability of d given X. That is

$$0<P\ (d=)\ <1$$

This equation implies that the probability of receiving treatment for each value of X lies between 0 and 1. By the rules of probability, this means that the probability of not receiving treatment lies between the same values. The second requirement is also known as overlap condition because it ensures that there is sufficient overlap in the characteristics of the treated and untreated units to find adequate matches (or common support). When these two assumptions are satisfied, the treatment assignment said to be strongly ignorable.

Estimation of standard error: Testing the statistical significance of treatment effects and computing their standard errors is not a straightforward thing to do. The problem is that the estimated variance of the treatment effect should also include the variance due to the estimation of the propensity score, the imputation of the common support, and possibly also the order in which treated individuals are matched. These estimation steps add variation beyond the normal sampling variation (Heckman et al., 1998). For example, in the case of NN matching with one nearest neighbor, treating the matched observations as given understate the standard errors.

Bootstrapping: this method is a popular way to estimate standard errors in case the analytical standard error was biased or unavailable (Caliendo and Kopeinig, 2008). Each bootstrap draw includes the re-estimation of the results, including the first steps of the

estimation (propensity score, common support). Bootstrap standard errors attempted to incorporate all sources of error that could influence the estimates. Because analytical standard errors were not computable for the Kernel-density matching methods, (Wooldridge, 2013) have used 100 bootstrap replications to compute robust estimates for standard errors of the outcome indicator. Thus, the bootstrapped standard error must report on the ATT.

3.7. Model diagnostic test

Multicollinearity

Before fitting the model, multicollinearity (relationship among explanatory variables) checked. Multicollinearity for the continuous variables was tested using the variance inflation factor (VIF) and for dummy variables was tested by Pearson correlation coefficients. STATA software version 14.0 used.

Goodness of fit-test

The goodness of fit test was to test significance of the model. Pseudo R-Square and probability of model joint significance used to check goodness of fit test for logit model (Maddala, 1992). Pseudo R-Square ranges from zero to one. Higher values show good fit of the model. Probability joint significance was to test significance of the model.

3.8. Variables specification and hypothesis

Dependent variable

The main variables that intended to be measured in this study were the farmers maize seed multiplication adoption or not and the amount of yield gained and annual income of households. Market channel (maize seed multiplier or not) was the dependent variable in impact analysis using PSM with outcome variables of the yield and annual income of households.

Table 3.3: - Description of dependents and outcome variables

Variables	Abbreviation	Description	Type
Dependent variable			
Either participate in seed multiplication or not	MKTCHNL	1" maize seed multiplier" 0" others"	Dummy
Outcome variables			
Yield gained	Yield	How many yield respondents gained from maize in quintal (1 quintal = 100 kg)	Continuous
Income	AAINC	Annual income of participants in ETB (1 ETB with 29.055 USD exchange)	Continuous

Source: own sketch

Independent variables

Independent variables are those variables that expected to influence the dependent variable. The following are the variables that expected to influence the specified dependent variables (willingness to participate in maize seed multiplication).

Sex of the household head (SXHH):

This is a dummy variable that takes a value of 1 if the household head is male and 0 if female. A study by (Abdissa et al, 2001) confirmed that women households head tend to adopt improved technologies at a lower rate than men is, because of limited access to information and resources. It therefore hypothesized that being sex has a positive influence specified dependent variables.

Age of household head (AGHH):

It is a continuous variable and measured in years. Age is a human capital variable that reflects the ability of the respondent to manage their farm and his performance in output markets. Older household heads may have more experience in farming and therefore make better farming decisions including the adoption of improved maize seeds. However, young household heads may be more innovative and less risk-averse, attributes that can make them use improved seeds (Nyamia, 2010).

Family size (FMLS):

It is a continuous variable, measured in how many persons there during the cropping year. Maize seed production is labor-intensive, such as planting, harvesting, and shelling. i.e., the availability of active labor force in the household, which affects the farmer's decision of the production. Since production is the function of labor, the availability of labor assumed to have a positive relationship with the dependent variables. Hence, family size expected to have a positive impact on the quantity supply of hybrid maize seed (Solomon, 2011) and (Yitbarec, 2017) finding shows, family size negatively affects improved technology adoptions.

Distance from delivery point (DFDP):

This variable measured in kilometers as a continuous variable, how many km seed deliveries point far from household's house. Hence, the distance from the delivery point hypothesized to negatively related to market participation and the extent of participation (Kabeto, 2014).

Experience in use of hybrid maize seed (EUHM):

It is a continuous variable for how many years of respondents participate in planting maize. A farmer's experience can either generate or erode confidence in using and adopting new technologies. With more experience, a farmer can become more or less averse to the risk implied by adopting new technology. This variable can thus have a positive or negative effect on a farmer's decision to adopt an improved maize seed (Abdissa et al, 2001).

Educational level of farmer (EDUL):

It is a continuous variable and refers to the grade level of formal schooling of the respondent completed during the survey period. The education level of the household head increased that determines the readiness to accept new ideas and innovations, and easy to obtain, process and use information relevant to the production and marketing of hybrid maize seed and use appropriate quality and quantity of technologies. Therefore, education level has positive influence on the quantity supply of hybrid maize seed (Solomon, 2011).

Total Maize Yields in previous year (TMYP)

It is a continuous variable and referrers to how many quintals of maize farmers get in the previous year. This variable used to capture farmer's incentives in using more improved

maize seeds. Farmers who used improved maize varieties and get higher maize yields are more incentive to buy improved seed and adopt improved technologies. Yield from the previous year was directly relationship with adopting technologies (Nyamia, 2010)

Total land holding (TNDH):

This is continuous variable measured in hectares of farmland owned by farmers. The larger the farm area implies more resources and greater capacity to purchase inputs like fertilizer, improved seed (Samuel, 2016). Landholding variable has positive relation to technology adoption.

Land allocated for maize cultivation

This variable shows the plot size of land allocated for maize production. Farmers those who have more land were more adopter of agricultural technologies. Study taken by (Jerena, 2014) shows that land allocated for bean production have positive impact on supply of bean seed.

Access to the seed on time (ASRT):

This variable show the time at which the seed is available and supplied in quality and quantity for sale at the market. A dummy variable takes a value of 1 if the household has access on time and 0 otherwise. It assumed to influence the quantity of seed purchased by farmers positively (Meseret, 2010).

Price of the hybrid maize seed (PHM):

This was a continuous variable measured as the average price of hybrid maize seed in ETB. The price of seed limited by seed producer and MoA by assuming production cost, transaction cost and buyer's capacity. The price was expected to positively affect market participation and the quantity of seed marketing (Kabeto, 2014; Elleni, 2014). (FAO, 2018) shows there is an inverse relationship between the quantity of seed purchase and the price of seed.

Livestock (TLU):

It is the ownership of livestock and taken as a proxy to understand the wealthy status. Production of maize requires a different level of inputs like seed, fertilizers, and agro-chemicals. For this reason, the demand for financial liquidity could be from selling livestock.

This is a dummy variable that takes a value of 1 if the household having livestock or 0 otherwise. It enables a farmer to procure inputs required to adopt improved technology (Getahun, et al., 2000). Consequently, a positive sign expected to this factor.

Number of oxen owned by households

Farming activities in most rural area of the country, specifically in the study area was mainly by ox and ox is the source of income. Farmers those who have more oxen were more technology adopter than those who have less. Study taken by Abera and Harko, 2018, shows number of ox have positive significant influence on volume of maize market.

Access to credit (ATC)

This is a dummy variable that takes a value of 1 if the household gets access credit from their environment or 0 otherwise. Credit was the source of income for smallholder farmers that enhances more purchasing of technologies. The study by Nyamaia, 2010, shows that access to credit has a positive influence on the choice of improved maize seeds.

Commercial fertilizer use (CFU):

This is a dummy variable that takes a value of 1 if the household used commercial fertilizer and 0 otherwise. Since the use of inputs in the farm like fertilizer, improved seed, and farm equipment will enhance potential productivity of the hybrid maize seed used by farmers' and the availability of such inputs encourages adopting and using technologies. According to the study by Kidane (2001), the farmers who have adequate knowledge of the use of fertilizer and its rate of application are more likely to adopt new technologies than those who lack it. Therefore, it is expecting that modern input use by farmers have a positive effect on the adopting and using technologies.

Frequency of contact with DA (FRCDA):

This is a continuous variable measured in the number of household's contact with development agents. DA considered as the source of information and technical support. The study by (Gazahgn, 2008) shows contact with DA affect farmers in potato seed multiplication positively and those households who have good access to DA are more likely knowledgeable, having more skill than others do.

Marital status (MRTS)

Marital status was categorical variable 0 for single, 1 for married, 2 for divorced, and 3 for widowed. Households those in married were more technology adopters and decision-makers and having human and physical productive than others. It may be a positive or negative impact on the dependent variables. A study by (Ali, 2020) shows marital status had a negative impact on hybrid maize seed adoption.

Seed information (SEDINF):

Seed information was categorical variables with 1 for those having information and 0 for others. Farmers getting information from other farmers, radio, and DA, households those having access information on agricultural inputs were more adopters and users of hybrid maize than other households were. (Poku et al, 2018) show that information accessibility had a positive impact on hybrid maize seed choice.

Table 3.4: -Description of explanatory variables

Variables	Abbreviation	Description	Type	Expec. sign
Sex	SXX	'1' male headed'0' female headed	Categorical	positive
Marital status	MRTS	'0'sin '1' mar '2'divo.'3'wido.	Categorical	Posit/nega.
Age	AGHH	How many age of hh head in year during survey	Continuous	positive
Family size	FMLS	Number family in person	Continuous	Posit/nega.
Distance from source	DFDP	Distance in km from seed source	Continuous	Negative
Experience in maize production	EUHM	For how many years participate in maize planting	Continuous	positive
Education level	EDUL	How many grade hh head learn academic education during survey	Continuous	positive
Yield from previous	TMYP	Yield gained from previ. in quin.	Continuous	positive
Land holding	TNDH	Land holding of HH in hectare	Continuous	positive
Land allocated to maize	LTMAIZE	Land allocated to maize in hectare	Continuous	positive
Seed accessibility	ASRT	'1' yes'0' no	Categorical	Positive
Price of maize seed	PHM	Price of Hybrid maize seed in ETB	Continuous	Pos/Nega.
Livestock	TLU	'1' yes '0' no	Categorical	Positive
Credit accessibility	ATC	'1' yes '0' no	Categorical	Positive
Fertilizer access	CFU	'1' yes '0' no	Categorical	Positive
Number of oxen	Ox	Number of ox owned by farmers	Continuous	Positive
Frequency of contact with DA	FRCDA	For how many days the DA contact with farmers per month	Continuous	Positive
Seed information	SDINF	'1' yes '0' no	Categorical	Positive

Source: own sketch

3.9. Ethical Consideration

Considering the ethical issue during any research is important. For this study, Voluntary consent was the first issue considered. The researcher would allow individuals to partake according to their own free will and the researcher has informed participants that the research is voluntary and that they can withdraw at any time. Informed consent on which participation in the research as well as the recording of the interviews will take place with the participant's informed consent. To facilitate the respondents to offer the information easily the researcher preserved the ambiguity to them by not mentioning any names of those who participated in the study.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

This chapter deals with the findings, descriptive statistics and econometric (PSM), on analysis factors affecting farmer's willingness to participate in maize seed multiplication and its impact on participants' welfare and analysis of the performance of market participants in maize seed multiplication in Sokoru Woreda.

4.1. Results of Descriptive Statistics

4.1.1 Household Characteristics

Table 4.1: -Demographic characteristics of farmers with categorical data

Character	Category	Total household		Seed multiplier		Other		Chi-square	P(t)
		Freq.	Perce.	Freq.	Perc.	Freq.	Perc.		
Sex	Male	265	90.14	98	89.91	167	90.27	0.0101	0.920
	Female	29	9.86	11	10.09	18	9.73		
	Total	294	100	109	100	285	100		
Marital status	Single	7	2.38	4	3.67	3	1.62	1.8181	0.611
	Married	240	81.63	90	82.57	150	81.08		
	Widowed	20	6.80	6	5.5	14	7.57		
	Divorced	27	9.18	9	8.26	18	9.73		
	Total	294	100	109	100	185	100		

Source: - Compiled from own survey, 2021

The survey conducted on, 265 (90.14%) male headed and 29 (9.86%) female headed; from the total surveyed households, 98 (89.91%) male and 11 (10.09%) female were seed multiplier and 167 (90.27%) male and 18 (9.73%) female were other maize seed user. From this, most households participate in maize seed multiplication were male-headed households. Those male-headed households actively adopt technology and decision-making. Chi-square value shows that, there was statistically insignificant different in sex between maize seed multiplier and other farmers

Concerning marital status in the study area, from 294 households 240 (81.63%) of them were married, 7 (2.38%) of them were single, 20 (6.8%) were widowed and 27 (9.18%) were

divorced. When divide to seed multiplier and other farmers; from 109 seed multiplier, 90(82.57%) of them were married, 4 (3.67%) of them were single, 6 (5.5%) were widowed and 9 (8.26%) were divorced. From 185 others, 150 (81.08%) of them were married, 3(1.62%) of them were single, 14(7.57%) were widowed and 18 (9.73%) were divorced. This show, in the study area hybrid maize seed user and maize seed multiplier farmers ware those who are married. Chi-square value shows that, there was statistically insignificant different in marital status between maize seed multiplier and other farmers

Table 4.2: - Demographic characteristics of farmers with continuous data

Character	Total house hold		Seed multiplier		Other		t-value	P(t)
	Mean	St. Dev	Mean	St. Dev	Mean	St. dev		
Age	44.30	8.95	45.30	8.57	43.7	9.13	1.57	0.13
Family size	6.47	2.03	7.24	2.01	6.02	1.90	5.1870	0.0000
Education level	1.87	2.36	2.97	2.53	1.23	1.99	6.52	0.0000

Source: - Compiled from own survey data, 2021

The average age of the sample household was 44.3 with standard deviation of 8.95 years. When distributed to seed multiplier and others, the average ages of the seed multiplier and other farmer were 45.3 years with standard deviation 8.57 and 43.7 years with standard deviation 9.13 respectively. Those older households head were more risk manager than younger one. T-test shows that, statistically insignificant different ages of households between maize seed multiplier and other farmers.

In terms of the number of a family member in survey time, a household has an average of 6.47 persons with standard deviation of 2.03, seed multipliers have 7.24 with standard deviation of 2.01 persons and other farmers have 6.02 with standard deviation of 1.90. T-test shows that, there was statistically significant different family size between maize seed multiplier and other farmers. Farmers those who have more family size were more productive and improved seed than others.

Farmers in the study area learn academic education in average up to grade two with a standard deviation of 2.36. The average education level of farmers participating in maize seed multiplication and other maize user households was grade three and two respectively. T-test shows that, there was statistically significant different education level between maize seed

multiplier and other farmers. Education increase farmer is ready to adopt improved seed and managing farming activities.

4.1.2. Socioeconomic status of households

Table 4.3: - Socioeconomic status of households

Character	Total house hold		Seed multiplier		Other		t-value	P(t)
	Mean	St. dev	Mean	St. dev	Mean	St. dev		
Annual income	37020.07	18311.94	49003.67	19359.57	29959.46	13371.26	9.94	0.0000
Land holding	1.51	0.76	1.78	0.91	1.35	0.61	4.91	0.0000
Land allocated for maize	0.89	0.47	1.08	0.55	0.78	0.37	5.50	0.0000
Number of ox	1.68	0.97	2.03	1.09	1.48	0.83	4.89	0.0000
Experience in hybrid maize plant	12.56	3.60	14.17	3.52	11.62	3.31	6.23	0.0000
Yield from previous	20.37	12.21	26.11	15.21	16.98	8.41	6.62	0.0000
Frequency of contact with DA	2.45	2.23	4.07	1.92	1.47	1.80	11.66	0.0000
Distance from delivery point	1.83	1.07	1.78	0.86	1.86	1.18	0.58	0.56

Source: - Compiled from own survey data, 2021

Source of income of households in the study area was from agriculture and agriculture product; insignificant and small in the number of households in the rural area take part in non-farm activities such as carpentry, trading livestock from rural to the local market, and other handwork. From this agricultural product, farmers in the study area educate their children, consume for food and drink, buy agriculture input for the following cropping year, participate in social participation; such as iqub and idir, participate in infrastructure expansion, and decorate their house and compound. The average gross annual income of households before devotes to explained activity was 37020.07ETB with a standard deviation of 18311.94; the average income of maize seed multiplier was 49003.67ETB and other was 29959.46ETB. T-test shows that, there was statistically significant different between income of maize seed multiplier and other farmers.

The overall average land size was 1.51 hectares per each household, total landowner of households for seed multiplier was 1.78 hectares and other farmer was1.35 hectares; of 1.51-hectare, 0.89 ha allocated for maize. Maize takes the largest part of land in the cropping scheme in which 60% of the total land hold devoted to maize. T-test shows that, there was statistically significant different in land size and land allocated for maize between maize seed multiplier and other farmers. Farmers those who have more land were more user of improved maize seed.

In the study area, the surveyed households have averagely 12.56 (more than twelve years) farming experience. When categorized to seed multiplier and other farmers, seed multiplier has 14.17 (more than fourteen years) farming experience while other farmers have 11.62 (more than eleven years) farming experience. T-test shows that, there was statistically significant different farming experience between maize seed multiplier and other farmers. Farmers those who were more experienced in using improved seed were more maize seed multiplier.

From previous year households get yield averagely 20.37 quintals. Seed multiplier farmers have 26.11 quintals in previous year while other farmers got 16.98 quintals in the previous year. T-test shows that, there was statistically significant different in yield from previous year between maize seed multiplier and other farmers. Farmers those who gain more yield from previous year were more adopter of seed multiplication in the study area.

DA at kebele level provides technical support and ways of applying agricultural production by contact with farmers at their farmland on average 3 days per month; while DA visits the farmland of maize seed multiplier was 5 days per month and other farmers three days per month. T-test shows that, there was statistically significant different in frequency of contact with DA between maize seed multiplier and other farmers. Farmers those who more contact with DA were more informed on the issue of technology adoption and using improved inputs.

The average distance of seed source to each farmer home is 1.83 km. Distance from the delivery point of seed multiplier was 1.78 km and the other was 1.86 km. T-test shows that, there was statistically insignificant different distance from a delivery point between maize seed multiplier and other farmers because of both have get seed from their kebeles.

4.1.3. Agricultural input using

Table 4.4: - Input utilizing of households

Character	Categ.	Total house hold		Seed multiplier		Other		Chi-square	P(t)
		Freq.	Perc.	Freq.	Perc.	Freq.	Perc.		
Commercial fertilizer	Yes	180	61.23	98	89.91	103	55.68	60.0332	0.0000
	No	114	38.77	11	10.09	82	44.32		
	Total	294	100	109	100	185	100		
livestock	Yes	274	92.20	108	99.08	166	89.73	9.4635	0.002
	No	20	6.80	1	0.92	19	10.27		
	Total	294	100	109	100	185	100		
Seed accessibility in time	Yes	207	70.41	102	93.58	105	56.76	44.6326	0.0000
	No	87	29.59	7	6.42	80	43.24		
	Total	294	100	109	100	185	100		

Source: - own survey, 2021

Seed accessibility on time to farmers within available fertilizer by suitable and more preferable price to near their house is the most influential variable in purchasing and using hybrid maize seed and participates in seed multiplication program. In study area, 180 get and use commercial fertilizer effectively while 114 do not. Chi-square test shows that, there was statistically significant different in commercial fertilizer using between maize seed multiplier and other farmers. Shortage and high price of commercial fertilizer was the challenge that limits farmers using improved seed and participate in seed multiplication.

In the study area 207 (70.41%) get access seed in time; while 87 (29.59%) do not. From seed multiplier 102 (93.58%) get access seed in time; while 87 (29.59%) do not and from other farmers 105 (56.76%) get access seed in time; while 80 (43.24%) do not. Chi-square test shows that, there was statistically significant different accessibility of seed on time between maize seed multiplier and other farmers. Accessibility of improved seed was the factor that initiates smallholder farmers to maize seed multiplication adoption (FGD with farmers)

Farming in the study area was by ox and livestock is the source of more income that supports farmers in buying farm inputs. From a survey in the study area, 274 (93.20%) of households

have livestock including ox for Plowing their farmland. This shows that most farmers in the study area have livestock.

As indicated in table 4.3 surveyed households have in average two oxen; seed multiplier farmers have three oxen while other farmers have two oxen. T-test shows that, there was statistically significant different in number of ox between maize seed multiplier and other farmers.

Table 4.5: Quantity of inputs utilized and yield gained by households

Character	Total house hold		Seed multiplier		Other		t-value	P(t)
	Mean	St. dev	Mean	St. dev	Mean	St. dev		
Quantity of improved maize seed purchase	17.56	8.79	20.25	10.95	15.98	6.77	4.13	0.0000
Fertilizer use (DAP)	67.41	37.27	80.27	39.83	59.83	23.90	5.5005	0.0000
Fertilizer use (UREA)	83.33	35.25	96.78	39.54	75.40	29.77	5.2523	0.0000
Price of maize seed	514.58	319.92	669.26	433.22	423.45	174.06	6.84	0.0000
Yield gained	21.91	13.73	30.61	15.97	16.79	8.98	9.5293	0.0000

Source: own field survey, 2021

From table 4.5 above, households in the study area uses improved maize seed averagely 17.56 kg per each person. Maize seed multiplier purchases improved maize seed in average 20.25 kg, while, others uses improved maize seed in average 15.98 kg. T-test shows that, there was statistically significant different in hybrid maize using between maize seed multiplier and other farmers.

In using fertilizer, all farmers in average use UREA 83.33 kg and DAP 67.41kg per each farmer. When distributed to seed multiplier and others, seed multiplier uses UREA 96.78kg and DAP 80.27 kg, while other farmers use UREA 75.40 kg and DAP 59.83 kg. T-test shows that, there was statistically significant different in fertilizer use between maize seed multiplier and other farmers. Farmers those who purchase more fertilizer were more adopter of technology in increasing production in the study area.

Hybrid maize seed sold to farmers in cash and price of seed limited based on pack size of the seed. In average, price of hybrid maize seed was 514.58ETB per each farmers, seed

multiplier purchase by 669.26ETB and others by 423.25ETB. Price difference is from quantity and transaction cost.

By exerting required inputs, yield gained was averagely 21.91 quintal per each household. Farmers who take part in maize seed multiplication gets yield 30.61 quintal, while other who do not participate in maize seed multiplication gets yield 16.79 quintal.

Credit provision in study area

Credit was as a source of income of farmer's, in increasing purchasing power of agricultural inputs. In the study area, credit provision was very low, because of imbalance community's demand in credit and potential of Oromia credit and saving Share Company of Sokoru branch and repayment (interview with OCSSCO of Sokoru branch). As indicated in table 4.6 below, from total 294 households, 55 (18.707%) get credit, and 239(81.293%) respond as shortage of credit. Credit provision and using in study area was very low, because of, shortage of initial capital, bureaucracy of service provision in OCSSCO Sokoru branch office, office is far from their house, because of religion issue, interest-bearing credit not recommended in the study area (triangular answer from FGD, individual, participants and Sokoru branch OCSSCO).

Table 4.6: - Credit accessibility

Character	Category	Total house hold		Seed multiplier		Other		Chi-square	P(t)
		Freq.	Perc.	Freq.	Perc.	Freq.	Perc.		
Credit accessibility	Yes	55	18.707	26	23.853	29	15.676	3.160	0.082
	No	239	81.293	83	76.147	156	8.324		
	Total	294	100	109	100	185	100		

Source: own field survey, 2021

4.1.4. Hybrid maize seed marketing and distribution

4.1.4.1. Input supplier to the study area.

In Sokoru woreda, Limmu, Shone, BH-660, BH-543, and BH- 661 maize seed varieties supplied to farmers. The price of seed and yield gained varied from variety to variety; for example, the price of limmu and yield gained from limmu variety was higher than others one (interview with WAO).

Sokoru Woreda Agriculture office distributes farming inputs to farmers in their kebele store based on identified demand by kebele level DA. In study area farmers those participate in maize seed multiplication get basic seed directly from Jimma cooperative union at their kebele store; 109 (37.07%) households were involved in maize seed multiplication, 176 (59.86%) farmer get seed that was supplied by woreda agriculture office, 9 (3.06%) get from both WAO and from the local market. The study by (Gush, 2011) shows hybrid maize seed supplied to farmers only through the Bureau of Agriculture office, because there is no other option in maize seed supply in the study area.

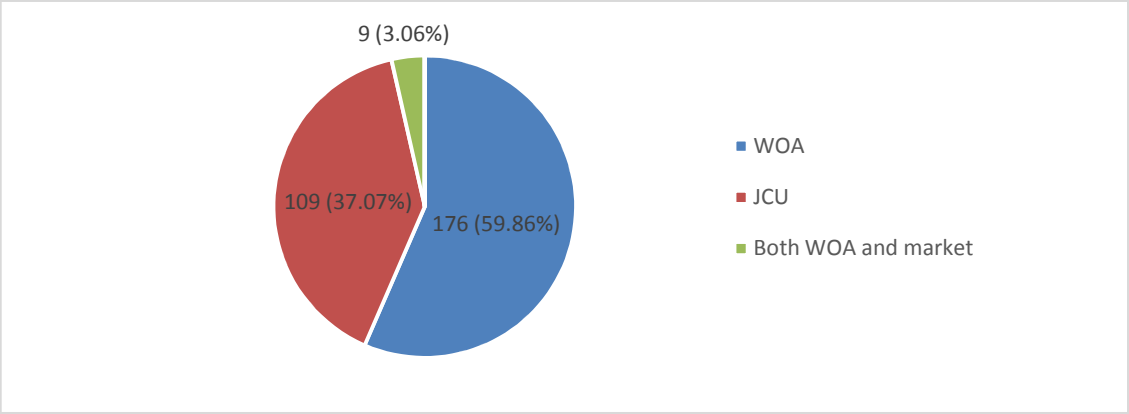

Figure 3: -Supplier of maize seed to farmers

Source: own result of field survey, 2021

4.2. Econometric Analysis

Multicollinearity: before running the model, the hypothesized explanatory variables tested for the existence of a multicollinearity problem that is the situation where the explanatory variable is highly interrelated. The Variance Inflation Factor (VIF) shows the presence/absence of Multicollinearity problem among the independent variable of the continuous variables and contingency correlation coefficients was to dummy variables. It concluded that in this study there were no serious Multicollinearity problems among the explanatory variables, as their respective VIF were less than 10 from the rule of thumb and correlation coefficient was less than 0.75(see Appendix 2).

4.2.1. Determinants of maize seed multiplication

The objective of the study was to identify variables that have significant influence on determining smallholder farmers' willingness to participate in maize seed multiplication in

the study area. Hence, family size, education level, land allocated to maize, having livestock, commercial fertilizer, access to maize seed, experience on maize production, price of hybrid maize seed, frequency of contact with DA and having information on hybrid maize seed were statistically significant factor that determine farmers willingness maize seed multiplication adoption in Sokoru Woreda since their p-value was less than 0.1.

4.2.2. Analysis of Factors influencing maize seed multiplication adoption

Size of land allocated for maize: the land was the most and influential factor that promotes agricultural production both in farming and in livestock rearing. From this land, farmers allocate to different types of crop. Hence, land allocated to maize cultivation was one variable takes part in increasing maize production and adopting of seed multiplication program. The model output predicts that for every increase in one hectare of land allocated to maize farmer's decision to adopt the seed multiplication increases by 16%. Land allocated for maize has negative significant influence on determining farmers maize seed multiplication at 10% significant level. In seed multiplication program, farmers those who have more land rent their land to others and less user (FGD from gengelata kebele farmers). The study by (Lemi, 2015), shows, small landholders are less adopters and users of technology, and large landholders more technology users.

Total land holding: the land was the most and influential factor that promotes agricultural production both in farming and in livestock rearing. The model output predicts that for every increase in one hectare of land own, decision to adopt the seed multiplication increases by 60% and have insignificant effect on seed multiplication adoption in the study area.

Number of oxen: the ox was the variable that promotes agricultural production in farming activities performed by oxen power. The model output predicts that for every increase in one number of oxen owned by farmer, decision to adopt the seed multiplication decrease by 1% and have insignificant effect on seed multiplication adoption in the study area.

Commercial fertilizer: was one of improved agricultural inputs used in production increment. Farmers those who use commercial fertilizer were more seed multiplication adopter. The model output shows that availability of commercial fertilizer just increases seed multiplication adoption of the farmer by 12% and commercial fertilizer have positive significant influence on determining farmers maize seed multiplication at 10% significance level.

Price of seed: Price is the value given to improved seed technologies marketed in the formal seed marketing system. The model output predicts that for every increase in one ETB increase in the price of seed the farmer's decision to adopt the seed multiplication increases by 0.2% and have positive and significant effect at 5% significance level. From aggregate demand theory as price increase quantity decrease, result from this study was inverse of this because of the price of seed was limited by seed producer and MoA based on the pack size of the seed. At kebele level price of seed is no more difference and payment with quantity, as the quantity increase price increases. A study by (Yitbarak, 2017) shows the price of technology positively affect the level of technology adoption in Ginier and Sinanaworeda, of the Bale zone.

Family size: family size was showing the main labor force to agricultural activities run by human power. Every activity; from land preparation to post-harvesting was by human power and households those having more person especially in productive age were more user of improved inputs such as fertilizer and improved seed. The model output predicts that for every increase in one family member in the household the farmer's decision to adopt the seed multiplication increases by 22% and have positive and significant effect at 5% significance level. Finding by (Solomon, 2011) show family size was significantly positive impact quantity of local hybrid maize seed production and marketing in Amhara region of Marwoled, goshiye, Wombarma and Yilmandensa Woreda.

Age: this variable show how many years of the farmers during survey time that increase decision to adopt improved seed. The model output predicts that for every increase in one year of household head, the decision to adopt the seed multiplication decrease by 14% and have insignificant effect to seed multiplication adoption.

Sex: This variable show the gender of household head surveyed. Male-headed household are more active in technology adopter and decision maker in the study area (FGD with farmers in each kebeles). Sex has insignificant impact on the seed multiplication adoption in the study area.

Education level: education was source of knowledge in increasing agricultural production by adopting improved inputs such as fertilizer and improved seed. Farmers who more educated were more aware on production and productivity than others were. The model output predicts that for every increase in one grade, the farmer's decision to adopt the seed multiplication increases by 18% and have positive and significant effect at 5% significance level.

Experience in improved maize seed use: experience in using improved seed positively and significantly determine smallholder's seed multiplication adoption at 5% significance level. The model output shows that one-year increase in experience of using improved seed just increases seed multiplication adoption of the farmer by 12%.This indicates farmers those who use hybrid maize seed for a long time were more actively participate in using technologies in increasing agricultural productivity. Finding by (Nyamia, 2010) shows farming experience was positively affecting technology adoption in Kenya in Machakos District.

Yield from previous year: This variable show how much quintal household gained in the previous year that initiates farmers improved seed adoption. The model output shows that one-quintal increase in yield from previous year just increases seed multiplication adoption by 2% and have insignificant effect on the seed multiplication adoption.

Livestock: livestock was the source of income for rural households and farming activities carried out by livestock. Farmers those who have livestock were more adopter and user of new agricultural technologies. The model output shows that availability of livestock just increases seed multiplication adoption of the farmer by 22%. Having livestock was significantly determining farmers' participation in maize seed multiplication at 1% significance level. A finding by (Ali, 2020) was consistent with this findings.

Credit accessibility: - credit was variable that increase purchasing power of inputs and using improved technologies for production increment. In study area, shortage of credit was the challenge that limits improved seed and fertilizer. The model output shows that availability of credit just decreases seed multiplication adoption of the farmer by 17%. Seed information has insignificantly influence on seed multiplication adoption.

Seed Information: - information was a critical issue in adopting and using improved technologies for production increment. In study area source of information was DA, on seed type, technical issue, ways of planting from land preparation to post-harvest by contact with farmers, and at their office (from FGD within farmers). Farmers those having more information on maize seed variety were more adopter of seed multiplication program. The model output shows that availability of information on seed just increases seed multiplication adoption of the farmer by 15%. Seed information was significantly positive influence on seed multiplication adoption at 1% significance level. The positive relationship shows, as households more informed on seed and ways of application were more participate in maize

seed multiplication. (Poku, et al, 2018) shows having information on technology makes more adoption and use.

Marital status: This variable show the households conducted with married that increase production by addition of more labor force in farming performed by human power. The model output shows that availability of seed just on the needed time will increase participate in seed multiplication by 11%. Marital status has insignificant impact on the seed multiplication adoption in the study area.

Frequency of contact with DA (FRCDA): DA was one of stakeholders who actively participate in any agriculture activities carried out in specified area by contact with farmers. DA considered as the source of information and technical support from land preparation to post-harvesting. Farmers those who frequently contact with DA are more technology adopter and user than those who less contact. In study area farmers, those who participate in maize seed multiplication are more contact with DA than others are. From the logit model result, the frequency of contact with DA was significantly affecting maize seed multiplication at 1% significance level. The coefficient 0.39 show, as number of days farmers contact with DA increase by one day the probability of adopting seed multiplication increase by 0.39. The study by (Gazahgn, 2008) shows contact with DA affect farmers in potato seed multiplication and those households who have good access to DA are more likely knowledgeable, having more skill than others.

Access to seed on time (ASRT): This variable show the time at which the seed is available and supplied in quality and quantity for sale. In the study area farmers those who participate in maize seed multiplication get basic seed directly from Jimma Cooperative Union in time with quantity demanded than other farmers. The model output shows that availability of seed just on the needed time will increase participate in seed multiplication by 12%. Access to seed on time was significantly affect maize seed multiplication at 1% significance level. A finding by (Samuel, 2016) shows participating in contract farming was important in getting basic seed in the required time.

4.2.3. Propensity score matching (PSM)

This study was to compare whether participating in maize seed multiplication or not, brought a significant impact on the household's yield and annual income. The PSM analyzed by

logistic regression model. Dependent variables ware (participate in maize seed multiplication '1' and not participate in maize seed multiplication '0').

A result presented in Table 4.7; The goodness of fit, prob> chi2 was less than 0.01 show overall logit model was significant and pseudo-R^2, show variation in dependent variables was 50.66% explained by variations in explanatory variables displayed in table 4.7. The objective of matching procedure is to get similar probability of maize seed multiplier (treated) group and other farmers (control) groups within a given covariates.

Table 4.7: - Result of logistic regression model

Market channel	Coef.	Std. Err.	z	P-value
constant	-9.820367[a]	2.13503	-4.60	0.000
Sex	-.0751588	.8143704	-0.09	0.926
Marital status	.0110259	.4060315	0.03	0.978
Education level	.1811078[b]	.0907011	2.00	0.046
Family size	.2262575[b]	.1092317	2.07	0.038
Age	-.0145541	.026889	-0.54	0.588
Credit accessibility	-.0176198	.4776976	-0.04	0.971
Land holding	.6040935	.5620187	1.07	0.282
Land allocated to maize	-1.618542[c]	.9413255	-1.72	0.086
Distance from delivery point	-.0939842	.1900678	-0.49	0.621
Livestock holding	2.248031[c]	1.29363	1.74	0.082
Number of Ox	-.0085567	.2717452	-0.03	0.975
Commercial fertilizer	1.249217[b]	.531232	2.35	0.019
Accessibility of seed on time	1.225965[c]	.6616907	1.85	0.064
Price of hybrid maize seed	.0025605[c]	.0015233	1.68	0.093
Yield from previous year	.0161386	.023003	0.70	0.483
Farming experience	.1082771[c]	.0655341	1.65	0.098
Frequency of contact with DA	.3947564[a]	.1193197	3.31	0.001
Seed information	1.558978[a]	.4214686	3.70	0.000
Number of observations = 294 LR chi2(18) = 196.40 Prob> chi2 = 0.0000 Log likelihood = -95.649046 Pseudo R2 = 0.5066				
Superscript of a, b and c show significance at 1%, 5% and 10% significance level respectively.				

Source: own computation, 2021

From the estimation result, there were variables (marked with a, b and c) that are statistically significant hence; their p-values were less than 0.1.

4.2.3.1. Common support condition

After estimating the values of the propensity score for program participator and other; the next step in the propensity score matching technique is the common support condition. Only observations in the common support region matched with the other group considered and others those out of common support should be out of further consideration.

The estimated propensity score lies in the range of 0.0000249 and 0.9999993 with a mean of 0.3669946. For maize seed multiplier (treated groups) lies in the interval of 0.0033446 and 0.9999993 with a mean of 0.7165443 and for other farmers (control groups) was in the range of 0.0000249 and 0.9924885 with a mean of 0.1610437. The common support was found between greater than minimum of treated and less than the maximum of control. Common support found between 0.0033446and 0.9924885.

Table 4.8: -Distribution of estimated propensity scores

Group	Observation	Mean	Std	Min	Max
All	294	.3669946	.3531673	.0000249	.9999993
Treated	109	.7165443	.2514731	.0033446	.9999993
Control	185	.1610437	.2155653	.0000249	.9924885

Source: own computation, 2021

Graphical representation of propensity score

The propensity score of treated and controlled group and both of them displayed as follows. Kernel density shows distribution of total households, treated and untreated with respect to their propensity scores.

Control group

From the following graph, the propensity score values of controlled group densely found at left side of the graph.

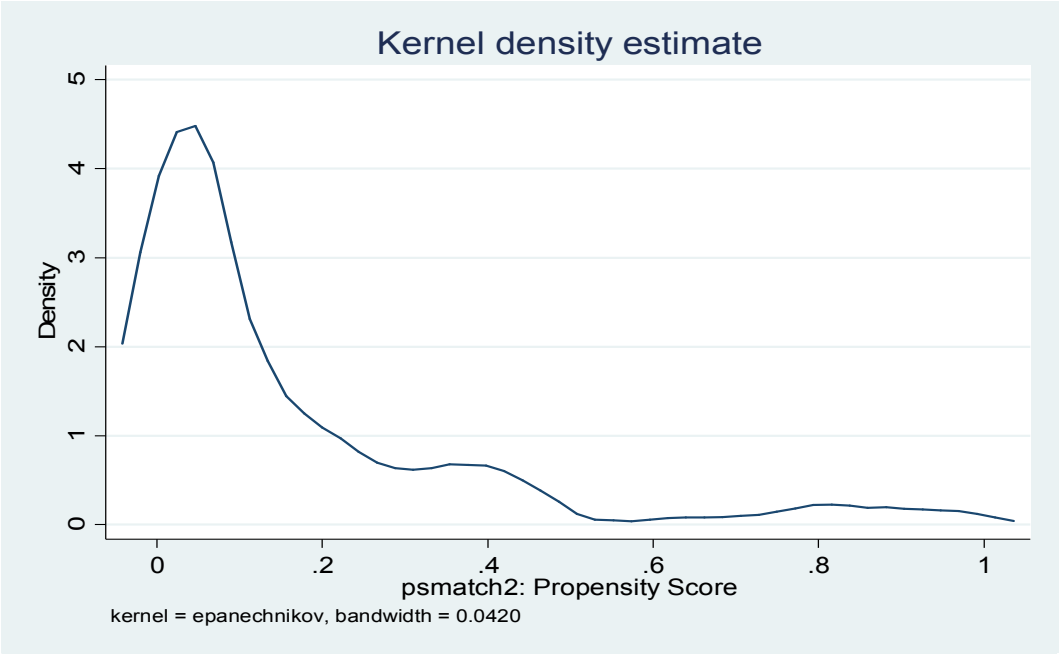

Figure 4: kernel density for control group

Source: own sketch

Treated group (seed multiplier)

From this graph propensity score values of the treated group were densely found at the right side of the graph.

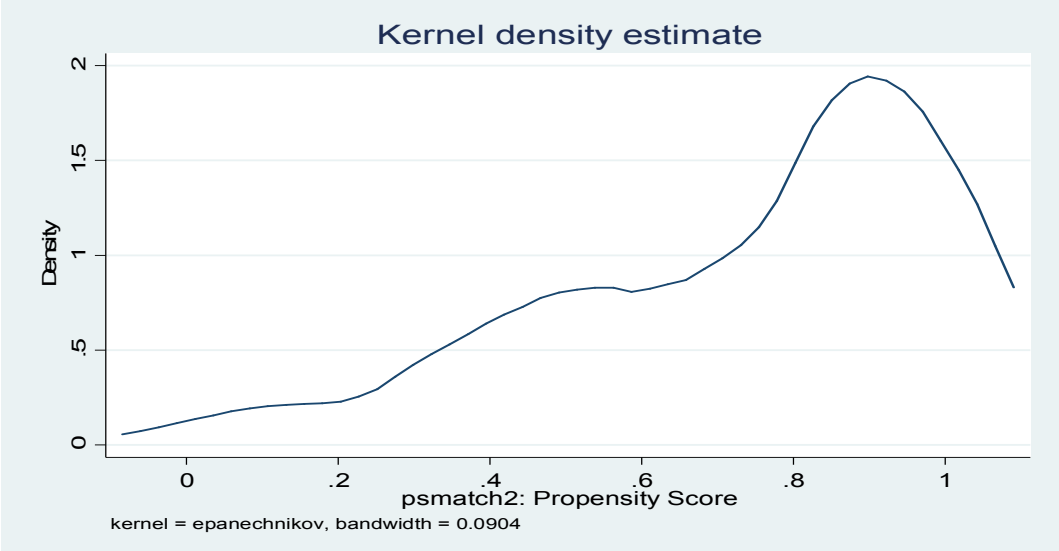

Figure 5: kernel density of treated group

Source: own sketch

Both treated and control

From the following graph the common support values of score matching was found between 2 and 6.

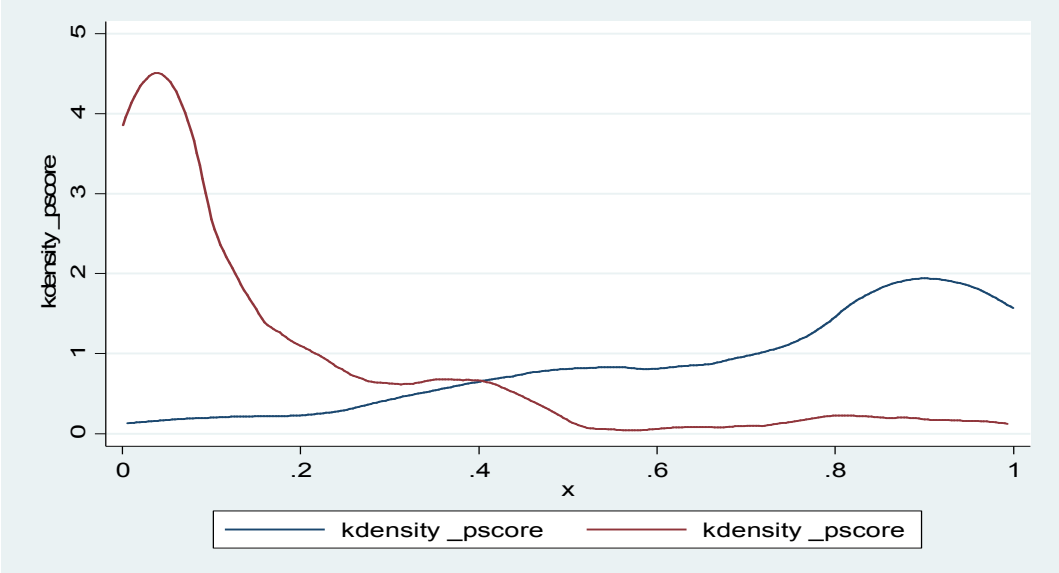

Figure 6: kernel density of both control and treated group

Source: own sketch

Identify Common support region

As suggested by (Khander, et al, 2009) to ensure maximum comparable units of treated and untreated households, the sample used for matching is restricted on those households who are located in the common support region. The common support region is where the values of propensity scores of both maize seed multiplier and comparison groups found. The basic criterion of this approach is to delete all observations whose propensity score is smaller than the minimum and larger than the maximum in the opposite group (Caliendo, 2005).

The ATT is only determined in the region of common support. Hence, an important step is to check the overlap and the region of common support between maize seed multiplier and other. To identify observations found in the region of common supports, visual analysis of the density distribution of the propensity score in both groups was common (Caliendo and Kopeinig, 2008). As seen in appendix 4 the kernel matching bandwidth (0.25), from 294 observation, twenty-nine (eight from treated and twenty-one from control) was out of common support and discarded from the observation.

4.2.3.2. Matching algorithm

An alternative matching estimator can be employed in matching maize seed multiplier and other households in the common support region. The choice of final matching algorithm can be selected by selection criteria like balance test, pseudo-R^2, and matched sample. Matching estimator which balances all explanatory variables (the result that significant difference between two groups), models which bear low pseudo-R^2, and the more matched sample was preferable for the matching algorithm (Dehejia and Wahba, 2002).Matching with varies algorithm displayed in the following table:

Table 4.9: - Matching algorithms

Algorithm	Balance test	Psoudo-R^2	Matched sample
Nearest neighbor matching (NNM)			
NN (1)	13	0.165	265
NN(2)	17	0.137	265
NN(3)	17	0.127	265
NN(4)	17	0.107	265
NN(5)	17	0.103	265
Radius matching (RM)			
Caliper (0.01)	16	0.242	135
Caliper (0.1)	14	0.165	265
Caliper (0.25)	14	0.165	265
Caliper (0.5)	14	0.165	265
Kernel matching (KM)			
Band width 0.01	16	0.238	135
Band width 0.1	17	0.112	265
Band width 0.25	**17**	**0.080**	**265**
Band width 0.5	14	0.090	265

Source: own computation, 2021

As discussed in table 4.9 from all matching algorithms, kernel-matching bandwidth 0.25 selected for this study because of low pseudo-R^2.

4.2.3.3. Testing the property of balance score and covariates

T-test: to check if there is a significant difference in covariates mean for both groups. Before matching, differences for both groups expected and after matching, covariates should balanced and no significant difference should found. As indicated in table 4.10 below, age of

household head, land, land allocated to maize, livestock, ox and seed information were significant before matching and after matching those variables become insignificant.

Bias: During the evaluation of treatment effect, major econometric problem is selection bias. As stated by (Khander, et al, 2009) percentage of the bias in covariates after matching reduced to less than 20% critical level. In this study, the mean bias was less than 20% for the covariates.

Table 4. 10:- Covariate test before and after matching

Variable	Before matching N=294					Kernel matching band width (0.25) N=265				
	Treated	Control	%bias	T	p>t	Treated	Control	%bias	T	p>t
_pscore	.71654	.7156	0.4	0.03	0.978	.7132	.67483	16.1	1.03	0.304
Sxx	.89908	.93578	-12.2	-0.98	0.327	.90099	.90962	-2.9	-0.21	0.835
Mristat	1.1835	1.0826	15.9	1.43	0.154	1.198	1.2106	-2.0	-0.14	0.887
EULE	2.9725	3.3945	-18.5	-1.03	0.303	2.8515	2.7699	3.6	0.21	0.836
FMLSZ	7.2477	7.1651	4.2	0.31	0.754	7.0693	7.6646	-30.3	-2.18	0.030
AGH	45.339	42.963	26.8	2.05	0.042	45.287	44.857	4.9	0.34	0.738
ATC	.23853	.26606	-6.9	-0.47	0.642	.25743	.20467	13.3	0.89	0.376
TNDH	1.789	1.2661	67.5	4.84	0.000	1.6436	1.605	5.0	0.36	0.716
LTMAI	1.0826	.8578	47.5	3.41	0.001	.99505	1.0438	-10.3	-0.72	0.475
DFDP	1.7867	1.8165	-2.9	-0.27	0.790	1.7797	1.7095	6.8	0.61	0.542
TLU	.99083	.91743	32.5	2.62	0.009	.9901	.97805	5.3	0.68	0.496
OX	2.0367	1.4771	57.4	4.42	0.000	1.9109	1.7519	16.3	1.33	0.185
CFU	.89908	.95413	-13.4	-1.56	0.120	.90099	.92896	-6.8	-0.71	0.479
ASRT	.93578	.9633	-7.0	-0.93	0.356	.94059	.95507	-3.7	-0.46	0.646
PHM	669.27	534.68	40.8	2.88	0.004	575.74	547.77	8.5	1.00	0.319
TMYP	26.11	23.358	22.4	1.61	0.108	24.02	22.943	8.8	0.65	0.513
EUHM	14.174	13.615	16.4	1.01	0.314	14.04	13.52	15.2	0.98	0.327
FRCDA	4.0734	4.2018	-6.9	-0.45	0.654	3.8416	3.6176	12.0	0.79	0.429
SEEDINF	.75229	.86239	-24.8	-2.07	0.039	.73267	.66961	14.2	0.98	0.330

Source: own computation, 2021

4.2.3.4. ATT estimation of the impact of maize seed multiplication on HH welfare

Seed multiplication was program that enables farmers to get more yields and improve their living standards. Because the farmers who participate in the program were, more treated than the others; getting basic seed on time and more quality, continuous extension service, and sell their product by high price than others. Before proceeding to estimate the treatment effect of

the seed multiplication, we have to be sure that the reliability of participants and controls to have a uniform distribution on its observed and non-observed characteristics. The average treatment effect measures the average difference in yield and annual income between the matched maize seed multiplier and others. The ATT for the matched maize seed multiplier and others has found using kernel matching at a bandwidth of 0.25 displayed in table 4.11.

Table 4. 11: Treatment effect on household's yield and income

Variable	Matching estimator (kernel bandwidth 0.25)	Treated	Control	Difference	Stand. Error	t-test
Annual income	Matched	45391.0891	34387.6201	11003.469	2977.52801	3.70[xx]
Yield gained	Matched	27.5544554	22.4338186	5.1206368	2.12832215	2.41[xx]

"xx" show, significance at 5% significance level.

Source: -Own survey result, 2021

The estimation results in table 4.11 show the effect of maize seed multiplication on household yield and their annual income. The study focused on the impact of maize seed multiplication on the total yield and annual income. Results of the analysis shows that household who participated in maize seed multiplication earned yield 27.55 quintals while those non-participated earned yield 22.43quintals in average and annual income of maize seed multiplier was 45,391.08 ETB while other farmers annual income was 34,387.62 ETB.

The PSM result showed, after controlling for pre-intervention differences of the maize seed multiplier and others, the average yield gained for maize seed multiplier was 5.12 quintal and annual income was 11003.46 ETB greater than others were. The PSM result shows that maize seed multiplication has a positive and significant impact on yield and annual income. The t-test shows that mean difference of yield and annual income between treated and control group was statistically significant at 5% significance level.

4.2.3.5. Sensitivity analysis

As suggested by Wooldridge, 2013, in quantitative research sensitivity analysis was mandatory. The sensitivity analysis show-matching estimator was not robust against un-explained biases. The problem addressed by sensitivity analysis.

The basic issue in the sensitivity analysis was to check whether the treatment effect is due to an unobserved factor or not. Rosinbaum, 2002, proposes and using the Rosenbaum, bounding approach to check the sensitivity of estimated ATT. The results show that the impact of the program was not changing through participants and non-participants households if it is allowed to differ odds of being treated up to gamma = three. That means for the outcome variable estimated, at various levels of critical values of gamma, the p-critical value is significant which further indicate that consideration of important covariates that affect dependent variables and outcome. We could not get the critical values gamma where the estimated ATT questioned even if we have set gamma values largely up to three. Thus, this study concluded that the impact estimates (ATT) are insensitive to unobserved selection bias and pure change of yield and annual income was only participating in maize seed multiplication (see appendix 4).

4.3. Maize seed multiplication status and its marketing

Maize seed multiplication was the program that executed to overcome aggregate supply shortage by producing quality seed. The seed produced by farmers was supplied to certified hybrid maize seed producers (contract body), and come back to farmers after processed. Various stake holders was take part in production of the quality seed including farmers themselves, DA, Woreda agriculture offices, cooperative promotion offices, research centers (Ambo University), JCU. From an interview with WOA, FGD with hh and document review, maize seed multiplication was the program applied by contract agreement between Jimma Cooperative Union and Sokoru Woreda of wolmera and gengelata kebele farmers. This program started since 2010. The agreement was before planting, in written form on the price of grain yield and risk management. JCU supply basic seed based on the required variety and training on ways of application and continuous monitoring and evaluation. From the yield, 5% left for farmers to use as seed for coming crop season and 95% sold to contractors based on their agreement. The price of grain yield was 10-15% higher than the local market price.

4.3.1. Market participants in maize seed multiplications

In the study area seed producer farmers, contractors (JCU) and farmers 'cooperative identified as hybrid maize seed marketing participants even though some of the agents accomplish one or more of the marketing functions.

Schematic representation of maize seed multiplication

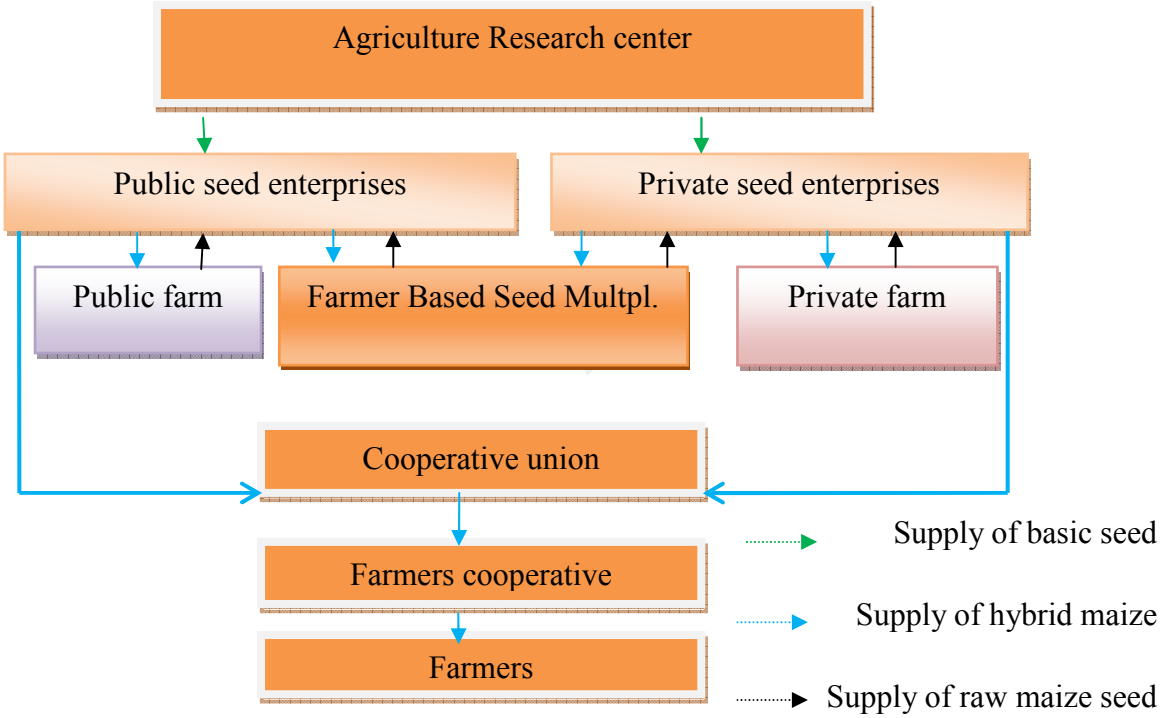

Figure 7: Schematic representation of market participants in maize seed multiplication.

Source: Modified from JCU

As indicated in above diagram, basic seed produced in agricultural research center and distributed to licensed hybrid maize seed producer including JCU. Improved seed producer produce the certified maize seed in farmers farm by directly supplying basic seed to farmers and buy un-processed seed from farmers, process it and sell the hybrid maize seed to farmers through farmers cooperatives.

4.3.2. Production cost and profitability of marketing participants

4.3.2.1. The Production cost of maize seed multiplication at producer's (farmers) level

Most activities include plowing, weeding, harvesting performed in maize seed multiplication was by family labor and "Debo" (two or more than two families working to gather). Based on survey with seed multiplier farmers production cost described as table 4.12 below:

Table 4. 12: Production Cost and profitability of maize seed multiplier, 2011 EC

Cost Items	Cost (ETB/ha)	Cost (ETB/quintal)
Plowing the farm land	2240.00	64.00
Inputs/ fertilizer, basic seed/	4600.00	131.43
Planting	480.00	13.71
Weeding	640.00	18.29
De-tasseling	500.00	14.29
Harvesting	600.00	17.14
Threshing	1200.00	34.29
Land rent	2000.00	57.14
Land use tax	40.00	1.14
Transport from farm to sales center	350.00	10.00
Total production cost	12,650.00	361.43
Selling price/producers price GMMp(%) Profit (Birr)	49,000.00 - 36,350.00	1,400.00 55.72% 1,038.57

Source: own survey, 2021

Table 4.12 above shows different types of marketing cost related to the maize seed multiplication at farmer's level. The production cost reveals that, price for plowing the land by including human power and oxen rent was 2,240 ETB/hectare, price to buy inputs such as fertilizer, and basic maize seed was 4,600 ETB/hectare and land rent was 2000 ETB/hectare and those parameters constitute 69.88% of production cost of seed multiplier farmers.

Profitability of maize multiplier farmers

The profitability calculated by taking the average total income and expense of the seed multipliers in 2011E.C. The result shows that seed multiplier farmers were profitable for the specified period. Maize seed multiplier earned a net profit of Birr 36,350 ETB/ ha, and Birr 1,038.57 ETB/quintal (Own result, 2021). The average yield maize seed produced for the year 2011EC was 35 quintal/ha and the average selling price of maize seed produced by maize seed multiplier farmers was 1400 ETB/quintal (Sokoru Woreda Agriculture office, 2019), used to estimate the profitability per quintal.

4.3.2.2. Costs and Profitability of JCUin producing and marketing hybrid maize seed

In Ethiopia, public and private seed producers sell their products through either chain of agricultural offices up to kebele level or directly by themselves (Benson et al, 2014). Cooperative union sell the seed to farmers by charging transport cost, unloading, loading cost within small profit (Husman, 2015). JCU licensed seed producers and distribute the produce to farmers through their farmers' cooperative means.

Table 4.13, show different types of production and marketing cost related to the maize seed multiplication at contractor (JCU). Seed cleaning, dressing and packaging cost accounts 54.05ETB/quintal (3.40%), transport cost 55ETB/quintal (3.46%)and price of raw maize seed purchased from farmers was 1,400 ETB/quintal (88.09%), respectively and marketing cost of processed seed includes transport cost from seed producer center to farmers 55 ETB/quintal(3.46%), loading and un-loading cost 8 ETB/quintal(0.48%). Processed seed sold to farmers cooperatives by 2500 ETB/quintal in estimating profitability of JCU; in then contractor (JCU) get net profit of 847.76 ETB/quintal.

Table 4.13: Cost and Profitability of Hybrid Maize Seed production and marketing 2011 EC

Cost description	Cost ETB/qt	Percentage of shares from totalmarketing cost
Purchase price of raw seed from farmers	1400	84.73
Loading and Unloading of raw maize seed	9	0.54
Loading and Unloading of processed hybrid maize seed	8	0.48
Transport expenses of raw seed from farmers farm	55	3.33
Transport expenses of hybrid maize seed	55	3.33
Sack for raw maize seed	12	0.73
Sack for processed hybrid maize seed packing	5.05	0.31
Cleaning and Packaging cost	30	1.82
Inbred maize seed purchasing cost	17.85	1.08
Chemical fumigation	19	1.15
Perdiem	15	0.91
Salary	23.26	1.41
Interest cost	3.08	0.19
Total cost	1,652.24	100.00
JCU sales price 2,500.00		
JCU Gross Margin 1,100		
JCU Net Profit 847.76		

Source: JCU, 2020

Table 4.14: Cost and Profitability of hybrid maize seed at farmers' cooperative, 2011 E.C

Cost Items	Cost and Profitability per unit (ETB/quintal)
Purchase price	2500
Miscellaneous costs	7
Total cost	7
Primary Cooperative average sales price = 2,507 Primary cooperative Gross Margin = 7 Primary cooperative Net Profit =7	

Source: Gengeleta multipurpose farmers cooperative, 2020

4.3.3. Gross Marketing Margin in hybrid maize seed marketing

Products reach to final consumers through a market chain. In the study area, there are three participants in maize seed marketing chain; Seed producer farmers, Cooperative Union (JCU), Primary cooperative and the seed user (the farmer). The seed multiplier farmers transport the maize from his farm to the collection center mainly for their kebeles. The contractor (JCU)purchases the raw maize seed from seed producer farmers at the seed collection center, transport the seed to the center of seed processing plant, clean the seed, treat it with chemicals, pack the processed seed and transport it to the farmers cooperatives at their kebeles. The primary cooperatives distribute the seed to final seed users (farmers).The price paid by the final consumers is thus made up of the amount of money paid out to the farmers for his produce plus all the costs involved until the produce reach the ultimate consumers. A marketing margin exists as the price difference between any stages in the marketing chain. The percentage share of final price, which taken up by the marketing function is known as the marketing margin (cited by Solomon et al, 2018 from Mendoza, 1995).

Depending on estimated prices by the different seed market participants, summarized in (Table 4.12- 4.14), the marketing margins calculated as:

TGMM (all channel) = 44.28%

GMM (Jimma Cooperative Union) = 44.00%

GMM (Farmers cooperative) = 0.28%

GMMP (Maize seed Producer's participation) = 100%-44.28% =55.72%

Based on the result of marketing margin analysis of the shares of the consumer price was; share of the maize seed multiplier farmer was 55.72% , the share of the hybrid maize seed producer (JCU) 44% and the share of Primary Cooperative was 0.28%. The share of the Net marketing margin of the e seed multiplier farmers was 74.2% is much greater than the share of improved seed producer (JCU) 33.9%. This can be from maize seed multiplier farmers sell their produce directly to JCU based on their agreement that minimize their transaction cost. From this, the maize seed multiplier farmers shares the maximum marketing margin and the Net marketing margin of hybrid maize seed production and marketing arrangement. This share may contribute in increasing the income of the seed multiplier farmers.

Table 4.15: Comparison of income between maize seed multiplier and others in 2011 EC

Description	Multiplied maize seed	Other (grain maize)
Average productivity (Quintal/ha)	35	48
Selling price (birr/quintal)	1,400	750
Total selling price (birr/ha)	49,000	36,000

Source: Own compilation, 2021

From the above table, maize seed multiplier get yield 35 quintal/hectare, selling their yield by 1,400 ETB to JCU and totally sell their product by 49,000 ETB; while other farmers get maize yield 48 quintal/hectare, selling their yield by 750 ETB and totally sell their product by 36,000 ETB. From this one can conclude that maize seed multiplication have positive impact on income of participants.

4.4. Challenges in hybrid maize seed production and marketing

In the study area, the majority of households were smallholders having land less than two hectare and dependent on rain feed agriculture system. To activate the agricultural production, supply improved technologies especially improved seed and fertilizer within a concise marketing system was paramount.

From FGD, interview with some stakeholders and observation, in study area identified challenges in seed system discussed as follows:

- ✓ Available seeds did not access in sufficient quantity at the right time for planting due to long supply chain, and leftover stock in WOA store, because of inadequate demand analysis. As a result, 30 quintals of hybrid maize seed left in the Sokoru Woreda agriculture store in 2011EC (Interviewee with WOA).
- ✓ Limited availability of hybrid maize seed varieties that are mostly adopted by farmers and suitable for local agro-ecologies and variety that more yield was gained from; example only variety BH-660 and BH- 661was supplied and BH-543 and Limmu are more productive (FGD With Wolmera kebele farmer)
- ✓ Lack of competitive seed supplier and seed supplied by Union to maize seed multiplier's price was too high.
- ✓ Those seed suppliers for contract farming are saw themselves as NGOs and less freely contact with farmers at their farmland.

- ✓ Only one storekeeper for more than one kebele; and the store does not open on time and farmers wait around for a long time (FGD with Wolmera and gengelatakebele farmer).
- ✓ Shortage of infrastructure
- ✓ Seed multiplier farmers sell their yield by means of black market to the neighbor kebeles and farmers. This can be from imbalance the price paid by contract body (JCU) and neighbor farmer by black market price for the seed in the following year (FGD with Wolmera and gengelata kebele farmer).
- ✓ There is limited understanding and linkage among stakeholders on the seed production and marketing.
- ✓ Despite the majority of the smallholder households have access to extension services and are located in the nearby Farmers Training Center (FTCs), they still have a gap in the knowledge, and usage of the maize seed varieties, and the needed agronomic practices.
- ✓ Lack of access to seed-credit and subsidy for poor farmers; those farmers prefer to use improved seed and because of income shortage constrained to use formal seed (FGD with farmers in each kebeles).
- ✓ The limited involvement and the low capacity of producers' organizations in maize seed production and marketing also pose a serious challenge to the development of the maize seed sector (Document review and interview with WOA).
- ✓ Shortage of credit for smallholder farmers in the capability of purchasing agriculture input in required time (FGD with participants at each kebele).
- ✓ Farmers report their demand to DA during demand assessment, and divert their land to other crop and supplied seed left in store (interview with DA).
- ✓ Farmers those who participate in maize seed multiplication seriously influenced by poor quality of basic seed and climate change mainly rain fail.

Some researchers finding also consistent with this finding on challenges on the seed system (Dawit, 2008; Kumlacho, 2015; ATA, 2017)

4.5. Stakeholders Participation in hybrid maize seed production and marketing

Stakeholder was government and non-government organizations, a private company, group of society and person those takes part for the success of the identified program, individually or by cooperation. The roles, responsibility, and interests of most of the stakeholders found to

overlap; however, different actor's work was inter-dependent. In hybrid maize seed production and marketing, those stakeholders take part from seed Production to farmers at their farmland. Those stakeholders aim were to smoothly producing and marketing of hybrid maize seed to overcome aggregate supply shortage and improving livelihood of smallholder farmers.

This section describes the findings from focus group discussions with farmers in the study area, interviews with key stakeholders, and referring reports of agriculture office. Those stakeholders perform the following activities.

Production: ESE produces the hybrid maize seed for several years since its establishment. Currently, RSE, private seed producers and cooperative union have emerged intending to supply quality-improved seeds to satisfy the increased demand in the regions.

Processing: Seed processing covers all operations that carried out after multiplication of hybrid seed, to improve the quality of the seed lot. In its widest sense, the main components of processing are drying, shelling, cleaning and grading; the removal of inert material and alien seed; and followed by chemical treatments to protect the health of the seed and to combat insects, fungi, and bacteria and finally packaging. Seed producers carry out these activities.

Handling: Seed packaging is the final stage of processing. It helps to maintain the quality while handling and identification of the Product and it has strong linkages to marketing. Each bag of hybrid seed labeled in a 12.5kg package sized bag according to the standard set (Benson, et al, 2014). Producers put a tag on each pack, which specifies the certification, the variety name, and date of production. The packaging is an aspect of seed processing which sometimes overlooked but which can have a significant impact on the subsequent ability of seed enterprises to market seed successfully on their brand.

Storage: Seed quality is determined in both genetics' capacity and physical purity. Genetic quality is the ultimate determinant of seed performance but if the seed losses its physical quality, the benefit of improved genetic potential cannot released. The quality of the seed determines largely the success of the crop in terms of yield and product quality. That seed producer has a clean, cold, well-constructed, and appropriate design of store near the seed plants because germination strongly influenced by the external environment.

Pricing: Seed price set by the government. The seed prices made by the board of directors of ESE that contain the Director-General of EIAR as chair, two ESE representatives, Director of Agricultural Extension, Director of the Agricultural Marketing, Director of the Planning Monitoring and Evaluation Directorates of MoA as members. The set price then communicated to the Agricultural Marketing Directorate of MoA.

Demand assessment: The Agricultural Inputs Marketing Department, a unit under the MoA, is responsible for assessing national seed demand and supply. MoA employs a bottom-up demand-assessment, whereby the regional BoA develops annual seed demand statistics with input from woreda, development agents (DAs), and individual farmers about their seed needs. This information aggregated into woreda, regional and national demand statistics. The result is a rough estimate of the types and quantities of seed farmers want to purchase for following year in each area. This target loosely apportioned to the various producers (i.e. ESE and the RSEs). At the end of the cycle, the government allocates supply proportionally through the woreda agriculture office based on the original demand, without considering shifts in demand due to changes in rainfall patterns and market situation (Dawit, 2010).

Transport: the produced seed had delivered from the producer store to the allocated woreda. This was concerned to supply quality seed beginning from the seed producer to end-user through appropriate transportation.

End-user: The produced seed transported to woreda office agriculture for onward distribution to farmers, based on the official demand projection of the regional bureaus of agriculture. The delivered seed was stored in WOA until farmers' purchase the seed, responsibility is falling on the woreda agriculture office. Store management practice often had given less attention in the WOA than the producer store, moisture, and seed-borne diseases that reduce the germination capacity and physical quality of seed.

Some identified stakeholders in maize seed production and marketing and their role

Development Agent (DA): DA considered an actor who was act actively in service providing for other actors, since they are critical for facilitating farmer's access to seed. In addition, directly involved in seed production and marketing or collaborative with farmers; in demand identification, continuous monitoring and evaluation by contact with farmers at their farmland identify constraints in any agricultural activities and try to solve challenges at kebele level and report to woreda agriculture office that is above their capacity. For farmers,

those participate in maize seed multiplication monitoring and technical support of DA is too high from land preparation to post-harvest and selling of yield (from focus group discussion at each kebele).

NGOs: These are characterized as the basis for the development of seed system and network that facilitates interaction between the stakeholders (Woreda agriculture office, DA and farmers) by providing training at woreda level, supply improved seed and fertilizer to poor farmers those identified by Woreda agriculture office, donate finance and logistic to cover government gap. In the study area, powerful and influential NGO was World vision, to apply discussed activities (interview with Sokoru WAO).

Farmers. Farmers are at the end of the maize seed marketing chains, as ultimate consumers of maize seed as they purchase seeds and use it for production, and initial in demand assessment. Farmers aim to maximize maize yields while keeping the cost of production low. Thus, they look for the highest-yielding maize variety given their environment yet accessed at low costs. In maize seed multiplication farmers are supplier and demand of maize seed; demand basic seed from JCU and supply grain yield to JCU for seed. A study by FAO, 2018, shows seed marketing begins by farmers (demand quantity with variety) and ends with farmers (purchase seed).

Jimma Cooperative union: JCU supplies basic seed to agreed sites and sold the seed directly either using their staff agents. Primary cooperatives or cooperative unions involved in seed production also served as seed marketing agents, receiving commissions for their service. Individual agents selected based on their business experience, their ownership of a store, and their reputation for honesty in their community.

Stockiest: The seed stockiest, agents, and sub-agents said they are responsible for distributing seed to farmers and ensuring it is available when and where required. Store for agricultural input constructed in all kebele to minimize transaction costs and having storekeeper (interview with WOA).

Sokoru Woreda Agriculture and Natural resource office: - Are the public institutions that collect and control other stakeholders in seek of high-level production in the study area. WAO:

- Demand analysis and report to the Zone agriculture office.

- Provide technical support; distribute agriculture inputs, continuous monitoring, and evaluation at farmland and farmers training center (FTC).
- Make agreements between Jimma cooperative union and farmer's and negotiation on grain yield price between them if necessary.
- Proved timely response to challenges faced on farmers in agriculture activities.
- Manage every agricultural activity in the district.

Agriculture research center: -The maize research is nationally coordinated by Bako National Maize Research Center under the Ethiopia Institute of Agricultural Research (EIAR) and Bako, Melkassa, Holetta, Ambo, Jimma, Hawassa, Adet, Gambella, Abobo, and Gode Research Centers are involved in the national maize research program (Dawit, et al,2014). In the study area, the Ambo University provides technical support and ways of application to farmers who participate in maize seed multiplication. They contact with farmers at their farmland from land preparation to yield collection (interview with WOA).

In the study area, farmers themselves, DA, NGO, cooperatives, WOA, Jimma Zone office of agriculture, BOA, JCU, Ambo University and public seed producers take part in hybrid maize seed production and marketing with mutual roles (interview with WOA).

Collaboration status of stakeholders

Seed production and marketing was a complex task that seeks the contribution of various bodies from seed producers to end-user. In study area linkages between expected stakeholders were very low; and challenges such as late seed delivery, less quality of seed, inadequate demand analysis, imbalance of demand and supply, lack seed information, shortage of technical support, and disagreement of supplied variety with agro-ecologies was welcomed.

The collaboration of stakeholders in maize seed multiplication was very high; because of the failure of one actor was failure aggregate maize seed and for the other maize seed producer. In maize seed multiplication, production cost was high, in the labor force, monitoring and evaluation by DA, woreda agriculture office, cooperative union, and Ambo University were timely contacts with farmers at their farmland from land preparation to post-harvest (interview with WOA). The finding by (Kumlacho, 2015) also similar to this finding in, all actors has inter-dependent roles in the seed system and inefficiency of one stakeholder will affect negatively the performances of the rest of the others.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

This study conducted to analyze determinants and welfare effect of improved seed adoption: A case of smallholder farmers in Sokoru Woreda, wolmera and gengeleta kebeles.

To carry out the study, Sokoru Woreda purposively selected in potential maize producer and maize seed multiplication program carried out in. Data collected from randomly selected 294 regularly maize producer farmers by using questioner, focus group discussion by selecting 6-8 households in each kebeles and interview with the key stakeholders. Descriptive and econometric statistics applied in analyzing both qualitative and quantitative data.

Descriptive statistics result show, statistically significant difference family size, education level, land holding, land allocated to maize, experience in maize plant, maize yield gained from previous year, frequency of contact with DA, having livestock, accessibility of hybrid maize seed on time, price of hybrid maize seed, credit accessibility, number of oxen owner and having information on the seed. And statistically insignificant with sex, marital status, age and distance from delivery point between seed multiplier and other farmers.

The descriptive result of the sample household in the study area discussed as follows: In gender perspective, 265 of households were male headed while 29 were female headed. The marital status of farmers in the study area was; out of 294 households, 240 were married, 7 were single, 20 widowed and 27 were divorced. The average age of the sample household was 44years. In terms of the number of family members, a household in the study area has an average of seven family members. The surveyed households learn academic education in average up to grade two.

Most farmers in the study area were smallholders having land averagely 1.51 ha, of which 0.89 ha allocated for maize. Maize takes the largest portion of land in the cropping scheme in which 60% of the total landholding has been devoted to maize. Farmers in the study area have more than twelve years of farming experience, gain yield from previous year averagely 20.37 quintal, DA contact with farmers was on average three days per month and seed source is 1.83 km far from household's house.

Households in the study area can get improved seed as follows; from 294 identified households 109 (39.9%) of them participate in maize seed multiplication and get basic seed directly from Jimma cooperative union and 185 (60.1%) get hybrid maize seed in multilevel seed marketing method.

The market participants of maize seed multiplication in the study area were farmers, farmers' cooperative and JCU. Maize seed multiplier farmers production cost per quintal was 361.43 ETB, and sell their produce by 1,400 ETB and getting profit of 1,038.57ETB while hybrid maize seed producer (JCU) production cost was 1,652.24 ETB and selling price was 2,500 ETB and getting net profit of 847.76 ETB. From marketing margin analysis, seed multiplier farmers' gross marketing margin and net marketing margin of the consumer prices was 55.72% and 74.2% respectively, while JCU's gross marketing margin was 44% and net marketing margin was 33.9%. From this maize seed multipliers share of the consumer price was higher.

The impact of maize seed multiplication on household yield and annual income analyzed by propensity score matching (PSM), logit model estimation. The model run by eighteen covariates and dependent variables either participate in maize seed multiplication or not. Pseudo-R^2indicates, the variation of dependent variables was 50.66% explained by covariates. The ATT show that yield and annual income for the treated household was 27.55 quintal and 45,391.08ETB while the control group was 22.43 quintal and 34,387.62ETB respectively. This shows that; seed multiplication program have positive impact on yield and annual income of households.

Late delivery, inefficient quantity, the poor quality and high price of basic seed, shortage of fertilizer especially UREA, production activities was mainly by traditional means, shortage of credit, Inefficient demand analysis, knowledge gap and linkage among stakeholders and climate change were influential challenges identified in the study area.

5.2. Conclusion

Maize was the most productive cereal crop, produced and consumed by most people in the study area. However, its productivity and life standard of the community was not much improved because of supply shortage and poor quality of hybrid maize seed. To overcome such problem JCU multiply maize seed in farmer's farm by contract agreement with Sokoru Woreda farmers within serious care and treatments by contribution of varies stakeholders.

Number of family size, education level of farmers, land allocated to maize, having livestock, accessibility of commercial fertilizer, access to maize seed on time, experience on hybrid maize plant, price of hybrid maize seed, frequency of contact with DA and having information on maize seed significantly determine smallholder farmer's participation on maize seed multiplication in Sokoru Woreda.

Seed multiplier farmers were more beneficial than others in getting yield, improving their living standard to participate in every program in their kebeles, such as infrastructure distribution in both financially and by their force. Propensity score matching (PSM) shows that maize seed multiplication have positive and significant impact on households yield and income

Stakeholders such as farmers themselves, DA, NGO, and WOA, Jimma Zone office of agriculture, BOA, JCU, Ambo University and public seed producers take part in seed production and marketing; the role and responsibility of those stakeholders were inter-dependent.

5.3. Recommendation

Seed multiplication program was one of the promising means in alleviating supply shortage of hybrid maize seed of Ethiopia in general and study area in particular and improving welfare of the smallholder farmers. Maize seed multiplication was a sensitive issue that requires the contribution and involvements of various stakeholders for its success. Based on the finding of this empirical study, the following recommendations suggested:

Maize seed production and marketing implemented by inter-connection of stakeholders, in the study area, low inter-linkages among stakeholders identified and the weakness of one actor was the cause for the failure of all seed production and marketing. This recommends, every stakeholder actively, wisely, responsible, and working to gather in making efficient and smooth hybrid maize seed production and marketing.

Hybrid seed production such as maize seed requires the farm field isolation and till farmers awareness in the farm field isolation was low; in so concerned stakeholders including woreda office of agriculture and DA make aware the neighbored community on the issues of farm field isolation.

The other serious problem at the national level especially in the study area was inefficient and time-based demand assessment, actively by contact with farmers identifies the quantity of seed and at what time they find seed was a core issue in the gap from seed producer and farmer, so the government gives priority to demand analysis.

Supply shortage of the basic seed in time based on farmers demand was the critical challenges for the seed multiplier farmers in the study area. Therefore, basic seed supplier (JCU) gives appropriate attention in supply of basic seed-to-seed producer farmers and designs other alternative source of basic seed to maize seed multiplier farmers.

Most activities in maize seed production in the study area including plowing of the land, harvesting was performed by traditional means of human power and oxen, and productivity was not much improved. In so, government gives prior attention in empowering farmer's cooperatives by providing tractor and threshing machine either in credit means or in subsidy form.

From the impact analysis, farmers who participate in maize seed multiplication were more profitable; get more yield, improve their life standard, actively participate in any community participation than others, this recommends the government to promote such program to others else.

Poor quality of basic seed and sudden climate change seriously affect production of maize seed by farmers and indirectly hybrid maize seed producer; this advise that maize seed producer farmers, cooperative union and agriculture research center propose crop insurance to mitigate production and marketing of hybrid maize seed risks.

From the logit model result, pseudo R^2 show variation in the dependent variable was **50.66%** explained by independent variables, future researchers study determinants and welfare effect of improved seed adoption by adding more variables.

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Appendix 1: - frequency distribution

Variables	Description	frequency	Percent
Kebeles	Wolmera	159	54.08
	Gengelata	135	45.92
Participate in maize seed multiplication or not	Participants	109	37.07
	Other	185	62.93
Sex	Male headed	265	90.14
	Female headed	29	9.86
Marital status	Single	7	2.39
	Married	240	81.63
	Divorced	20	6.80
	Widowed	27	9.18
Credit accessibilities	Yes	55	18.71
	No	239	81.29
Having livestock	Yes	274	93.20
	No	20	6.80
Fertilizer accessibility	Yes	180	61.22
	No	114	38.78
Access to seed	Yes	107	70.41
	No	87	54.08
Seed information	Yes	135	45.92
	No	159	54.08

Appendix 2: -multicollinearity test by VIF

Command: estat vif

Variable	VIF	1/VIF
LTMAI	4.81	0.207866
TNDH	4.44	0.225239
PHM	2.76	0.362171
TMYP	2.05	0.486707
OX	1.67	0.598623
FRCDA	1.42	0.702157
AGH	1.35	0.740835
FMLSZ	1.34	0.747940
EUHM	1.31	0.764835
EULE	1.13	0.888741
DFDP	1.04	0.961741
Mean VIF	2.12	

Appendix 3: - Correlation coefficients

	sxx	mristat	ATC	TLU	CFU	ASRT	SEEDINF
sxx	1.0000						
mristat	-0.6326	1.0000					
ATC	-0.0168	0.0337	1.0000				
TLU	0.0012	-0.0517	-0.0782	1.0000			
CFU	-0.0526	0.0107	0.1491	0.0900	1.0000		
ASRT	-0.0895	0.0564	0.1390	0.0320	0.6464	1.0000	
SEEDINF	0.0072	-0.0189	-0.0045	0.0321	0.1870	0.1637	1.0000

Appendix 4: Propensity score matching summary

Result of the logit model

Number of obs = 294

LR chi2(18) = 196.40

Prob> chi2 = 0.0000

Log likelihood = -95.649046 Pseudo R2 = 0.5066

marchan	Coef.	Std. Err.	Z	P>z	[95% Conf.	Interval]
sxx	-.0751588	.8143704	-0.09	0.926	-1.671296	1.520978
mristat	.0110259	.4060315	0.03	0.978	-.7847811	.8068329
EULE	.1811078	.0907011	2.00	0.046	.0033368	.3588787
FMLSZ	.2262575	.1092317	2.07	0.038	.0121672	.4403477
AGH	-.0145541	.026889	-0.54	0.588	-.0672555	.0381472
ATC	-.0176198	.4776976	-0.04	0.971	-.9538899	.9186502
TNDH	.6040935	.5620187	1.07	0.282	-.4974428	1.70563
LTMAI	-1.618542	.9413255	-1.72	0.086	-3.463506	.2264225
DFDP	-.0939842	.1900678	-0.49	0.621	-.4665103	.278542
TLU	2.248031	1.29363	1.74	0.082	-.2874368	4.783499
OX	-.0085567	.2717452	-0.03	0.975	-.5411675	.5240541
CFU	1.249217	.531232	2.35	0.019	.2080216	2.290413
ASRT	1.225965	.6616907	1.85	0.064	-.0709246	2.522855
PHM	.0025605	.0015233	1.68	0.093	-.0004251	.0055461
TMYP	.0161386	.023003	0.70	0.483	-.0289464	.0612237
EUHM	.1082771	.0655341	1.65	0.098	-.0201674	.2367215
FRCDA	.3947564	.1193197	3.31	0.001	.1608941	.6286187
SEEDINF	1.558978	.4214686	3.70	0.000	.7329148	2.385041
_cons	-9.820367	2.13503	-4.60	0.000	-14.00495	-5.635785

Propensity score distribution

Group	Observation	Mean	Std	Min	Max
All	294	.3669946	.3531673	.0000249	.9999993
Treated	109	.7165443	.2514731	.0033446	.9999993
Control	185	.1610437	.2155653	.0000249	.9924885

```
. sum _pscore,detail

                psmatch2: Propensity Score
-------------------------------------------------------------
      Percentiles      Smallest
 1%     .0001557       .0000249
 5%     .0017737       .0000647
10%     .0051515       .0001557       Obs                 294
25%     .0431607        .000176       Sum of Wgt.         294

50%     .2336376                      Mean           .3669946
                        Largest       Std. Dev.      .3531673
75%     .7296974       .9993952
90%     .9398732       .9999963       Variance       .1247271
95%      .972363       .9999985       Skewness       .5562167
99%     .9999963       .9999993       Kurtosis       1.767645
```

Common support region for varies algorithms

Matching Algorithm	Treatment assignment	Off-support	0n-support	Total
NN (1)	Un-treated	21	164	185
	Treated	8	101	109
NN (2)	Un-treated	21	164	185
	Treated	8	101	109
NN (3)	Un-treated	21	164	185
	Treated	8	101	109
NN (4)	Un-treated	21	164	185
	Treated	8	101	109
NN (5)	Un-treated	21	164	185
	Treated	8	101	109
Caliper (0.01)	Un-treated	100	85	185
	Treated	59	50	109
Caliper (0.1)	Un-treated	21	164	185
	Treated	8	101	109
Caliper (0.25)	Un-treated	21	164	185
	Treated	8	101	109
Caliper (0.5)	Un-treated	21	164	185
	Treated	8	101	109
Kernel (0.01)	Un-treated	100	85	185
	Treated	59	50	109
Kernel (0.1)	Un-treated	21	164	185
	Treated	8	101	109
Kernel (0.25)	**Un-treated**	21	164	185
	Treated	8	101	109
Kernel (0.5)	Un-treated	21	164	185
	Treated	8	101	109

Average treatment effect for treated and un-treated groups

Variable	Matching estimator	Treated	Control	Difference	Stand. Error	t-test
Annual income	Unmatched	49003.6697	29959.4595	19044.2103	1914.06857	9.95
	Matched	45391.0891	34387.6201	11003.469	2977.52801	3.70
Yield gained	Unmatched	30.6146789	16.7945946	13.8200843	1.45026707	9.53
	Matched	27.5544554	22.4338186	5.1206368	2.12832215	2.41

Sensitivity analysis

. rbounds rho, gamma(1(0.25)3)

Rosenbaum bounds for rho (N = 101 matched pairs)

Gamma	sig+	sig-	t-hat+	t-hat-	CI+	CI-
1	0	0	27	27	25	29
1.25	2.9e-15	0	26	27.5	24	30
1.5	5.1e-13	0	25	28.5	23	31
1.75	2.1e-11	0	24.5	29.5	22.5	32
2	3.4e-10	0	24	30	22	32.5
2.25	2.9e-09	0	23.5	31	21.5	33.5
2.5	1.7e-08	0	23	31	21	33.5
2.75	7.0e-08	0	22.5	32	21	34.5
3	2.3e-07	0	22.5	32	20	35

gamma - log odds of differential assignment due to unobserved factors

sig+ - upper bound significance level

sig- - lower bound significance level

t-hat+ - upper bound Hodges-Lehmann point estimate

t-hat- - lower bound Hodges-Lehmann point estimate

CI+ - upper bound confidence interval (a= .95)

CI- - lower bound confidence interval (a= .95

Appendix 5: -Questioner

Dear respondents,

I am GetahunYigezu. I am a graduate student from Jimma University writing my thesis as a part of the fulfillment of the Masters in economics. My research aims at understanding and explaining the determinants and welfare effect of improved seed adoption: A case of smallholder farmers in Sokoru Woreda, Jimma Zone.

The information you provide in this questioner extremely important only for research studies and seen only by researchers and my advisors who are responsible to supervise the progress of the research. Therefore, you kindly requested to give realistic information confidentially by yourself.

I thank you in advance for your willingness!

Kebele _____ date _____

Village name_____

Instruction: Start with Fill the responses in the space provided or circle alternative response (s) where appropriate and write your idea based on given question.

Part A: Structured questioner

I. Demographic & geographic information

Respondent identification number:

(1) For maize seed multipliers, (**0)** for other hybrid maize seed users (customers)

1. Sex of the household head: 1. Male 2. Female

2. Marital status of the household head: 1. Single 2. Married 3. Divorced 4. Widowed

3. The educational level of respondent: _____ grade

4. How many members of families? Female _____ 2.Male _____ 3. Total_____

5. Age of Respondent _____years

II. Socio-economic characteristics

1. How much is the estimated annual income of your family? _____ ETB

   1.1 Major source of household income: 1. on farm activities 2. Non-farm activities

2. Do you have access to credit to purchase seed? 1. Yes 2. No

   2.1 If yes for question, 2 fill the following table.

Name of credit service	Credit in Birr	Year	Repayment year	Source of income for repayment

   2.2 What are the major problems you faced to get credit?

   1. Shortage of capital 2. Interest rate is high

   3. Bureaucracy 4. Distance from their house

   5. If other _____

3. Input utilization for maize production in 2010/2011 EC cropping season

   3.1 Total land holding of the household _____ hectare

   3.2 Land allocation for maize crop _____hectare

   3.3 Fertilizer used: DAP _____kg UREA _____kg

   3.4 Yield gained _____ quintal

4. Distance of farmers home in km …

   1. From Development agent office _____km
   2. From woreda agriculture office _____km
   3. From local market _____km
   4. From seed source _____km

5. Is there access market to sell your product? 1) Yes 2) No

6. Do you have livestock? 1. Yes 2. No

III. Status of agricultural technology

1. Is there access any agricultural inputs at your environment? 1. Yes 2. No

1.1. If yes for question 1, what is the main agricultural input used for the farming activity (on the farmland)? More than one is possible 1. Fertilizer 2. Improved seed

2. Did you use improved maize seed variety during 2010/2011EC cropping season?

a. Yes b. No

2.1. If yes how much? _____kg

2.2.If yes Total land coverage by hybrid maize seed _____ha

2.3.If yes yield gained in 2010/2011 EC production year? _____ (In quintals)

3. Did you purchase maize seed in 2010/ 2011 EC crop year? 1. Yes 2. No

3.1.If yes from where did you get improved hybrid maize seed? (multiple choices are possible) circle on your choices

1. From contract body (JCU) 2. WOA 3. Pioneer hybrid 4. If other _____

4. By What means did you get the improved seed from the source?

1. Cash 2. Loan 3. Other (specify) _____

5. If in cash for question 4 above by price per kilogram? _____

6. Did you get the required amount of seed with the package size of your interest?

1. Yes 2. No

6.1. If yes for question 6, by what pack size? _____ Kg

7. In 2009/2010 cropping year yield gained from hybrid maize _____quintal

8. For how many years you plant hybrid maize _____years

9. How do you rate amount of hybrid maize used from year to year? 1) In increase rate 3) at the same amount 4) in decrease rate

IV. Communication and capacity building

1. What is your source of information about the seed system available? More than one answer is possible. 1. Radio 2.TV 3. Another farmer 4. DA
2. Is there any training given by seed suppliers on improved hybrid Maize varieties?

1. Yes, 2. No

2.1. If yes for the above question training on what? (Multiple choices are possible)

1. Quality of seed 2. Ways of application 3. 1& 2

3. Is there a Development Agent (DA) in your kebele? 1. Yes, 2. No

3.1. If yes, what types of service you get from them?

1. Technical advice 2. Input use 3. Credit use

3.2. How often the extension agent (DA) contacted you in a month? _____

4. Do you have access to information on the seed system? 1. Yes, 2. No

For seed multiplier

1. Have you ever participated in maize seed multiplication during 2010/2011? Yes=1 No=0

1.1. If yes, from where you get hybrid maize?

1. WOA 2. Directly from the union (contract)

1.2. If yes, land allocate for maize seed multiplication _____he

1.3. If yes, seed use in _____kg

1.4. If yes, yield gained _____quint.

1.5. If yes, price paid for seed _____ birr/Kg

1.6. If yes, fertilizer use, DAP _____Kg/he UREA _____Kg/ha

2. To whom did you sell the maize seed you produce?

2.1. To your contractor---------- Birr/quintal

2.2. To cooperative(s) ---------- Birr/quintal

2.3. To local market and neighbors for seed----------Birr/quintal

2.4. Use for own seed consumption----------kg

2.5. Use for own grain consumption----------kg

2.6. To the local market for consumption---------- Birr/quintal

3. Which market system is better for you to get seed at the needed time?

1. WOA 2. Directly from the union (contract)

4. Which market system is better for you to get the required amount that you want to purchase?

1. WOA 2. Directly from the union (contract)

4. What is/are a major advantage(s) of acquiring hybrid maize seed directly from the union (contract) (Multiple choices are possible

1. Easy to access / shorter process to buy/ 2. Quality assurances

3. Affordable prices 4. Timely supply

5. What is/are the disadvantage(s) of acquiring the seed directly from the union (contract)? (Multiple choices are possible)

1. High price 2. No supply on needed time 3. No supply on required time

6. How much did you pay when you buy from WOA? _____

7. How much did you pay when you buy from union (contract)? _____

8. Is there a price difference between two marketing system WOA and directly from the union (contract) / on the same amount & variety? 1. Yes, 2. No

9. What is/are the reason(s) for participating in maize seed production in contract farming? Multiple answers are possible (Circle)

Market access for input =1 price protection =2 credit support =3Technical support =4 guaranteed market for output =5 guaranteed for stable income =6Others =7

10. What were the major problems in maize seed marketing in your area in the 2010/2011 crop year?

Lack of market information =1 lack of road/ transport =2 lack of market places =3

The low purchasing power of people =4 low buyer and seller =5 lack of storage facility =6

Low output price =7 other =8

11. How much you expense for production of the maize seed multiplication:

_____

_____

12. What benefit did you achieve in participating seed multiplication?

_____

_____

13. What benefit did you lose in participating seed multiplication?

_____

_____

14. What are the major constraints in the existing maize seed production and marketing arrangement?

_____

_____

Part B: checklist for Focus Group Discussion Issues within selected farmers

1. Quality of seed

1.1. How you can understand the quality of seed?

1.2. Is it suitable within agro-ecologies?

1.3. How you can rate seed varieties within its quality?

2. Varieties

2.1. You can get required variety in your local?

3. Marketing system

3.1. You can get the required quantity of seed in time you went?

3.2. How you can rate the price of seed within the farmer's purchasing power?

3.3. From where you get the hybrid seed?

4. What you can say on the roles and responsibility of stakeholders those take part in marketing and production of hybrid maize seed?

5. What challenges faced in the production and marketing of seed?

6. Is there access agricultural inputs and creditin your local?

7. What must correct in smoothing production and marketing of hybrid maize?

Part C: cheek-list for interview with woreda agriculture office

1. How do you explain existing hybrid maize seed production and marketing?
2. What about demand assessment for hybrid maize seed in Sokoru woreda?
3. How hybrid maize seed distributed in kebele level?
4. What do you think serious problem in hybrid maize seed production and marketing that need immediate solution?
5. What was suggested in smoothly hybrid maize seed production and marketing?
6. What ware stakeholders, their role and working to gather status in production and marketing of hybrid maize seed in Sokoru woreda?

Part D: Data gathered from secondary sources

Existing maize production system:

1. Total cultivated land in the woreda (area by ha) ……

2. Total maize cultivated land in the woreda (area by ha) ……

3. Production and marketing cost for maize seed multiplication and hybrid maize seed by market participants

4. Total area covered by maize (area by ha): ……1: Local (area, ha):2: Hybrid (area, ha):
5. Of hybrid maize seed production demand & supply system from 2010-2011 EC

T.L	Subject	Year	
		2010	2011
1	Total household hybrid maize required, Kg(DD)		
2	Hybrid maize required for cultivation, Kg(DD)		
3	Hybrid maize supplied, Kg(SS)		

4	Local price for maize seed production,(ave p/kg)		
5	Local price maize grain for home consumption,(ave p/kg)		
6	Selling price of hybrid maize seed to farmers, (ave p/kg		

6. Maize area harvested, yield and production from 2010-2011

Year	Stated/expected demand in quintals	Actual hybrid maize supplied to the Zone	Actual hybrid maize supplied to the woreda	Hybrid maize sold to farmers/actual demand
2010				
1011				

7. Maize area harvested, yield and production from 2010-2011

Local			
Year	Area harvested(hectares')	Yield(Kg/ha)	Production(quintals)
2010			
1011			
Hybrid			
2010			
1011			

8. Hybrid maize selling price 2010-2011 EC

T.L	Subject	Type of variety	Year	
			2010	2011
1	Public seed producer selling price to BoARD(ave p/kg)			
2	Private Hybrid Maize selling price to BoARD(ave p/kg			
3	BoARD selling price to woreda (ave p/kg)			
4	Woreda selling price to farmers (ave p/kg)			